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Relevant OSU Fact Sheets and Websites:

CR-1726 Grain Bin Entrapment: What If It Happens To You?
BAE-1100 Maintaining Quality of Stored Grain by Aeration
BAE-1101 Aeration and Cooling of Stored Grain
BAE-1102 Aeration Systems for Flat Bottom Round Bins
BAE-1103 Aeration System Design for Cone-bottom Round Bins
BAE-1105 Auger Conveyors
PSS-2130 Producing Winter Hardy Canola in Oklahoma
EPP-7180 Stored Grain Management in Oklahoma
http://www.canola.okstate.edu/
http://www.canola.okstate.edu/relatedsites/index.htm

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Storing Oklahoma Winter Canola

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With the development of winter hardy canola varieties, Oklahoma producers have the option of rotating canola with wheat to break the weed and disease cycle, while potentially increasing wheat yields. Production of canola also provides an income source outside of the typical grain market for Oklahoma producers. The interest in canola production has prompted many questions about storage methods for Oklahoma conditions.

Successful canola storage requires cool, dry conditions. Therefore, storing canola in Oklahoma requires aeration. Potential risks of improper storage include heating and spontaneous combustion, insect infestation, clumping due to molding, and free fatty acid (FFA) development.

Ripe canola varies in moisture and oil content. When placed in storage, moisture content and seed temperature determine the amount of drying and cooling necessary to prevent spoilage. Canola undergoes a period of extended respiration or "sweat," producing heat and moisture for six to eight weeks after harvest. Aeration and intensive monitoring are required to prevent quality loss.

Optimum Storage Conditions

Canola seed may be conditioned in storage using aeration to reduce moisture and temperature to safe levels for long-term storage. Figure 1 shows the moisture content and temperature relationship for safe storage up to five months. Seed stored at conditions below and to the left of the curve showed no loss of quality for five months. While optimum storage conditions are 55° F and 7 percent seed moisture, every reduction of 10°

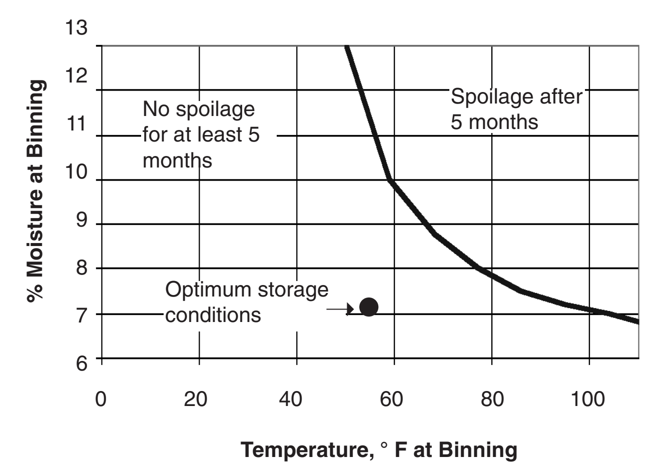

Figure 1. Safe and spoilage conditions for canola adapted from Mills (1996).

F below 77° F and 1 percent seed moisture below 9 percent will double the storage life. Storage below 6 percent seed moisture may result in seed damage during handling.

Cleaning Canola Seed

Broken seeds, pods, dirt, and other debris (also known as "dockage") make aeration more difficult by reducing airflow through the seed and can effect seed moisture content. Surface debris in storage also attracts insects. Insect development and activity cause excess heat and moisture which encourage mold growth. Broken seeds provide additional opportunity for mold growth, which increases respiration rate. Therefore, seed should be cleaned to less than 2.5 percent foreign material before storage. Canola can be cleaned by a number of different methods, including air aspiration, indent cylinder cleaning, sieve screening, or a combination of these methods.

Moisture, Oil Content, and Storability

Equilibrium relative humidity (ERH) is the point at which there is no exchange of moisture between the seed and the surrounding air. Mold begins to grow when the ERH is above 60 percent. Temperature and seed oil content determine the ERH of the stored canola. Canola varieties available for Oklahoma usually contain oil between 35 percent and 45 percent. Table 1 shows the ERH for canola with 40 percent seed oil content at various temperatures and seed moistures. The shaded area shows the seed moisture content percentage for optimum conditions to prevent mold growth and seed damage due to handling. For example, a seed temperature of 80° F must have a moisture content of 7.6 percent or less to have an ERH less than 60 percent.

Higher oil contents require lower seed moisture levels for successful storage. For example, at 60° F canola with 50 percent oil content can be safely stored at 6.5 percent moisture content or less as compared to 8.4 percent moisture content for seed with 40 percent oil content as shown in Table 1. As the oil content increases, the safe moisture level decreases.

Lower seed moisture and lower oil content allow storage at higher temperatures. However, at temperatures greater than 77° F for longer than a year, excessive free fatty acid may form.

Free Fatty Acid Production

Table 1. Equivalent relative humidity and temperature influence on seed moisture content. (NDSU 2005).

