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Carinata, the Sustainable Crop for a Bio-based Economy: 2018–2019 Production Recommendations for the Southeastern United States[1]

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Brassica carinata (carinata) is an oilseed crop with potential for profitable cultivation in the southeastern US. Its high oil content and favorable fatty acid profile make it suitable for the biofuel industry as a biojet fuel. The UF/IFAS North Florida Research and Education Center (NFREC) in Quincy, Florida has been working to identify advanced carinata varieties that are high-yielding (seed and oil), disease-resistant, early-maturing, and adapted to southeastern US. The work at NFREC is in conjunction with Agrisoma Biosciences Inc., a private sector partner with the world's largest, most advanced carinata breeding program. Agrisoma is developing varieties for global commercialization including southern US, the northern prairie states, southern Canada, South America, Europe and Australia.

Figure 1. From field to flight.
Credits: David Wright, UF/IFAS (field, seed); Thinkstock (oil); ARA (plane)

1. This document is SS-AGR-384, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date December 2014. Revised October 2015, December 2018, and January 2019. Visit the EDIS website at https://edis.ifas.ufl.edu for the currently supported version of this publication. This research is supported by the Florida Department of Agriculture and Consumer Services Office of Energy grant SRD007 and focuses on the development of best management practices, demonstration of commercial potential, and feasibility of the presscake as a feedstuff. Our research partner, Applied Research Associates, FL, USA, was also supported through this grant to develop efficient conversion methods for *B. carinata* oil into "drop-in" bio-jet and bio-diesel fuels. The selection of regionally adaptable carinata genotypes with superior agronomic performance and high oil concentration is done in collaboration with Agrisoma Biosciences Inc. and Mustard 21 Canada Inc.

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The "Agronomic Management" section of this publication provides recommendations based on research conducted at the University of Florida (UF). These recommendations are based on research from five years of research at the North Florida Research and Education Center, Quincy, FL and West Florida Research and Education Center in Jay, Florida. The validity of the management recommendations is being verified through continued testing at these locations. These recommendations will be refined through regional testing in Mississippi, Alabama, Florida, Georgia, South Carolina and North Carolina from 2018 to 2022 through the SPARC project.

Early harvest is an important agronomic consideration in double cropping systems. When planted by mid-November and harvested in early May, carinata can be double cropped without lowering yields of subsequent crops. Other key management strategies to maximize yield potential include chisel ploughing followed by rolling or cultipacking to prepare a compact seedbed and planting carinata in 14-inch rows using 5 lb seeds per acre. Elite advanced varieties are currently being tested at multiple locations throughout north Florida and the southeastern US (Mississippi, Alabama, Georgia, South Carolina, and North Carolina) to identify frost-tolerant, high-yielding, early varieties that are adapted to this region. Preliminary findings suggest that carinata provides ecosystem services similar to other winter cover crops, including reduced leaching and soil erosion, suppression of weed populations, improvement of soil fertility through the addition of organic matter, and provision of a food source for pollinators.

Carinata has been grown commercially for several years on the Canadian prairie, in the southeastern US, the US northern plains and Uruguay. For the past five years, UF has conducted research to evaluate management practices that incorporate winter carinata into current cropping systems with minimal modification to existing infrastructure in the southeastern US.

Carinata is agronomically superior and frost-tolerant when compared with other oilseed crops and mustards. It also has relatively high oil content (more than 40%), larger seed size, and lower lodging and shattering rates than other brassica species. Carinata is more heat- and drought-tolerant than canola. However, carinata prefers cooler temperatures, making it well-suited as a winter crop in the southeastern US.

The benefits of growing carinata as a winter crop are two-fold: (1) increased revenue for farmers and (2) ecosystem services. Growing carinata following summer row crops and pastures may be a viable option for many producers.

Additionally, carinata as a winter crop may help to reduce soil erosion, nutrient losses to water bodies through leaching, increase soil organic matter, and retain soil moisture. Crop diversification also helps to break disease and pest cycles and control weeds.

Carinata is not an invasive plant in the Southeast US. Volunteer seedling emergence in subsequent crops is not an issue when normal site preparation and herbicides are applied for the summer crops.

Background

Carinata Characteristics

Carinata is high in erucic and linoleic acids and has less than 7% saturated fatty acids. These characteristics make it a desirable oil which can be minimally processed into a high quality, "drop-in" biofuel. The oil is considered a non-food oil because it is high in erucic acid (approx. 36%). This makes carinata oil attractive as a biofuel because the 22-carbon chain can be cleaved into two biofuel hydrocarbons, essentially doubling the fuel output for every one erucic acid molecule. Carinata has the potential to help meet renewable energy demands in the US and abroad without displacing feed and food crops.

