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**La Société Canadienne de Génie
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Paper No. CSBE11-120

Feasibility of Storing Canola in Harvest Bags (Silo Bags) under Western Canadian Prairie Conditions: Preliminary Results

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**Written for presentation at the
CSBE/SCGAB 2011 Annual Conference
Inn at the Forks, Winnipeg, Manitoba
10-13 July 2011**

ABSTRACT Large harvest bags (silo bags) are becoming popular for on-farm temporary storage of grains and oilseeds in several countries including Canada. These harvest bags are made of a three-layer plastic membrane (230–250 μm thick) and often used with dedicated grain loading and unloading equipment. This is a cost effective method compared to other temporary and permanent storage systems, but there are some concerns over grain spoilage, insect and mould damage, and quality losses. To quantify the changes in seed quality of canola inside the harvest bags, studies were conducted at the University of Manitoba, Winnipeg, Canada. Canola of 8, 10, 14% moisture contents (m.c.) was loaded into the bags in October 2010. Samples were collected every 2 weeks. Temperature, seed germination, free fatty acid value (FAV), and intergranular CO_2 concentration were measured or determined. The FAV nearly doubled, and germination rate reduced below 50%,

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for the 14% m.c. bags after 32 wk of storage. There was no significant change in quality of dry seeds (8 or 10% moisture content canola) stored in the silo bags.

Keywords: Canola, Storage, Harvest bags, Seed quality.

INTRODUCTION Canola is one of the major oilseed crops widely cultivated around the world, and Canada is the world's largest producer of canola. Canada produces on an average of 9.4 Mt of canola annually. The prairie region accounts for nearly 99% of total area of canola production in Canada (Statscanada, 2011). The recommended moisture content (m.c.) for harvesting of canola seeds is 10%. Numerous challenges occur during harvest and post-harvest storage of canola due to small size of the seeds (Bartosik, 2008). Respiration rate of freshly harvested canola seeds is high, and produce high amounts of carbon dioxide (CO₂) and heat (Mills, 1996). It requires 6 weeks to stop respiration, and goes to dormant stage (Thomas, 1984). If canola is harvested at more than 10.5% m.c. it will spoil rapidly, so it is recommended to dry the seeds as soon as possible. Ambient air drying is the common technique used by farmers to dry the seeds to recommended moisture content when it is stored in bins.

Harvest bag (grain bag or silo bag) is one of the alternate on-farm storage techniques, which is becoming quite popular in western Canada. The harvest bags are made up of three-layer polyethylene membrane (235 microns thick), and provide a nearly air tight environment for the grains. In Argentina, more than 50% of the harvested grains were stored using silo bags in 2007 (Cardoso et al., 2008). This is a cost effective method compared to other temporary storage systems, but there are some concerns over seed spoilage, insect and mold damage, and quality losses. Grain bags are mainly used to fill the storage capacity gap and reduce the high transport cost during harvest season. Moisture migration through leaks and accumulation of condensation inside the harvest bag create localized seed spoilage inside the bag. Accumulation of condensed water inside the grain bags is a common problem under Canadian climatic conditions. When compared to other storage systems, a high proportion of the bulk seed is held in the surface (peripheral) layer of the bag storage system. This peripheral layer undergoes large temperature and moisture changes during storage. More than 18% of the stored bulk in harvest bags has some quality changes (Darby and Caddick, 2007).

The main objective of this study was to quantify the changes in seed quality of canola during bag storage. This study will give detailed information about the feasibility of the use of harvest bags to store canola in the Prairie regions.

MATERIALS AND METHODS

Experimental setup Canola seed was obtained from a commercial elevator (James Richardson International, Dauphin, Manitoba) at 3 different moisture contents (8,10, and14% m.c.) and loaded into grain bags on October 7, 2010 using a bag loader (Figure 1). Each moisture content (m.c.) was considered as a treatment (Treatment A – 8% m.c., Treatment B- 10% m.c., and Treatment C- 14% m.c.), and 3 replicates per treatment were used. Each of the nine bags was loaded with approximately 20 t of canola seeds, and will be stored until the end of July 2011. Seed sampling, temperature monitoring and gas sample collection locations were established at 0.15, 0.8 and 1.35 m from the top of the bag, which represent the top, middle and bottom layers of seeds in the bag. Once in every 2 week (wk) seed samples were collected using a standard torpedo probe for quality analysis.