Equivalent Relative Humidity, %	*(40% seed oil content) Temperature, °F*						
	20	30	40	50	60	70	80
20	4.9	4.5	4.1	3.8	3.6	3.4	3.2
30	6.5	5.9	5.5	5.1	4.8	4.5	4.3
40	8.1	7.4	6.8	6.3	6.0	5.6	5.3
50	9.6	8.8	8.1	7.6	7.1	6.8	6.4
60	11.3	10.3	9.6	9.0	8.4	8.0	7.6
70	13.1	12.1	11.2	10.5	10.0	9.3	8.9
80	15.4	14.2	13.2	12.3	11.6	11.0	10.5
90	18.6	17.2	16.0	15.0	14.2	13.5	12.8

Other factors that reduce the quality of stored canola include free fatty acid (FFA) production and oil color changes. FFAs cause oil to go rancid quickly. FFA levels increase as a result of the hydrolysis of triglycerides and cause off flavors in the oil. Even when the conditions provide little risk of mold growth, these oil quality changes can occur. High temperature is the cause of FFA production and oil color change. Freshly harvested canola seed typically has FFA levels less than 0.5 percent. However, storage above 77° F for extended periods of time (longer than one year) may cause levels to rise above 2 percent. These high levels of FFA can be reduced during refining but the process is expensive. This makes canola seed with FFA levels above 1 percent less desirable to buyers. Therefore, it is important to cool canola seed to below 77° F as soon as possible after harvest.

Aeration for Cooling

Aeration systems properly designed to provide adequate uniform airflow provide a cost effective way to cool and store canola in Oklahoma. Round steel grain bins are well suited for storing canola. They are easy to maintain and to seal against weather and pests. The floor should accommodate an aeration system, preferably with full perforation. Extension Fact Sheets BAE-1102 and BAE-1103 provide information for the design of aeration systems for flat-bottom and cone-bottom round bins, respectively. Because canola seed is much smaller than wheat and other cereal grain, fine mesh screen (such as window screen) may be placed over the floor perforations to prevent seed leaking through the perforations. Bins should be equipped with temperature and relative humidity monitoring equipment. If this equipment is not available, weekly testing with a grain probe is essential. Extension Fact Sheet BAE-1101 gives aeration and grain cooling information for Oklahoma.

Air flow may be positive pressure (upward) or negative pressure (downward). Positive pressure is generally preferred for canola storage because operating the fan as the bin begins filling helps keep the floor perforations open. However, condensation may occur on the underside of the roof during cool weather in an upward flow system if adequate roof ventilation is not provided. Cross-ventilation in the headspace can remove this moisture. In a negative pressure system, warm summer air is pulled down into the grain. If new seed is added to the bin, the heat from the new seed is pulled down into the previously cooled seed requiring it to be cooled again. In addition, negative pressure systems can cause more packing with canola seed and increase the static pressure. Figure 2 shows the two different air flow directions.

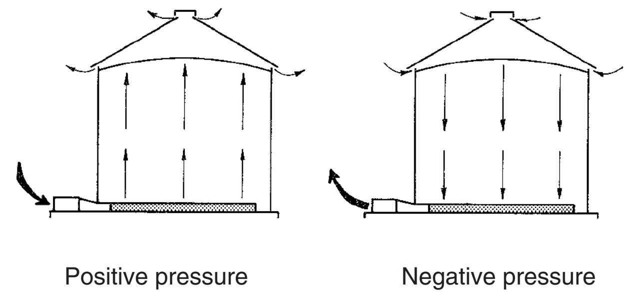

Figure 2. Grain bin airflow directions. Positive pressure systems are preferred for canola storage.

Airflow rates for temperature management of canola are usually 0.08 to 0.15 cfm/bu. At 0.08 cfm/bu, about 150 to 200 hours are needed to change the temperature of the entire bin 20°F (i.e. from 80°F to 60°F or from 60°F to 40°F). At 0.15 cfm/bu, the time is reduced to less than 100 hours. Canola containing fine material will take longer to cool.

Aeration fans should be started as soon as the seed covers the floor and run continuously until the seed temperature throughout the bin is near the average outside temperature. After the initial cooling period, the fans should operate whenever the outside air temperature is at least 5 to 10°F below the seed temperature and the relative humidity is less than 95 percent.

Aeration for Natural Air Drying

Being able to reduce seed moisture content in the bin provides producers more options for harvesting. Canola can be harvested above 10.1 percent moisture content. Harvest can be started earlier with higher moisture levels to reduce mechanical losses from pod shattering (Thomas 1984). Bin aeration can be used to dry the seed to the proper storage moisture content but increased airflow rates are required. Typical airflow rates for drying range from 0.4 to 2 cfm/bu. These higher airflow rates increase the static air pressure. Table 2 shows the static pressure for canola with fan airflow rates of 0.75 and 1.0 cfm/bu at several grain depths. Canola that has been in a negative pressure storage system may become packed. Static pressure can double for packed seed. Static pressure due to canola seed plus the static pressure due to duct work must be considered when selecting fans. Extension Fact Sheets BAE-1101, BAE-1102, and BAE-1103 provide additional aeration system design information. The static pressure of canola is up to two to three times that of wheat. Therefore, if an existing aeration system designed for wheat is used for canola, check the velocity and pressure ratings of the system to ensure adequate airflow.