Carinata Biology

In the early stages of growth, plants resemble collards or mustard. However, carinata becomes highly branched and can grow as tall as 5 to 6 feet. At maturity, it resembles canola. An extensive deep root system, low canopy temperature, and thick, waxy leaves increase the plant's tolerance to heat and drought. The taproots can reach 2 to 3 feet deep with more than 50% of the root system present in the upper 12 inches. In north Florida, the crop cycle ranges from 180 to 200 days (November to May), depending on variety, row spacing, temperature, and rainfall during seed maturation. When planted in early November in Quincy, FL, seedling emergence and establishment of the current commercial variety, Avanza 641, occur between 7 and 14 days after planting (DAP). First bolting occurs at 86 DAP while 50% bolting occurs at 93 DAP. The first flower opens at 96 DAP with 50% flowering at 107 DAP and flowering is completed at 136 DAP. Pod development and maturation occur between 136 and 170 DAP. Flowering and pod set starts from the bottom and progresses to the upper part of the inflorescence with subsequent seed maturation. Pods

are 1.5 to 2 inches long with an average of 10 to 16 seeds per pod and a 1,000-seed weight of 4.2 g.

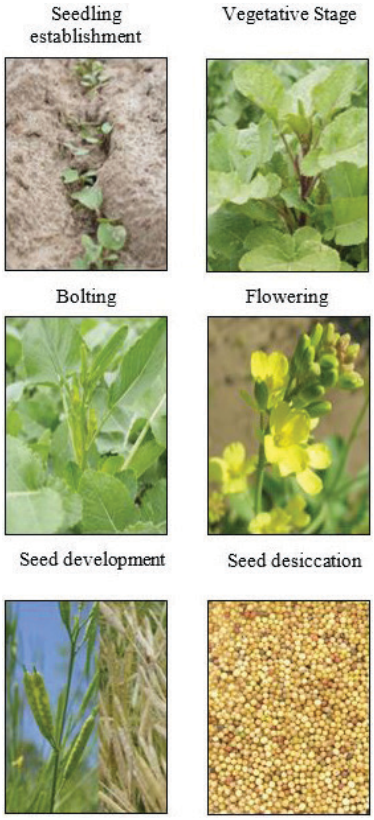

Figure 2. The growth stages of carinata.
Credits: R. Seepaul, UF/IFAS

Agronomic Management

Nutrient Management

The nutrient requirements of carinata are similar to those of canola; therefore, the Production Guide to Canola in Florida (Wright 2010) guides carinata nutrient management decisions until such time that carinata specific recommendations for the deep Southeast can be developed. Soil tests are needed to determine fertility status and pH of the fields where carinata will be grown. It is recommended to follow fertilizer recommendations for canola, except as noted below. Carinata is expected to show a positive response to phosphorus (P) and potassium (K) application if recommended by soil testing labs (Silveira 2014). Carinata grows best on well-drained soils with pH between 5.5 and 6.5. Without the benefit of a soil test, the suggested fertilizer application would be (in lb/ac): 80 N, 40 P2O5, 80 K2O, and 25 S for a yield goal of 60 to 75 bu/ac on loamy sands, and between 100 and 120 N on deep sands. Similar to nitrogen (N), sulfur (S) is important for protein synthesis. Unlike N, S is not mobile within the plant, so a continuous supply of S is needed from seedling emergence to crop maturity. A deficiency of S at any growth stage can result in reduced yields. Split applications of N and S are recommended to avoid early season deficiencies and/or excessive leaching. Avoid applying excessive N at planting since this will increase susceptibility to freeze damage. For sandy loam soils, apply 20 to 30 lb/ac N, 10 to 15 lb/ac S, and all of the P and K fertilizers at planting. Apply the remaining N and S fertilizer at bolting. For deep, sandy soils, a three-way split of N and S fertilizer is recommended to maximize nutrient uptake and minimize N leaching. At planting or at emergence, apply 20 to 30 lb/ac N, 10 to 15 lb/ac S, 50% of the K, and all P fertilizer. Phosphorus may be applied and incorporated prior to planting. Apply 20 to 30 lb/ac N, 10 lb/ac S, and the remaining 50% K at bolting. The remaining N fertilizer should be applied at early flowering. Fertilizer can be broadcast and incorporated at planting followed by topdress, sidedress, or through center pivots at bolting and flowering. Foliar applications may be used to address critical nutrient deficiencies but should be accompanied by a sound soil nutrient management plan. Boron deficiency occurs in coarse, sandy soils with pH greater than 7.0, or during prolonged periods of drought. Use 1 lb/ac of boron either as a preplant broadcast or an addition to N applications.

