

BIOMASS ENERGY TRAINING CURRICULUM

J. de Koff, R. Nelson, A. Holland, T. Prather, S. Hawkins

This curriculum was developed through a Southern SARE grant and collaboration between Tennessee State University, the University of Tennessee, eXtension.org, and USDA-Rural Development. The objective of this curriculum is to provide training on biomass energy to extension agents and local officials so that they may deliver this information to their stakeholders.



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Biomass Energy Training Curriculum

Collaborators: Jason de Koff, Ramona Nelson, Adia Holland, Tim Prather, Sue Hawkins

Cover design: Brett Seybert

Funding was provided through the Southern Sustainable Agriculture Research and Education (SARE) Program

Tennessee State University
3500 John A. Merritt Blvd.
Nashville, TN 37209

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Jason P. de Koff, Ph.D.
(615) 963-4929
jdekoff@tnstate.edu

Part II: On-farm Biodiesel Production

Agronomics of sunflower and winter canola

Learning objectives:

- Participants will be able to explain the agronomics of sunflower and winter canola production

Materials:

- PowerPoint® slides “Agronomics of sunflower and winter canola”
- Lesson guide: Use the notes in this lesson guide to present information for each presentation slide.

- Factsheet: “Sunflower for biodiesel production”
<http://www.tnstate.edu/extension/documents/Sunflower.pdf>

Factsheet: “Growing winter canola for biodiesel production”
<http://www.tnstate.edu/extension/documents/Canola.pdf>
Copies of factsheets can also be found in the Appendix.

- Questions found at the end of this lesson guide can be used to test participants’ knowledge at the end of the presentation. This can be combined with clickers to improve audience engagement and create discussion.
- An evaluation of the presentation can be found in this lesson guide following the lesson questions.

Topics:

Comparison of biodiesel feedstocks

Sunflower production

Planting sunflower

Fertilizer management of sunflower

Harvesting sunflower

Winter canola production

Planting winter canola

Fertilizer management of winter canola

Harvesting winter canola



Slide 1

The topics of this presentation will involve a comparison of different feedstocks for biodiesel production, and planting, fertilizer management, harvesting and storage of sunflower and winter canola.



Slide 1

Slide 2

This slide shows a good comparison of different oilseed feedstocks based on the expected yields of biodiesel on a per acre basis. Sunflower and rapeseed (canola) are on the upper end of this chart which is why we will be going through the agronomics of growing these for biodiesel production. Soybean has much lower yields because the seed only contains about 20% oil whereas sunflower and rapeseed (canola) have about 40% oil.

Feedstocks

Feedstock	Biodiesel (gallons/acre)	Feedstock	Biodiesel (gallons/acre)
Corn	18	Crambe	65
Oats	23	Safflower	83
Cotton	35	Rice	88
Soybean	48	Sunflower	100
Mustard	61	Peanut	113
Camelina	65	Rapeseed	127

Collins et al. Biofuel Variety Trials

Slide 2

Slide 3

Sunflower is a summer annual crop that produces high oil yields. There are a number of different types of seed which we will get to in the next couple of slides.



Slide 3



Slide 4

North Dakota currently has the most acres of sunflower in production for both oil and non-oil uses. Altogether, according to the 2012 Census of Agriculture there are around 1.9 million acres in sunflower production in the U.S., about 1.6 million acres for oilseed production. Almost half of the total U.S. production comes from North Dakota.

Sunflower production	
State	Oilseed Sunflowers (Harvested acres)
North Dakota	759,145
South Dakota	557,582
Kansas	64,730
Colorado	60,890
California	46,521
Minnesota	37,001
Texas	34,369
Nebraska	30,073
Montana	7,745

Slide 4

Slide 5

There are two different types of sunflower seed, the oilseed (left) and the confectionary (right). The oilseed is the one that we will be focusing on for oil and biodiesel production while the confectionary is the type that we normally eat. There are 3 types of oilseed: standard or linoleic, NuSun or mid-oleic, and high oleic



Slide 5

Linoleic: used to produce a low-saturated fat cooking oil

NuSun: predominant oiltype grown, seeds produce a healthier oil that contains less saturated fat than linoleic types

High-oleic: produce seeds that contain specialty oil very low in saturated fats, used in lubricants and coatings, grown by contract only.

The seed generally contains about 40% oil and 18 to 25% protein whereas soybean contains 20% oil and 40% protein.

