Annual Performance Report - Summary of Activity under the Canola/Flax Agri-Science Cluster 2012-2013

Activity Code / Title:	3.5.1. STORAGE AND HANDLING CHARACTERISTICS OF NEW VARIETIES OF HIGH OIL CONTENT CANOLA
Start Date (yyyy-mm-dd):	2012-04-01
Expected End Date (yyyy-mm-dd):	2013-03-31
Name / Organization of Principal Investigator (PI):	Digvir S. Jayas University of Manitoba
Cluster Name:	Canola/Flax Canadian Agri-Science Cluster Project No. 04772

Short Executive Summary of report:

The following three experiments were conducted in this year:

1) High oil content canola (Nex4 105) with 8.1±1.3% (n=8) moisture content was stored inside three bins (2.2 m in diameter and 4.8 m height) for four months. The bins were located inside an environment room. At the beginning of the storage, aeration was conducted. After the average oilseed moisture content was raised to 10%, aeration was stopped and the temperature and relative humidity of the environmental room was controlled by simulating the weather of Winnipeg (from September to December, 2010). Every 2 weeks, samples were collected at different grain depths and locations. Germination, mould, and fat acid value (FAV) of the sampled seeds were determined.
2) One variety of high oil content canola (45H29) and one variety of low oil content canola (5525 Clearfield) was stored in plastic pails for 20 weeks under different temperatures and moisture contents. It is the 12th week now (March 10th to March 16th, 2013). Samples were removed from the containers every 2 weeks. Germination, visible mould, invisible mould species and Fat acid value (FAV) of the sampled canola were determined.
3) Physical properties of three varieties of high oil content canola (Nex4 105, 45H49 and Invigor 5440) and one variety of low oil content canola (5525 Clearfield) at moisture contents of 8, 9, 10, 11 and 12% were determined.

Primary data analysis was conducted.

A. Research Progress and Accomplishments (to date in relation to expected deliverables / outputs)

- Include brief summary of:
  - Introduction, literature review, objectives and deliverables / outputs.
  - Approach / methodology (summary by objectives).
- Include results and discussion (overview by objectives and deliverables), next steps and references.

1. Introduction

Since 2005, high oil content canola was predominantly planted to replace low oil content canola in western Canada (CWB, 2011). Safe storage guidelines of low oil content canola were developed (Sathya et al., 2009). It is required to determine storage and handling characteristics of high oil content canola, in order to store high oil canola without quality loss, or design processing, storing, and transporting equipment and facilities. Germination, free fatty acid values (FAV), and visible mould were main factors indicating the deterioration of stored canola. High moisture content and temperature would accelerate the deterioration of stored grains (Sinha, 1973; Wallace et al., 1983; Jayas and White, 2003). Sathya et al. (2009) used 20% germination drop or appearance of visible microflora as the criteria to develop safe storage guidelines of low oil content canola.

Physical properties of canola are important parameters in the design of storage bins, processing equipment and transport facilities. In the Canadian grading system, bulk density is a significant element (Muir et al., 2000), and it affects structure loads of stored canola. The coefficient of friction of canola seed on different structure surfaces reflects the sliding capability of the seed against various structural materials, and is also used to calculate load applied on structures (Rusinek and Molenda, 2007). Angles of repose reflect the internal friction within a grain bulk (Muir et al., 2000).

The objectives of the study in 2012 to 2013 was to: 1) develop safe storage guidelines of high oil content canola, and compare the developed guidelines with that of the low oil content canola; 2) conduct a large scale study of storing high oil content canola with 10% m.c. in non-ventilated bins; and 3) repeat the small scale study conducted in 2011 to 2012.

2. Approach

Large bin study

Canola seeds (Nex4 105) at 8.1%±1.25 (n = 8) moisture content were loaded into three welded-steel (approximately 2.2 m in diameter and 4.8 m height) flat bottom bins (fully perforated floor). The bins were located inside a large environment room which was located at the campus of the University of Manitoba. At the beginning of the study, the canola was aerated by using high humidity air (about 90% RH). The aeration fan was stopped after the average moisture content of canola seeds inside the bins reached 10%. The temperatures and relative humidities of the big environmental room were controlled by a computer system (DELTA) to simulate the western Canadian storage condition (from September to December, 2010). Thermocouples were installed at four locations and the distance between temperature sensors in the vertical direction was 1.2 m (4 feet). Every 2 weeks, samples were collected at a seed depth of 0.25, 1.25, 2.25 and 3.25 m. At each seed depth, canola at the wall and at the centre of the bins was sampled. Germination, mould, and FAV of the sampled seeds were determined. The canola was stored inside the bins for 4 months.