Tillage

Soil type and previous cropping history will influence the type of tillage necessary to prepare the seedbed. Reduced or minimum tillage may improve water conservation and increase soil organic matter, fuel efficiency, and erosion control. Carinata can be planted into conventionally or minimally tilled soil, or it may be no-till planted in standing stubble. From small plot research, chiseling to about 8-inch depths produced 8% more yield than disking and 33% more yield than no-tillage. These results were consistent with other small grains' response to deep tillage. When carinata is no-till planted into sod or other row crop fields, the previous crop residue should be reduced to minimum stubble height to allow for good seed-to-soil contact.

A fine and firm seedbed allows for good seed-to-soil contact, germination, and uniform emergence. If deep tillage is used (turning plow or chisel plow), the area may need to be firmed with a roller, allowed sufficient time for a rain, or irrigated with enough water to create a firm seedbed.

Variety Selection

Evaluations of advanced lines to identify high-yielding (seed and oil), disease-resistant, early-maturing lines adapted to the Southeast US are ongoing. According to evaluations throughout the past three years, yield ranged from 1750 to 2700 lb/ac. The current commercial variety, Avanza 641, produced approximately 2300 lb/ac (46 bu/

ac at 50 lb/bu), which is higher than yields reported in northern US states and Canada.

Carinata evaluations in the 2017–2018 season identified promising lines with higher tolerance to cold weather, increased shatter resistance, and higher yield potential than the current commercial variety (Figure 3).

Figure 3. Carinata screening at NFREC, Quincy, Florida.
Credits: David Wright, UF/IFAS

Planting Date

Carinata should be planted about 3–4 weeks before the first frost. In the Florida Panhandle, South Alabama, and South Georgia, it is recommended that carinata be planted between early- to mid-November. Figure 4 highlights general planting windows for other regions in the southeast. Earlier and later plantings than recommended may incur high incidence of freeze damage, reduced stand density, and reduced yield. Late plantings may result in increased pest damage and late harvest.

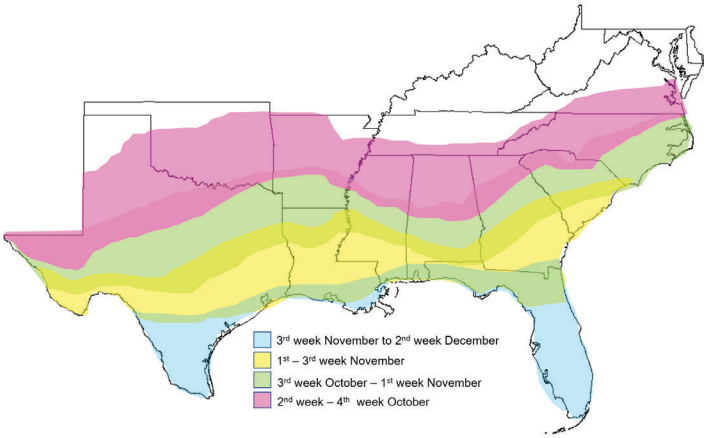

Figure 4. Recommended planting windows across the southeast.
Credits: Agrisoma, 2018–2019 S. Tier Commercial Production Manual

Seeding Depth

Carinata should planted not more than 0.5 inches deep because of its small seed size. Some seed visible on the soil surface is normal and an indication that planting depth is not too deep. That said, greater planting depths should be considered for sandy soils. Fields may be prepared with a drag attached to a cultivator frame to establish a level seedbed. Seed drills should be calibrated to ensure consistent seeding depth and rate.

Seeding Rate and Row Spacing

Carinata should be planted at 5 lb/ac with a target end of season plant density of 6 to 10 plants per square foot. A lower seeding rate (4 lb/acre) is suggested if air or vacuum planters are used. Increased plant densities may reduce the number of days needed to reach maturity as well as reduce yield. If seedbed conditions are less than optimum, higher seeding rates should be considered.

Row spacing a more important consideration than seeding rate (Figure 5, Mulvaney et al. 2018). From small plot research, row spacings of 7 to 14 inches will maximize yield, with a numerical yield advantage at 14 inches compared to 7 inches. Row spacing wider than 14 inches lowers the crop's ability to compete with weeds and results in significant yield reductions.