Select seeds that have high oil content (at least 40%) and high weight (at least 25 lbs. per bushel) and disease and insect resistance if possible. The oilseed market pays a premium for seeds with high oil contents (>40%). Certain hybrids are also tolerant of herbicides. Clearfield, usually identified by “CL” in the hybrid name indicates that it can use the herbicide, Beyond, which will eliminate broadleaf competition but not harm the sunflower plant.



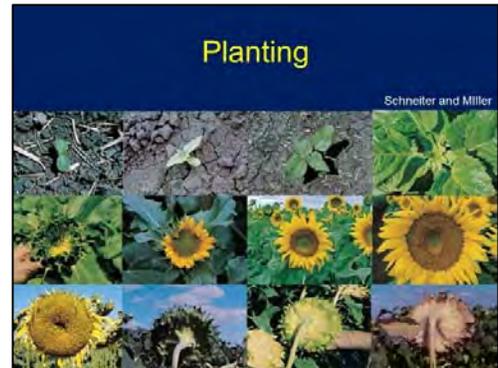
Slide 6

It is recommended to plant once soil has reached 50F. Seeds are generally planted at 1-2 inches depth and take about 4-5 days to emerge if soil is warm, a few days longer in cool soil. 30 inch row spacing is traditionally used.

In early development the heads track the sun so many times the sunflowers are planted in N to S rows so that the plants will lean into the row spaces rather than into each other and cause seeds to fall. Plants will adjust to some extent based on stand density by adjustments in head size, seed size, and number of seeds per head.

Usually want 14,000 to 22,000 plants per acre.

Reaches bloom stage about 65 to 70 days after planting and maturity 105 to 115 days after planting.



Slide 6

Slide 7

Anytime no-till is used, it is a good idea to incorporate crop rotations and pre- and post-emergence herbicide applications to help reduce weed competition. The crop residues remaining on the field from the previous crop help to reduce erosion and weed competition and increase soil moisture and water infiltration. Planting into these residues can cause some issues, however. It is important to use residue managers to at least remove residue from the seeding row prior to planting to ensure even planting and placement for double disc openers. Single disc openers and narrow-point hoe openers have been used successfully for planting into residue.



Slide 7

Slide 8

It is always recommended to take a soil test prior to planting.

Sunflower requires 6 to 7 lbs of N for every 100 lbs of seed production. Therefore a yield of 1500 lbs of seed per acre would require 90-105 lbs N per acre. If wheat or a legume is grown prior, then N rates should be lowered. Excessive N can result in decreased oil content and increased lodging. N can be applied as preplant, sidedress or a combination.

Phosphorus should be applied if soil tests are below medium.

It can be applied as preplant broadcast, preplant knifed, or banded at planting.

Potassium should be applied if soil tests are below medium. Can be applied preplant broadcast and incorporated.

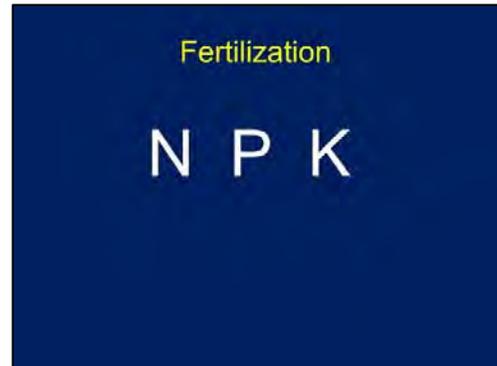
Liming is recommended if pH is 6 or less.

Slide 9

Seeds are mature when the back of the flower head is yellow. When the head turns brown on the back, the seeds are usually ready for harvest.

Platform, row-crop and corn heads can be used to harvest sunflower. Row-crop heads can be used without modifications. Corn heads need to be modified with a stationary cutting knife. Platform heads can be used without modification but can have higher seed and head loss. Adding pans to the front of the platform and/or modifying the reel can improve efficiency.

With threshing you want to pass the head nearly intact through the combine or in a few large pieces with all developed seeds removed from the head. If the head is too ground up it will make the seed trashy. Store at 10% moisture during colder periods, 8% moisture during warmer periods



Slide 8



Slide 9



Slide 10

Canola is a variety of rapeseed that was bred by a Canadian scientist to remove erucic acid and glucosinolates. This can be found in the name as it stands for Canadian Oil of Low Acid. This improved the negative health effects and bitter taste associated with rapeseed, making it edible. One million acres of canola are produced in the U.S. and 90% of this is produced in North Dakota.