The moisture content was determined by placing approximately 10 g of unground seeds, in triplicate, in a hot air oven for 4 h at 130°C (ASAE, 2008). Dried samples were ground in a Stein mill and the FAV values were determined once in 4 wk using a Goldfish fat extractor followed by titration with a KOH solution (Schroth et al., 1998). Germination percentage of seeds over storage

time was measured according to the method developed by Wallace and Sinha (1962), every 2 wk. Thermocouples placed at temperature monitoring locations were connected with a Data logger unit for continuous temperature monitoring. Gas samples for CO₂ concentration measurement were collected using 60 ml syringes at 2 wk interval and analyzed using a gas chromatograph (Model : Clarus 420, Perkin Elmer, ON).



Figure 1. Loading of canola seeds into silo bags

RESULTS AND DISCUSSION

Moisture Content Initial moisture contents of all three treatments and changes in m.c. at 3 sampling locations per bag were analyzed once every 2 wk, and are given in Figure 2. Initial moisture contents of canola seeds delivered from the elevator were 9.1, 10.5 and 14.36% m.c. (wet basis). In all three treatments, m.c. of seeds at the top of bags were higher than the other parts of the bags.

Germination Germination is one of the major quality parameters for monitoring seed deterioration. Germination of the canola seeds collected from all 3 treatments were analyzed and are shown in Figure 3. In treatment A, germination of the seeds were more than 90% after 32 wk of storage at all sampling locations. Seed germination was more than 80% at all sampling locations except three locations near the top of the bag in treatment B. A localized hotspot was found at the middle portion of a bag in one of the treatment C silo bags. Germination of seeds decreased with increase in storage time. Germination rate of canola seeds in treatment C decreased below 50% at top and bottom parts of the bags after 32 wk of storage. Germination rate of canola seeds in treatment A and B were always higher than that of treatment C seeds, except the treatment B top portion.