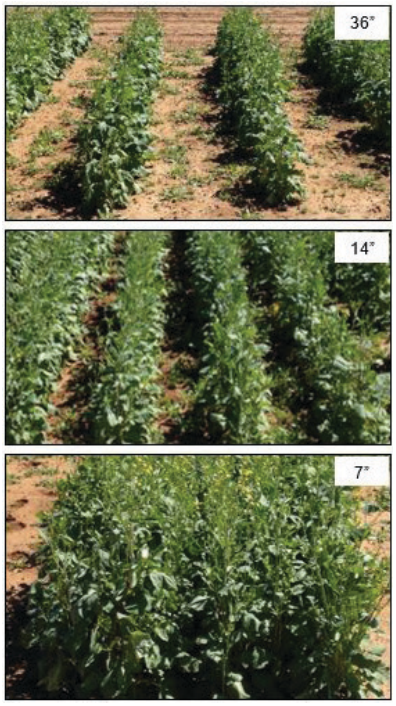

Figure 5. Wide row spacing favors weed growth while narrow row spacings increase shading by carinata canopy and favor weed suppression.
Credits: Ramon Leon, NCSU

Weed Management

Carinata is an aggressive crop and will outcompete many winter weeds. However, wild radish may cause a reduction in harvest value by decreasing oil quality if a significant amount of wild radish seed is included in the harvest. Therefore, identify fields with low weed pressure, particularly for wild radish and wild mustard. These two weeds are more likely to survive carinata registered herbicides and to compete and reduce yields.

It is very important to start the season with a clean field. Therefore, preplant burndown applications with postemergence herbicides with no residual activity such as glyphosate, glufosinate, paraquat, 2,4-D or carfentrazone are important especially in no-till or reduced-tillage fields. These applications must be done at least 7 days before planting. A preplant soil incorporated (PPI) application of a residual herbicide such as trifluralin or ethalfluralin will reduce weed pressure during the first 4 to 6 weeks of the growing season giving time to carinata to get established and grow taller than the weeds.

Planting in narrow rows (no more than 14 inches and preferably 7.5 inches) and using high seeding rates (at least 5 lb/acre) will favor rapid canopy closure and weed suppression. Carinata has wide leaves that can shade the ground and reduce weed emergence and growth. If you have weedy fields, limit your nitrogen fertilization at planting to the minimum recommended. This will reduce the number of weeds emerging with the crop (Figure 5).

Carinata falls into EPA Oilseed Crop Group 20 and Rapeseed Subgroup 20A (Protection to Environment 2016) where permanent tolerances for a number of selective herbicides have been published in the Federal Register, which supports regulatory approvals without additional residue research. Carinata tolerance to commercially available herbicides is still being studied. There are several products available for weed control (Table 1). *Check label information for restrictions before planting carinata*.

Currently, there are no selective herbicides for control of broadleaf weeds once carinata is established. However, grass herbicides including sethoxydim, quizalofop and clethodim are safe to use on carinata and can help control grassy weeds. There are populations of perennial ryegrass that have evolved resistance to those herbicides. In those cases, the use of PPI herbicides is critical.

Carinata is susceptible to residual herbicides, such as Cadre (imazapic), commonly used in cotton-peanut rotations, so it is critical to consider the herbicide history of the field before planting. Herbicides used in cotton-peanut rotations may reduce carinata establishment, growth, and yield. Most residual herbicides used in other summer rotational crops such as corn, cotton, and soybeans should not represent a major risk for carinata establishment as long as they are applied in early in the spring and rotational intervals are met. Table 2 provides canola's crop rotation restrictions for some of the most restrictive residual herbicides due to their persistence in the soil. This table may be used as a preliminary guide for carinata rotation intervals.

Tillage before planting can help eliminate early emerging weeds that will be competing with the crop. Cultivation is not recommended for narrow rows to avoid crop damage.

Disease Management

Carinata disease management is similar to that of canola and other mustards. Scouting for disease is a necessary preventative measure. Like other Brassica crops, carinata should not be grown every year on the same field but once every three years to reduce disease problems. Trials and development of recommendations for fungicide use on carinata are ongoing. Table 3 lists approved fungicides for carinata. The following are diseases found during the past three years at NFREC.

Figure 6. Fungicide application, Quincy, FL.
Credits: David Wright, UF/IFAS

Sclerotinia Stem Rot or White Mold

Sclerotinia stem rot, also known as white mold, is caused by *Sclerotinia sclerotiorum,* which may infect carinata at any stage of development. It grows well in wet environments, especially after prolonged rainfall or irrigation. Symptoms in the early stages include soft watery lesions or areas of very light brown discoloration on the leaves, main stems and branches. Lesions expand, become greyish white, and may have faint concentric markings (Figure 7). Under wet conditions the fungus may produce white, fuzzy growth from infected tissue (Figure 7). Dark or brown stem lesions

may also occur. When the stems of diseased plants are split open, hard black fungal resting bodies (sclerotia) may be seen. These structures may be about the size of a carinata seed or up to 0.8" long and oblong. Under some circumstances these sclerotia and white moldy growth may occur on the outside of the plant. Sclerotinia may cause premature seed ripening, shrunken seeds, and shattering. Currently, it is not considered a serious problem in the Southeast US and should be manageable if proper rotation cycles are followed. If disease risk is sufficient to justify a fungicide application the typical target window for application is between 20 to 50% bloom. If plants are damaged due to cold temperatures but it looks like the crop will survive, a preventative fungicide application may be considered to protect the damaged plants from *Sclerotinia sclerotiorum*.