Canola contains edible oil low in saturated fats with a high oleic acid/omega-3 content.

The low saturated fat content can also help to improve cold weather performance (double bonds creates a kink in the structure which keeps it from solidifying)

Canola can work into a rotation with soybean or sorghum



Slide 10

Slide 11

In the south, we can grow a winter variety of canola whereas the northern climates (North Dakota and Canada) rely on a spring variety. Within winter canola there are also early and late maturing varieties. Planting both can help mitigate risk in two ways. The early maturing varieties have the highest yields but are susceptible to winter freeze injury. The late varieties are more vulnerable to drought. Therefore, depending on the year, one may perform better than the other. Also, with winter canola it is important to get these out of the field as soon as possible to prevent reduced yields. Planting both early and late maturing varieties allows for extending the harvest window and providing extra time to harvest.



Slide 11

Try to get seed that are resistant to blackleg disease.

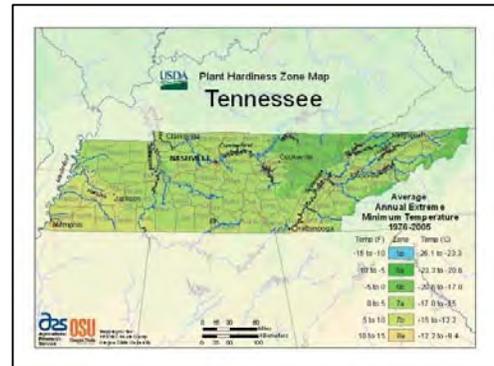
There is winter canola available that has the Clearfield technology which allows growers to use Beyond herbicide to remove broadleaf weeds without harming the canola.



Slide 12

The rule of thumb is to plant about 6 weeks before killing frost. Planting too early or too late can cause winter kill...either the plant has bolted or the plant is too small to make it through the winter. On the USDA Plant Hardiness Zone Map, Zone 7a could plant canola between Sept. 10 – Oct. 15 and Zone 7b between Sept 15 – Oct. 25.

In medium textured well-drained soil, canola can be planted at about ½ inch depth, 6-14 inch row spacing, 5-8 lbs per acre.



Slide 12

Plants can compensate for planting density; more space, plants grow larger.

Slide 13

As with sunflower, it is important to manage the residue properly in no-till systems when planting winter canola. Planting in the residue can lead to a higher crown height and roots may not even penetrate the soil. This could lead to substantial winter loss. Using a harrow or burning the residue can assist with this if the residue is very thick or unevenly distributed. Increasing seeding rate by 15-20% and using a “wavy” coulter (to remove residue from the seed row) can also help to ensure a good stand.



Slide 13

No-till soils are generally lower in temperature than conventionally tilled soils due to the insulation effect of the residue. Therefore, it is a good idea to plant in the earlier part of the planting window to ensure proper germination and development before the first killing frost.

A no-till grain drill with a small seed box like the one in the image can be used for planting no-till winter canola.



Slide 14

Soil testing is recommended prior to fertilizer application to reduce the chance of excess applications. Fertilizer rates are similar to wheat except for N and S. N is usually 20-25% more than wheat. N can be split applied (50:50) in fall and spring. Nearly 40% of N is removed with seed so much N may still be left for summer crop. There is no good fertilizer rate data for winter canola in Tennessee. The recommendations from other nearby states create quite a range of recommendations. In Missouri, the recommendation for N is 90 to 150lbs N /acre. In Virginia, they recommend applying 100 lbs/acre N. Georgia recommends 135 to 180 lbs N/acre.



Slide 14

Canola needs S for proteins, if soil has less than 25 lbs/acre then add an additional 25 lbs/acre.

Apply P, K, micronutrients (Boron, 1 lb/acre) preplant. In Virginia, they recommend applying 100 lbs/acre P and K (if P soil test is medium and K soil test is high). In Missouri, they recommend applying 50-60 lbs P or K per acre.

Lime if pH is below 5.8

Slide 15

The next few slides show pictures from some work done at Tennessee State University. Winter canola was planted no-till using a no-till grain drill with a native seed box that could handle the small canola seeds on October 1st, 2013 at the TSU Agricultural Research and Education Center in Ashland City, TN at a rate of 5.5 lbs/acre. Prior to planting, a field cultivator was used over the field. After planting, preemergent herbicides Prowl (quart/acre) and Gramoxone (pint/acre) were applied.