Two types of fans are available for grain bin aeration. Axial type fans are adequate for static pressures less than about 5 inches of water. Centrifugal type fans are more expensive but give more consistent air delivery over a wider range of pressures.

Table 2. Static pressure of canola in storage.

Static Pressure	*Airflow Rate (cfm/bu)*	
inches of water and psi	0.75	1.0
	Canola Depth	
6" (2.6 psi)	13 ft.	11 ft.
7" (3.0 psi)	14 ft.	12 ft.
8" (3.5 psi)	15 ft.	13 ft.

As the airflow moves through the grain, a drying front develops and moves slowly through the grain. Behind the drying front, the grain is close to the temperature of the incoming air and at a moisture level in equilibrium with the relative humidity of the incoming air. Table 3 shows the relationship between the seed moisture level and the relative humidity of the incoming air. The grain ahead of the drying front will remain at a moisture level within about 1 percent of its initial storage level.

The airflow pattern in a bin with a fully perforated floor and a leveled grain surface will provide even air distribution unless debris and packed grain have gathered under the filling spout. If this is the case, coring the bin or pulling seed from the center of the bin will help to reduce the problem. Uneven airflow patterns will leave moisture pockets that can cause mold and hot spots resulting in spoilage of the surrounding seeds. Stirring or moving the seed will help reduce these problems.

When drying canola, the fans should be run continuously until the desired moisture level is achieved even if the relative humidity occasionally spikes. This ensures the drying front will continue to move through the stored seed. The moisture will redistribute through the seed and spoilage should not occur.

Table 3. Incoming air relative humidity influence on seed moisture level.

Relative humidity, %	50	57	65	72	77	82	86	88
Moisture level, %	6.0	6.6	7.4	8.2	10.0	11.2	12.8	13.9

(Bailey 1980)

Heated Air Drying

Heated air drying can be used if available. It is much faster but more expensive than natural air drying. Care must be taken to control temperatures. Canola seed to be used for future plantings should not be subjected to temperatures over 113° F. Seed used for oil extraction can be dried at temperatures up to 180° F. Over drying can cause cracking of the seed coats plus increase free fatty acids. If high-temperature batch and continuous flow dryers are used, two passes may be required if initial seed moisture content is above 17 percent. The drying process will be quicker and more consistent through the grain bed if the grain depth is less than 10 ft (Mills 1996). For seed moisture contents below 15 percent, natural air and low temperature drying should be adequate.

Insect and Mite Control

Insects can cause extensive damage in stored bulk products. Good management practices can help prevent this damage. Always clean bins thoroughly prior to grain storage.

The surface of stored canola is the primary area of attack. Insects are attracted by trash, broken seeds, and fine material that accumulate on the surface. Cleaning seed before storage will reduce infestations.

Proper temperature control using aeration will also help control insect and mite infestations. Optimum temperature for rapid insect development is 86 to 95°F. Grain temperatures below 68° F slow the development of insects, with development ceasing at temperatures below 59° F. Red flour and rusty grain beetles have been observed in canola stored in Oklahoma. Indian meal moths and lesser grain borers also have the potential to infest stored grain. Extension Fact Sheet EPP-7180 provides detailed information about the identification and prevention of different pests commonly found in Oklahoma stored products.

A good plan for controlling insects and mites in canola includes the following:

1. Clean bin by thorough sweeping and/or using a shop vacuum before binning grain
2. Level surface of grain after binning
3. Cool grain as quickly as possible
4. Closely monitor insect infestation monthly using traps or a grain trier. (Extension Fact Sheet EPP-7180 provides testing method information.) If hot spots appear, stir grain and continue aeration to re-cool the entire bin. Safety Note: Take appropriate safety measures when entering a confined space such as a grain bin; do not work alone. (Extension Current Report CR-1726 provides safety information for working with grain bins and emergency procedures in case of accidents.)

Grain Handling Equipment

Equipment used for cereal crop production may be used to handle canola. Since the seed is small, holes in truck beds, grain carts, and combines must be plugged with tape or caulk to prevent seed loss.

Canola has an angle of repose of 22°, compared to 28° for wheat. This difference causes seed to flow more readily and may cause additional force on the sides of carts and bins. Care must be taken to load canola evenly throughout the bin to prevent buckling.

Augers should be operated at full capacity to prevent seed from flowing back down the tube. Belt conveyors should be enclosed in a trough to prevent seed from dropping off the conveyor. Damage to seed due to handling is minimal above 7 percent seed moisture content (Mills 1996).

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