Figure 7. Sclerotinia stem and pod infection.
Credits: R. Seepaul, UF/IFAS

Alternaria Black Spot

Alternaria black spot is caused by a fungus (*Alternaria* spp.) that infects leaves, stems, and pods (Figure 8). Symptoms begin with small, dark, circular lesions or spots that expand if conditions are favorable and may lead to leaf drop. Lesions can multiply rapidly and later spread to the upper leaves, stem and pods. Stem and pod lesions first appear as small brown or black dots that may develop into conspicuous spots or longer and wider lesions of various shapes. Pod infection may cause seed just beneath the black spots on the pods to be small, shriveled, and grey to brown. Infected pods may ripen prematurely and shatter while the crop is standing or being harvested. Alternaria is typically present every year but the severity of the disease varies from year to year based on the suitability of the environment for the disease (temperature and humidity). Black spot epidemics begin to intensify at flowering and reach their maximum intensity in late stages of crop development. Currently, Alternaria is not considered a serious problem in Florida.

Figure 8. *Alternaria* infection on leaf, stem, and pod.
Credits: R. Seepaul, UF/IFAS

Fusarium spp.

Fusarium seed rot compromises seed quality by specifically reducing oil content and test weight. Warm temperatures and extended periods of moisture promote infection and disease development at maturity. Plantings in November seldom have a problem if harvested in a timely manner, as conditions become more favorable for Fusarium with June harvests. The crop should be harvested as soon as seeds are 10% moisture or less. Crop rotation is a particularly important part of disease risk reduction, because Fusarium survives in crop residue.

Turnip Mosaic Virus

Turnip mosaic virus (TuMV) symptoms include mosaic or mottled pattern on leaves in broad, yellow, circular, and irregular areas (Figure 9). The disease may also cause distortion and stunting of plants. It survives in weeds or alternate host plants outside the growing season and is spread from these infected plants into crops by aphids which act as vectors for virus transmission. Wild radish is likely to be the most important weed host, but the virus does have a wide natural host range and many weed species can act as reservoirs for infection. TuMV is transmitted by many aphid species. Fortunately, aphids are normally not as prevalent during periods of frost or cool weather in the winter season and late season infections in spring are less likely to have an impact on yield. To help manage this disease try to control broadleaf weeds (especially over summer) to reduce this potential reservoir for the viruses.

Insect Management

As a new crop in the region, there is a need for an inventory of the pest species associated with this crop and documentation of their ecology when feeding on carinata. Specific information about pest biology when feeding on this crop and the relationship between pest injury and yield loss in seed production and oil content are needed to establish IPM strategies (Baldwin et al. 2018). Carinata is in the same family as canola, other mustards, and cabbage, so it is expected to share similar insect pests. Potential pests may

include aphids (such as root aphid), cabbage seedpod weevil (*Ceutorhynchus obstrictus*), silverleaf whitefly (*Bemisia argentifolii*), and worm complex, which includes diamondback moth (*Plutella xylostella*), cabbage looper (*Trichoplusia ni*), and imported cabbageworm (*Pieris rapae*). Preliminary pest survey indicates performed in commercial and experimental fields indicated that diamondback moth and yellow margined leaf beetle were the predominant species associated with commercial fields of carinata (Moore et al. 2018). Currently, there is no data concerning economic thresholds for control decisions although studies have been performed to document the relationship between pest injury and yield loss in carinata. The recommendation is sampling of the crop, by plant inspection to detect initial infestation of pests. Table 3 provides a list of insecticides registered for use on carinata. *Check label for restrictions.*

Figure 9. Turnip mosaic virus on carinata.
Credits: R. Seepaul, UF/IFAS

Figure 10. Whiteflies on carinata.
Credits: Paula-Moraes, UF/IFAS

Figure 11. Larva of yellow margined leaf beetle and defoliation on carinata.
Credits: J. Baldwin, UF/IFAS

Harvest Management

Harvest aids are used to accelerate carinata harvest maturity, improve crop uniformity, and desiccate weeds and green tissue (pods, stems). Using harvest aids may also result in increased harvest efficiency and reduce potential shatter loss which may or may not occur depending on weather.