Small scale study

About 1 kg high oil canola seeds (45H49) and a standard canola variety (5525 Clearfield) with 8, 10, 12, and 14% moisture content (wet basis) were stored in 20 L plastic pails (Sathya, 2009).

These plastic containers were kept inside environmental chambers (Model: C1010, Controlled Environment Limited, Winnipeg, Manitoba) for up to 5 months. Samples were removed from the containers every 2 weeks. Germination, visible mould, invisible mould species and FAV of the sampled canola were determined. The measured quality parameters and testing protocols are given in Table 1.

Table 1. Measured quality parameters and testing protocols.

Parameter	Frequency	Testing protocol
Seed germination	Every 2 week	Method developed by Wallace and Sinha (1962) was used. There were three replicates and 25 seeds were tested in each replicate.
Moisture content	Every 2 week	About 10 grams of canola seeds were oven dried at 130°C for 4 h (ASABE, 2010). Three replicates.
Visible moulds	Every 2 week	Visual inspection. Three replicates.
FAV	Every 2 week	FAV was determined as milligrams of KOH needed to neutralize acids in 100 g of dry canola (Schroth et al., 1998). Five gram of dried samples was tested using a Goldfish fat extractor.
Mould species	Monthly	Mould species were determined by placing 25 seeds on Whatman no. 3 filter paper saturated with 5.5 mL of 7.5% aqueous sodium chloride solution (Mills et al., 1978). The plates were incubated at room temperature for 7 days and the microorganisms were identified using dissecting microscope. Three replicates.

Physical property test

(1) Bulk density. Standard bulk density was determined by the method of the Canadian Grain Commission (CGC, 2012).

(2) Angles of repose. Emptying and filling angles of repose were determined following the methods of Irvine et al. (1992).

(3) Coefficient of friction. Coefficients of friction of canola against four structural surfaces (galvanized steel, plywood, and wood-floated and steel troweled concrete) were tested by using the method of Irvine et al. (1992).

3. Results and discussion

Safe storage guideline.

Based on 20% drop of germination or the appearance of visible mould, high oil content canola at 8% m.c. could be safely stored at 10 and 20°C for 20 weeks. Canola at 10% m.c. could be safely stored at 10, 20, 30 and 40°C for 20, 18, 6 and 2 weeks, respectivelyy. Canola at 12% m.c. could be safely stored at 10 and 20°C for 12 and 8 weeks, respectively. Canola at 14% m.c. could be safely stored at 10 and 20°C for 8 and 6 weeks, respectively. Canola at 12 and 14% m.c. could only be stored for 2 weeks at 30°C, and could not be stored safely at 40°C (Fig. 1).

The Canadian grain commission (2010) published a graph of deterioration conditions of low oil content canola stored at different temperatures (10 to 50°C) and m.c. (7 to 12%) (Fig. 2). The safe storage periods of high and low oil content canola were similar. For example, both high and low oil content canola at 8% m.c. and at 10 and 20°C could be safely stored up to 20 weeks; 10% m.c. canola at less than 10°C could be stored without deterioration up to 20 weeks; and both high and low oil content canola at higher m.c. (12 and 14%) could not be stored safely for 20 weeks at all tested temperatures (10, 20, 30 and 40°C).