Slide 15



Slide 16

About 4 weeks later there was good emergence...



Slide 16

Slide 17

By 8 weeks after planting we had some large plants that would be able to make it through the winter.



Slide 17

Slide 18

This slide is after the first polar vortex came through and we had a lot of winter kill. Even in an average year, you will see some winter kill but as long as that growing point in the center of the plant is still viable, it will still come on strong in the spring.



Slide 18



Slide 19

In this case, the polar vortex did not cause any noticeable issues and you can start to see flower production by the middle of April.



Slide 19

Slide 20

By the late May/early June, you start to see the winter canola become mature. It takes about 145 to 160 days from planting for the canola to reach maturity.



Slide 20

Slide 21

This is a picture around the same time but in Franklin County. There are a number of farmers in southern middle TN and northern middle TN that grow winter canola. You can see these plants are becoming mature at about the same time as what TSU had.



Slide 21



Slide 22

This is still in Franklin County on the same day and you can see that the winter wheat is maturing at about the same time. Since the lifecycle of winter wheat is about the same as winter canola these can be rotated with each other. This has been found to increase winter wheat yields and is most likely due to reduced weed, disease and insect competition provided by the rotation.



Slide 22

Slide 23

As mentioned previously, it is important to harvest the winter canola as soon as it is mature. This is usually once the plant has reached about 10% shatter (10% of seed pods on the plant have shattered). The seeds should all be dark like those on the bottom of the slide. Greater than 2% green seeds will lead to a reduction in revenue at the crushing facility. The seed moisture at harvest should be 8-10%. Canola can be harvested directly using a combine with the concave nearly wide open and slower cylinder/rotor speeds. Chaffer and shoe sieves are usually closed more than for wheat. It is also a good idea to patch any holes with duct tape to reduce losses in yield.



Slide 23

Slide 24

Storage is important so that the seed does not get too moist and start to mold. Higher temperatures will lead to a greater risk of moisture than cooler temperatures so it is important to keep the humidity low inside the grain bin/elevator under these conditions. Storage life doubles for every 10 degree drop below 77°F or 1% moisture reduction below 9%.



Slide 24



Test their Knowledge - Questions for the audience

Q: Which feedstock has the highest yield of biodiesel?

A: Rapeseed (Canola)

Q: Which feedstock has the lowest yield of biodiesel?

A: Corn

Canola and sunflower contain 40 % oil while soybeans contain 20 % oil.

T or F If a soil test reveals below medium levels of phosphorus and potassium, there is no need to add more of these for sunflower production.

Sunflowers require 6-7 pounds of N for every 100 pounds of seed production.

Q: What types of equipment can be used to harvest sunflowers?

A: Platform, row-crop and corn heads.

Q: What does the name "canola" stand for?

A: CANadian Oil of Low Acid

Q: What is the difference between canola and rapeseed?

A: Canola was developed by Canadian scientists who found a way to reduce the erucic acid and glucosinolates which improved the negative health effects and bitter taste associated with rapeseed, making it edible.

Plant winter canola about 6 weeks before killing frost.

Except for N and S, fertilizer for canola is similar to winter wheat .

N rate is 20-25% more than wheat and S should be at least 25 lbs./acre.

Canola takes 145 to 160 days to reach maturity.

Evaluation

Please give us your feedback regarding this activity. Your feedback will help us improve the activities you attend in the future.

Name of Activity: Agronomics of sunflower and winter canola	Date of Activity:
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A. Instruction	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. The specialist was well prepared.	①	②	③	④	⑤	⑥
2. The specialist presented the subject matter clearly.	①	②	③	④	⑤	⑥

B. General Learning and Change	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. I have a deeper understanding of the subject matter as a result of this session.	①	②	③	④	⑤	⑥
2. I have situations in which I can use what I have learned in this session.	①	②	③	④	⑤	⑥
3. I will change my practices based on what I learned from this session.	①	②	③	④	⑤	⑥

C. Specific Learning How much <i>did you / do you</i> know about these subjects?	Before this program I knew...					Now I know....				
	Very little	Little	Some	Much	Very Much	Very little	Little	Some	Much	Very Much
1. <i>How to grow sunflower</i>	①	②	③	④	⑤	①	②	③	④	⑤
2. <i>How to grow winter canola</i>	①	②	③	④	⑤	①	②	③	④	⑤