Carinata has a high level of resistance to pod shattering, however, timing, proper machine adjustments, and harvest methods are critical for optimum yield and quality. In the SE, harvesting can be delayed due to continuous erratic wet periods in late spring. Green stems, weeds and uneven ripening can also hinder optimum harvest. The application of harvest aids enables uniform crop ripening by drying down all green vegetative growth. To optimize yield and seed quality, the crop must be physiologically mature before harvest aids are applied.

Carinata seed is physiologically mature when the seed color changes from green to light green. Leaf, stem or pod color change may not be predictors of physiological maturity. Normal seed desiccation progresses rapidly, indicated by a drop in moisture content from 50% to 10% in 4 weeks. A harvest aid can be applied when >70% of the seeds are physiologically mature. At this time, the upper branches and pods will be brown, however, the main stem may remain slightly green.

Harvest aids are suggested but not required.

Reglone (diquat dibromide) and Sharpen (saflufenacil) are labeled for use on Carinata as harvest aid desiccants.

Reglone is a contact herbicide that is activated by light reactions in the plant. When applied on sunny days, Reglone is activated as soon as the product comes in contact with the plant surface. It is recommended to apply Reglone in the evening or on cloudy days to allow the active ingredient to cover the plant surface for improved efficacy (quicker burn and dry down). Efficacy will be maximized with highest volumes of water that is feasible (20 gallons/acre or more but will work with lower rates).

Another option is Sharpen that has a mode of action similar to Reglone but is also translocated. Similar to Reglone, allow up to 7 days for optimum desiccation effect depending on environmental conditions.

When the moisture content < 10%, carinata may be combined using the machine settings and screens for rapeseed outlined in the operator's manual and fine-tuned for conditions in the field.

Optimized harvest methods will reduce seed loss that occur at the combine header, seed leaks, loss during threshing, separating, or cleaning. To minimize harvest seed loss, monitor and quantify the seed loss behind the combine and adjust the combine settings to crop and field conditions to reduce these losses.

How to minimise harvest losses?

1. Application timing of harvest aid should be optimized to minimize loss of seed yield.

2. The weather forecast and condition of the crop are important factors to consider when applying harvest aids. Harvest aids will need about 7–10 days to be effective. Plan on harvesting as soon as the seed moisture is 10% or less. Seeds will deteriorate if allowed several cycles of wetting and drying.

3. Use the machine settings for rapeseed outlined in the operator's manual. Settings will have to be adjusted and fine-tuned depending on crop moisture and harvest conditions. It is essential to have the proper screens and combine settings to reduce dockage and loss of seed. An example of average recommended John Deere S-Series Combine setup for canola (deere.com) is:

    a. Feederhouse Chain Speed—26T
    b. Feederhouse Drum Down
    c. Feed Accelerator on High Speed
    d. Serrated Feed Accelerator Wear Strips are recommended
    e. Backshaft Speed—510rpm / 1st Gear 5 Speed
    f. Cleaning Fan speed—750rpm, 600–900 working range
    g. Rotor Speed—450rpm, 350–550 working range
    h. Concave Clearance—20, 15–40 working range
    i. General Purpose Chaffer—13mm, 10–14mm working range
    j. High Performance Chaffer if equippped—12–16mm + increase fan 100rpm
    k. Dual Zone Chaffer—manual adjust 5mm Level Land/10mm Hills
    l. General Purpose Sieve—3mm, 2–5 working range
    m. Match reel speed with ground speed. Set fingers straight up and down to minimize wrapping.

4. Cut carinata as high as possible, just below the seed pods, to minimise the amount of biomass to be threshed. Pulverized high moisture residue or straw may fall onto the sieves thereby reducing the air flow and separation while increasing the seed loss.