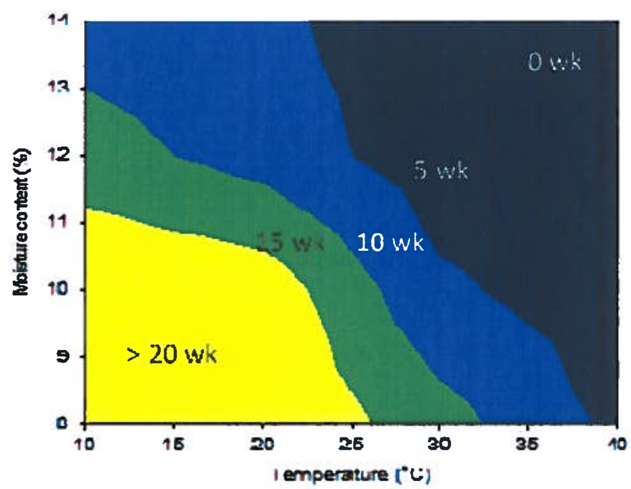

Fig. 1Safe storage guidelines of high oil content canola

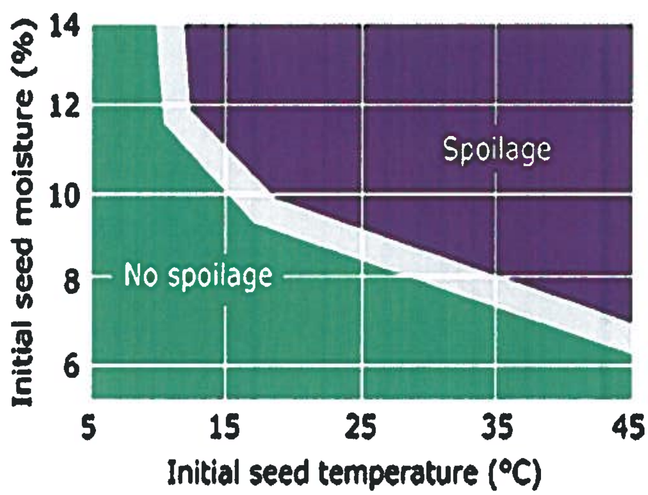

Figure 2. Safe storage guidelines of low oil content canola (CGC, 2010)

Large bin study

The simulated weather temperature changed from approximately 15°C at the beginning of the experiment to -20°C at the end of the experiment. The grain temperature also changed in this temperature range. There were large differences of germination and visible mould at different locations in a bin or in different bins. For example, visible mould of canola from the top two layers grew faster than the bottom two layers. Samples from the top layers of all three bins were observed to have visible microflora from the 6th week. The moisture contents of top layer samples increased much faster than other layers as well, and reached to about 15% m.c. There was no obvious trend of the difference between samples from the centre and the wall.

Germination of the canola at the top layers of all three bins dropped more than 20% in 16 wk storage. At top layer, germination of canola at the centre of the bin dropped faster than that at the walls. Germination of canola at other layers also dropped more than 10%. Germination of canola at the bottom layer had a smaller decrease than that at other layers.

FAV of all sampled canola increased to more than 40 mg KOH/g. No relationship was found between locations and the FAV values of canola at these locations.

By 6 wk, visible mould appeared at the top layers of the three bins when germination of the canola dropped approximately 10%. Visible mould was found on all samples of one of the three bins by 10 wk. However, visible mould was only found on the canola sampled at the top layer and close to walls in another bin, and the canola sampled in the upper two layers in the third bin.

Penicillium spp. and *Cladosporium* were the predominant species at the beginning of the storage. *Cladosporium* became dominant by 8 wk to 12 wk. The number of infested seeds by *Cladosporium* decreased, but *A. glaucus* increased at the end of the storage.

The high oil content canola (Nex4 105) at 10% initial m.c. could spoil in 6 weeks without aeration, even though stored at cold weather condition.

Physical property tests

Bulk densities of high oil content canola decreased with increasing moisture contents. Bulk densities of high oil content canola were affected more by changing moisture contents than bulk densities of low oil content canola. Bulk densities decreased with the increasing of oil contents.

The angles of repose decreased by the increasing of oil content, but increased with rising moisture content. The angles of high oil content canola increased more dramatically with increasing of moisture contents.

The coefficient of friction was not significantly affected by the moisture content. The coefficient of friction increased by the increasing of oil content on the structures of galvanized steel, wood-floated concrete, plywood and steel trowelled concretes. The coefficient of friction of canola was the highest on the surface of wood-floated concrete among the four tested structural surfaces.

The horizontal pressure of grain to the wall holding high oil content canola was lower than that of the low oil content canola. Therefore, buildings that are strong enough for low oil content canola could also support the high oil content canola.

4. Future work

Small scale study of the high oil content canola (45H29) and the low oil content canola (5525

Clearfield) is on-going, and will be finished by the end of June, 2013. The results of all the three high oil content canolas will be used to develop more reliable safe storage guidelines for high oil content canola, and then compare to the guidelines of the low oil content canola. The data analysis will be completed in September, 2013.

5. References

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B (I). Funded Collaborators (Co-PI, AAFC, other federal scientists, and third party scientists)

- Include the name of scientist / organization.

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