D. Specific Practices To what degree <i>did you / will you</i> do the following?	Before this program I did...					In the future I will realistically do...				
	Very little	Little	Some	Much	Very Much	Very little	Little	Some	Much	Very Much
1. <i>Seek information related to growing sunflower or winter canola</i>	①	②	③	④	⑤	①	②	③	④	⑤
2. <i>Grow sunflower or winter canola</i>	①	②	③	④	⑤	①	②	③	④	⑤
3. <i>Produce biodiesel</i>	①	②	③	④	⑤	①	②	③	④	⑤

E. Satisfaction with Activity	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. <i>I would recommend this program to others.</i>	①	②	③	④	⑤	⑥

F. Other comments?	
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Thank you for completing this survey!

Bioenergy

Sunflower for Biodiesel Production

Jason P. de Koff, Assistant Professor, Richard Link, Research Assistant, Tennessee State University
Contact: 615-963-4929, jdekoff@tnstate.edu, [@TSUBioenergy](https://twitter.com/TSUBioenergy)

Sunflower is a seed crop made up of two distinct types; confectionary and oilseed. The confectionary type is grown for human consumption while the oilseed type can be used for birdseed, food-grade oil, or biodiesel production (Fig.1).



Fig. 1. Confectionary sunflower seeds (left) usually have a striped shell whereas oilseed sunflower seeds (right) usually have a black shell.

Current Production

According to the USDA National Agricultural Statistics Service, there were 1.6 million acres of oilseed sunflowers harvested in the U.S. in 2012. North Dakota currently has the most acres of oilseed sunflower in production (755,000 acres) (Table 1). Other states with high oilseed sunflower production include South Dakota, Colorado, Kansas, California and Texas.

Table 1. Harvested acres of oilseed sunflower in 2012 (National Agricultural Statistics Service).

State	Oilseed Sunflowers (harvested acres)
California	47,500
Colorado	61,000
Kansas	65,000
Minnesota	37,000
Nebraska	29,500
North Dakota	755,000
Oklahoma	3,800
South Dakota	560,000
Texas	33,000

Types of Oilseed Sunflowers

Oilseed sunflower seeds generally contain about 40% oil and 20% protein. There are a few different types of oilseed sunflower seeds that differ based on the type of oil they contain.

1. Linoleic: used to be widespread for low-saturated fat content (11% saturated fat).
2. NuSun or mid-oleic: predominant oilseed sunflower currently grown (estimated at 85% to 90% of oilseed sunflower acres grown in 2007), seeds contain less saturated fat than linoleic types (<10% saturated fat).
3. High oleic: low in saturated fats like NuSun, but higher monounsaturated fat content than NuSun (82% vs. 65%). It is currently grown by contract based on consumer demand.

In general, a gallon of oil from one oilseed crop will produce the same amount of biodiesel as a gallon of oil from a different oilseed crop. The difference lies in the quality of biodiesel produced. Oils high in unsaturated fats (NuSun or High-oleic) may be best for biodiesel quality because their chemical structures can help reduce coagulation in fuel lines under cold temperatures. These sunflower oil varieties generally contain about 91% unsaturated fats according to the National Sunflower Association whereas soybean oil contains about 85% unsaturated fats.

Production Recommendations

It is important to take soils tests prior to planting. University of Tennessee recommendations are 90 to 105 lbs N per acre for typical yields of 1500 lbs seed per acre. Phosphorus and potassium should be applied if soil tests are below medium values. Lime should be applied if pH is 6 or less.

It is recommended to plant once soil has reached 50°F. Based on soil data from a National Climatic Data Center collection site at UT Martin, this can occur between mid-March and mid-April. Seeds are generally planted at 1-2 inches depth and at a rate that will produce 14,000-22,000 plants per acre. Row spacing can be highly variable. At TSU we use a 30 inch row spacing and 10 inch within row spacing. In

early development, the heads track the sun so sunflowers are planted in N to S rows so that the plants will lean into the 30 inch row spaces rather than into each other which could cause seed loss.

Preplant or preemergent herbicides are recommended for weed management as there are no herbicides registered for control of broadleaf weeds in sunflower (one exception is Clearfield® sunflowers which are resistant to imazamox which can be used to control these broadleaf weeds).

Grass-type weeds can be managed once sunflowers have germinated using herbicides containing clethodim or sethoxydim. Broadleaf weeds can only be managed using tillage between rows up to the 4-6 leaf stage.