5. Check periodically for seed loss behind the combine and adjust settings if necessary for optimized harvest.

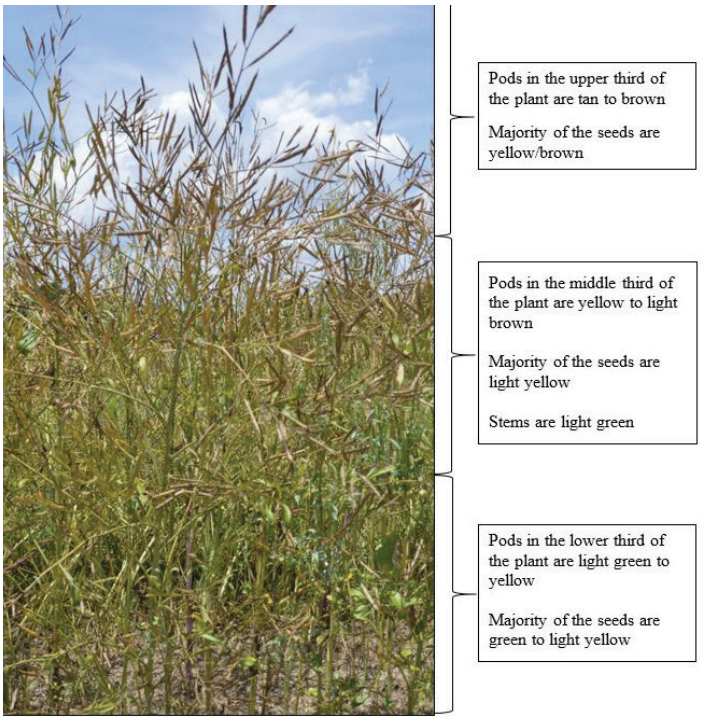

Figure 12. Harvest aids may be applied when >70% of the seeds are physiologically mature or when the upper branches and pods turn brown. At this stage, the main stem may remain slightly green. Credits: R. Seepaul, UF/IFAS

Carinata Economics

Carinata economics are like those for any regular cash crop. Inputs, yields and market prices determine profitability of carinata. While carinata does require more inputs than a normal cover crop to realize economic benefits, the crop is relatively easy to grow and can provide an economic return without major investment. Table 4 shows the net return per acre based on yield and market prices.

Crop Insurance

Carinata is eligible for crop insurance under the canola and rapeseed crop provisions by written agreement with USDA Risk Management Association (RMA). This requires 3 years of cool season small grain yields (wheat, oats, etc.) determined by grain harvested and delivered to elevator with tickets proving yields. If this data is not available producers may be eligible for the Noninsured Crop Disaster Assistance Program (NAP) from USDA Farm Services Agency (FSA). For new farmers, application is due on the acreage reporting date (January 15) for canola/rapeseed program counties and on the sales closing date (September 30) for non-program counties. Carinata crop insurance costs are estimated to be between $15–25 per acre as shown in Table 1. It is highly recommended you discuss carinata insurance options with a licensed insurance agent.

Carinata Markets

Carinata is an oilseed that produces a premium, industrial oil and high-quality animal feed. The oil can be converted into a host of industrial products including high performance jet fuel. The meal is certified as a high protein cattle feed similar to soy meal and studies are underway to certify the meal for use as feed for poultry, swine and aquaculture. In addition, because it is grown in the cool season there are many environmental benefits associated with carinata that increase its value for specific applications. Due to these diverse markets and environmental benefits carinata often has a premium price as compared to traditional oilseed. For more information contact your local Agrisoma representative for market details.

SPARC—Southeast Partnership for Advanced Renewables from Carinata

SPARC is a collaboration of regional land grant universities, and industry partners representing subject matter experts in basic and applied research, extension and outreach and workforce development. The three pillars of research, extension and workforce development collaboratively support our five-year goal of establishing over 800,000 acres of carinata as a viable winter crop in the Southeast US, resulting in a carinata centered advanced renewables and coproduct supply chain in the region with national and global impact. SPARC has a twofold mission of removing physical, environmental, economic and social constraints of regional Brassica carinata production as a renewable fuel, bioproducts and coproducts feedstock and ensuring stable markets for jet fuel and bioproducts through demonstration of enhanced value across the supply chain. Our mission is aligned with USDA's focus of delivering regionally-appropriate sustainable biomass feedstock to produce alternative jet fuel in supply chain systems that may be linked to facilities in proximity to civilian or military aviation hubs.

Collaborative work among University of Florida (UF), Agrisoma Biosciences Inc., holder of the world's largest carinata germplasm collection, and Applied Research Associates (ARA), FL, USA, a chemical engineering company with a patented catalytic hydrothermolysis (CH) technology for conversion of carinata oil into 'drop-in' bio-jet and bio-diesel fuels, has brought this crop to the forefront of advanced biofuel alternatives making it competitive with petroleum.

For more information, visit SPARC's website.

Summary

We have demonstrated the potential of carinata as an oilseed crop for the Southeast US and identified promising varieties that are and will be commercialized as quickly as possible. Baseline management and agronomic production practices have been developed and are continuing to improve.

Establishing carinata as a winter cash crop on underutilized or fallow land will increase diversification, generate revenue, and improve conservation of nitrogen and water, which in turn reduces input costs and increases ecosystem sustainability. Ongoing research at UF and other regional universities participating in the SPARC project in collaboration with Agrisoma Biosciences Inc. is focused on developing region-specific agronomic production recommendations and improved carinata varieties targeted for double crop production in the southeastern US.