Other pest problems may include fungi and insects. Sunflowers are drought tolerant but wet periods may cause fungal issues. There are hybrids available with resistance to certain fungi but crop rotation can also help avoid these problems. For insects, those that attack the seed or those that infest the vegetation during the early formation of the bud (R1-R3 growth stages) are the most important to manage using recommended integrated pest management techniques because these may reduce yields. Insects that affect the foliage prior to bud growth are usually not so extensive as to have a significant effect on yield.

Harvesting Seeds

At the Tennessee State University Agricultural Research and Education Center (AREC) in Nashville, NuSun and high-oleic varieties of sunflowers bloomed about 8 to 9 weeks after planting (Fig. 2) and began to mature (senesce) around 10 to 11 weeks after planting (Fig. 3). Sunflowers are usually fully mature by 15 to 17 weeks after planting.



Fig. 2. Sunflowers in bloom at Tennessee State University AREC in Nashville.



Fig. 3. Sunflowers in the beginning stages of senescence at Tennessee State University AREC in Nashville.

Seeds are mature when the back of the flower head is yellow, and when it is brown it can usually be harvested. Seed should have 18-20% moisture or less when harvesting and a conventional grain combine with a sunflower head attachment can be used.

Oil Yields

In a 4 year (2004-2007) field trial conducted by the University of Tennessee, average yields were 1296 lbs seed per acre. At 40% oil content this gives about 518 lbs oil per acre. In comparison, a 5 year (2009-2013) field trial of soybeans also conducted by the University of Tennessee observed an average yield of 2340 lbs seed per acre. Soybeans, however, have a much lower oil content (~20%), and give an overall value of 468 lbs oil per acre. In other words, sunflower production yields about 50 lbs more oil per acre than soybeans.

References and Resources

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Dean - Dr. Chandra Reddy, Associate Dean for Extension - Dr. Latif Lighari

Bioenergy

Growing Winter Canola for Biodiesel Production

Jason P. de Koff, *Associate Professor*; Chris Robbins, *Extension Associate*; Richard Link, *Research Assistant*,
Tennessee State University

Contact: 615-963-4929, jdekoff@tnstate.edu, [@TSUBioenergy](https://twitter.com/TSUBioenergy)

Canola was bred from the rapeseed plant by Canadian scientists to provide erucic acid and glucosinolate levels that were low enough to be palatable for animals and humans. Hence, the name canola is derived from CANadian Oil of Low Acid. The oil from canola is used as a healthier cooking oil due to its low saturated fat content and high omega-3 fatty acid content (Marianchuk et al., 1995). The oil can also be used by farmers to produce biodiesel for their own use.

Current production

According to the USDA National Agricultural Statistics Service, there were 1.7 million acres (2.9 billion pounds) of canola harvested in the U.S. in 2015. U.S. canola production is dominated by North Dakota which currently produces 87% of U.S. canola (Table 1). In 2015, Tennessee planted over 5,600 acres of winter canola (USDA-FSA, 2016).

Table 1. Harvested acres of canola in 2015 (USDA-NASS, 2016).

State	Canola (harvested acres)
Idaho	27,000
Minnesota	21,500
Montana	78,000
North Dakota	1,400,000
Oklahoma	115,000
Oregon	1,800
Washington	34,000

Types of canola

There are two main types of canola; winter and spring canola. The majority of canola grown in the U.S. is the spring type, however, winter canola is best suited to states in the southern U.S. like Tennessee. Spring canola is planted in spring and harvested in fall while winter canola is planted in late summer/early fall (September/October in Tennessee) and harvested in late spring (around June in Tennessee). Winter canola can produce 20-30% greater yields than spring canola (Boyles et al., 2007).

Production recommendations

It is important to take soil tests prior to planting. There are currently no recommended fertilizer rates for growing winter canola in Tennessee. In Georgia, recommended nitrogen (N) rates are 135 - 180 lbs N/acre. In Virginia, it is 100 lbs N/acre. The recommended N rate in Missouri is 90 - 150 lbs N/acre. Nitrogen should be split applied (50:50) before planting in fall and before bolting in spring. Recommended phosphorus and potassium applications range from 50 to 100 lbs/acre. Sulfur is required at 20-30 lbs/acre and boron may also be necessary (~1 lb/acre). Soil pH should be maintained around 5.8 - 6.5 (Weber et al., 1993; Bhardwaj, 2007; Buntin et al., 2010). A pre-plant herbicide, like trifluralin, can be incorporated in the soil prior to planting. In cases where the planted seedbed needs further cleanup, paraquat or glyphosate, can be used prior to germination.

It is recommended to plant canola about six weeks before the first killing frost. This will allow the plant to produce enough biomass to overwinter successfully but not too much where stem elongation occurs. In Tennessee, planting usually falls around mid-September and mid-October. A grain drill can be used to plant canola and since it is a small seed (Fig. 1) it requires a firm seedbed and shallow planting (1/4" depth).



Fig. 1. Canola seed is small and requires a firm seedbed and shallow planting depth.

A 6-8" row spacing can help to control weed competition

(Buntin et al., 2010). Grass-type weeds can be managed with herbicides once canola has germinated. Some broadleaf weeds can be managed using clopyralid or tillage in wide rows. Broad spectrum post-emergence weed control can be found in Roundup Ready and CLEARFIELD herbicide tolerant cultivars.

The major plant diseases for canola are blackleg disease and *Sclerotinia* stem rot. The best way to avoid blackleg disease is to select resistant varieties. To avoid *Sclerotinia*, it is best to plant on well-drained soils and use crop rotation. The major insect pests include aphids and the cabbage seedpod weevil. Both insects can be controlled using insecticides depending upon the number of insects present and the growth stage of the canola (Buntin et al., 2010).

Harvesting seed

In Tennessee, winter canola will usually begin to bloom in April and be ready to harvest in early June (Fig. 2). Canola is planted and harvested around the same time as winter wheat and can therefore be part of a winter rotation. It is important for canola to be harvested as soon as it is ready as the seed pods will shatter if left in the field too long. Seed should be harvested once seed moisture has reached 8-10% and green seeds have turned black (<2% green seeds present) (Buntin et al., 2010). Canola can be harvested directly using a combine with the concave nearly wide open and slower cylinder/rotor speeds. Chaffer and shoe sieves are usually closed more than for wheat. It is also a good idea to patch any holes with duct tape to reduce losses in yield.



Fig. 2. As canola matures, the moisture decreases and the seeds change from green to black.

Grain yield and canola meal

In the 2014-2015 season, 40 winter canola varieties were planted on 3 different planting dates (Sept. 10, Sept. 24, Oct. 9). The winter canola for all 3 planting dates survived and yields were evaluated. In a previous publication (Illukpitiya and de Koff, 2014), it was concluded that the value of canola

meal (material remaining after oil is removed) as an animal feed allowed on-farm biodiesel production to be economically viable. Therefore, canola meal was produced using an oilseed handpress and the meal protein concentrations from the 5 highest-yielding varieties were measured (Fig. 3).

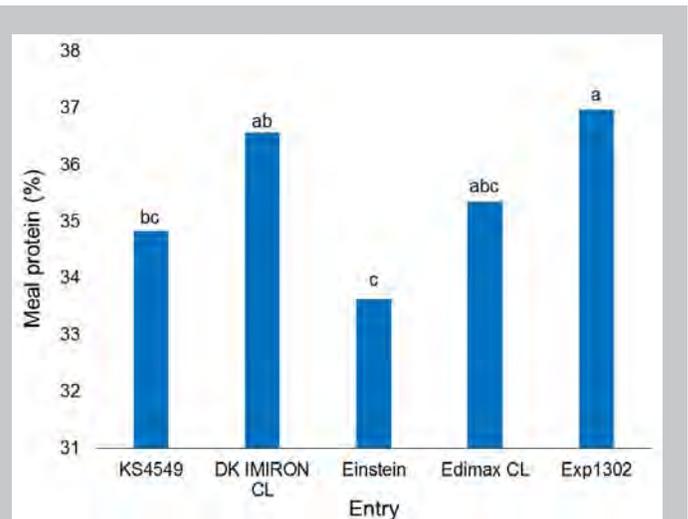


Fig. 3. Canola meal protein content for the five highest-yielding varieties from the first planting date (Sept. 10).

The Exp1302, DK IMIRON CL, and Edimax CL varieties had the greatest grain yields and protein contents with values ranging from 35-37%. Since these are used as protein sources in animal feed, it is assumed that winter canola meal with greater protein may receive greater prices.

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Dean - Dr. Chandra Reddy, Associate Dean for Extension - Dr. Latif Lighari