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Table 1. Registered herbicides for carinata. Always read and follow label instructions before use.

Timing	Herbicide	Trade name	Weeds	Rate
Preplant burndown	2,4-D amine or ester	various	Broadleaf weeds	0.37–1 lb ai/a
	Carfentrazone-ethyl	Aim EC	Broadleaf weeds	up to 2.0 fl oz/a 0.031 lb ai/a
	Glufosinate	Liberty 280 SL	Most annual broadleaf and grass weeds	29–36 fl oz/a
	Glyphosate	Roundup and others	Most annual and perennial broadleaf and grass weeds	up to1.55 lb ae/a
	Paraquat	Gramoxone and others	Most annual broadleaf and grass weeds	2.5–4 pt/a
Preplant incorporated or Pre-emergence	Ethalfluralin	Sonalan	Broadleaf and grass weeds	Depending on soil texture: Coarse 1.72 lb ai/a Medium 2.34 lb ai/a Fine 3.0 lb ai/a
	Trifluralin	Treflan	Broadleaf and grass weeds	Depending on soil texture: Coarse 0.5 lb ai/a Medium 0.75 lb ai/a Fine 1.0 lb ai/a
Post-Emergence (2 to 6-inch weeds)	Clethodim	Select Max, Shadow	Grass weeds	up to 0.091 lb ai/a
	Sethoxydim	Poast	Grass weeds	up to 0.47 lb ai/a
	Quizalofop-ethyl	Assure II	Grass weeds	up to 0.082 lb ai/a
Pre-harvest (middle pods starting to turn in color)	Saflufenacil	Sharpen	Harvest aid/desiccation	1.0 to 2.0 fl oz/a 0.022 to 0.044 lb ai/a

Table 2. Crop rotation restrictions of some commonly used herbicides for canola based on product label guidelines. Always read and follow label instructions before use.

Trade name	Active ingredient	Crop rotation restriction (months)
Group 2 (ALS-inhibitors)		
Cadre	Imazapic	40
Classic	Chlorimuron	18
Permit or	Halosulfuron-Methyl	15
Sandea		
Pursuit	Imazethapyr	40
Staple	Pyrithiobac sodium	10*
Strongarm	Diclosulam	30*
Group 14 (PPO-inhibitors)		
Reflex	Fomesafen	18
Valor	Flumioxazin	4 to 18**

*With a successful field bioassay.
**Depending on quantity applied and tillage.

Table 3. Registered fungicides and insecticides for canola/carinata on product label guidelines (Florida). Always read and follow label instructions before use.

Fungicide	Disease	Timing	Rate
Aproach (Picoxystrobin)	Alternaria black spot, Sclerotinia stem rot	Varies according to target disease—see label	6 to 12 oz/ac
Endura (Boscalid)	Sclerotinia stem rot	20 to 50% flowering, or prior to onset of disease	5 to 6 oz/ac
Quash (Metconazole)	Sclerotinia stem rot	20 to 50% flowering, or prior to onset of disease	2 to 4 oz/ac
Priaxor Xemium (Fluxapyroxad + Pyraclostrobin)	Alternaria black spot, Sclerotinia stem rot*	Varies according to target disease—see label	4 to 8 oz/ac
Proline (Prothioconazole)	Sclerotinia stem rot	20 to 50% flowering, or prior onset of disease	4.3 to 5.7 oz./ac
Quadris (Azoxystrobin)	Alternaria black spot, Sclerotinia stem rot	Varies according to target disease—see label	6 to 15.5 oz./ac
Tilt (Propiconazole)	Alternaria black spot	Prior to bolting	2.6 to 4 oz/ac
	Pest	**Timing**	**Rate**
Coragen (Chlorantraniliprole)	Diamondback moth	Apply as required by scouting	Varies—see label
Mustang Maxx, Mustang Maxx EC (Zeta- cypermethrin)	Aphid, cutworm, diamondback moth, stink bug	Apply as required by scouting	Varies—see label
Prevathon (Chlorantraniliprole)	Diamondback moth, cutworm, armyworm	Apply as required by scouting	14 to 20 oz/ac
Intrepid (Methoxyfenozide)	Many insects—see label	Apply as required by scouting	2 to 24 oz/ac
*Suppression only.			

Table 4. Net returns as a function of yield and price. Net returns are calculated assuming an average production cost of $275/acre.

Price ($/bu)	Yield (bu/ac)		
	40	50	60
9.0	$87	$177	$267
9.5	$107	$202	$297
10.0	$127	$227	$327
Calculated by R. Seepaul (2018).			