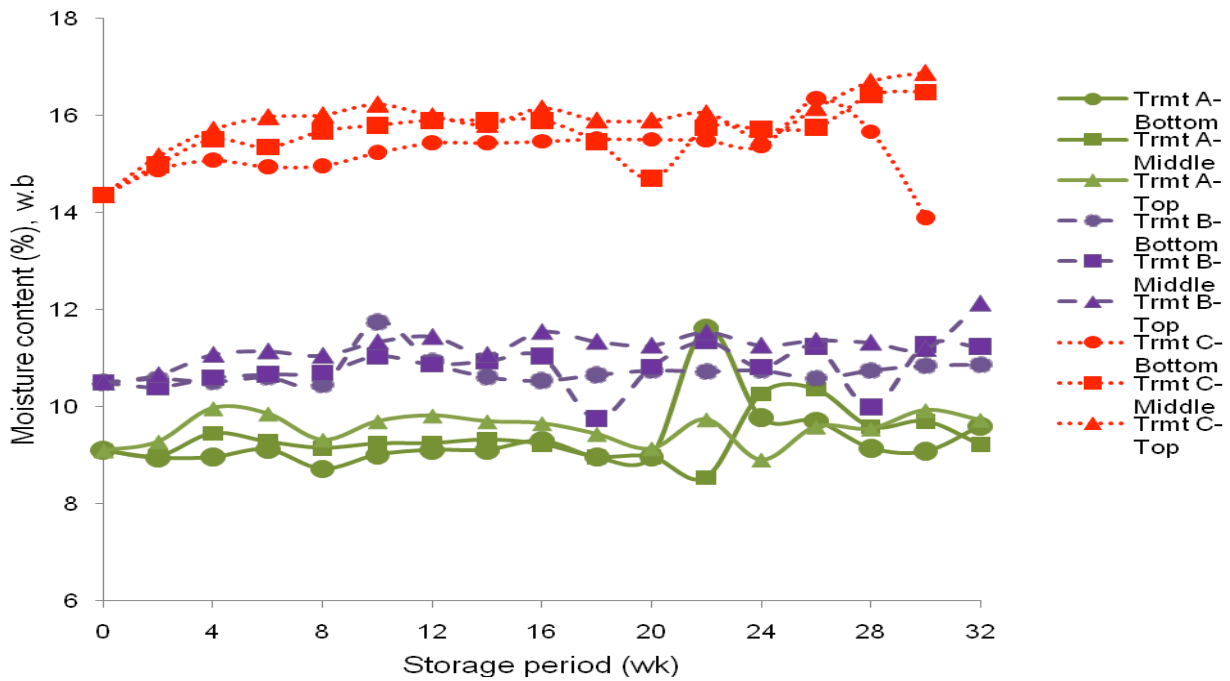


Figure 2. Moisture content of canola seeds with respect to storage time at different parts of silo bags

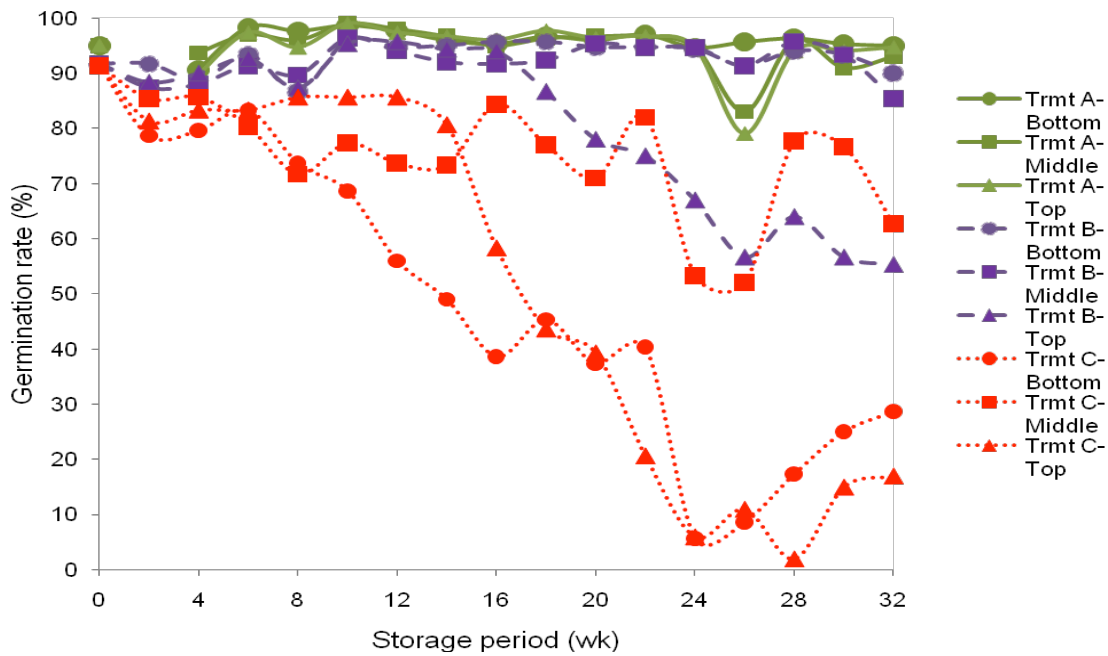


Figure 3. Germination rate of canola seeds with respect to storage time at different parts of silo bags

Free Fatty acid value Free fatty acid values (FAV) of the seed samples for the first 28 wk of storage are given in Figure 4. FAV values increased from 23.16 to 25.92, 23.48 to 34.99, and 25.16 to 41.22 mg KOH/100 g of dry seed, for treatments A, B and C, respectively after 28 wk of storage. In treatment B, FAV values are high at the sample locations near the top of bags and correlate with the high moisture seeds near the top of bags. Christensen and Kaufmann (1969) reported that production of free fatty acid is directly proportional to the moisture content of the seeds and fungal activity. The lower FAV values of the treatment A indicate the less biological activity in dry seeds.

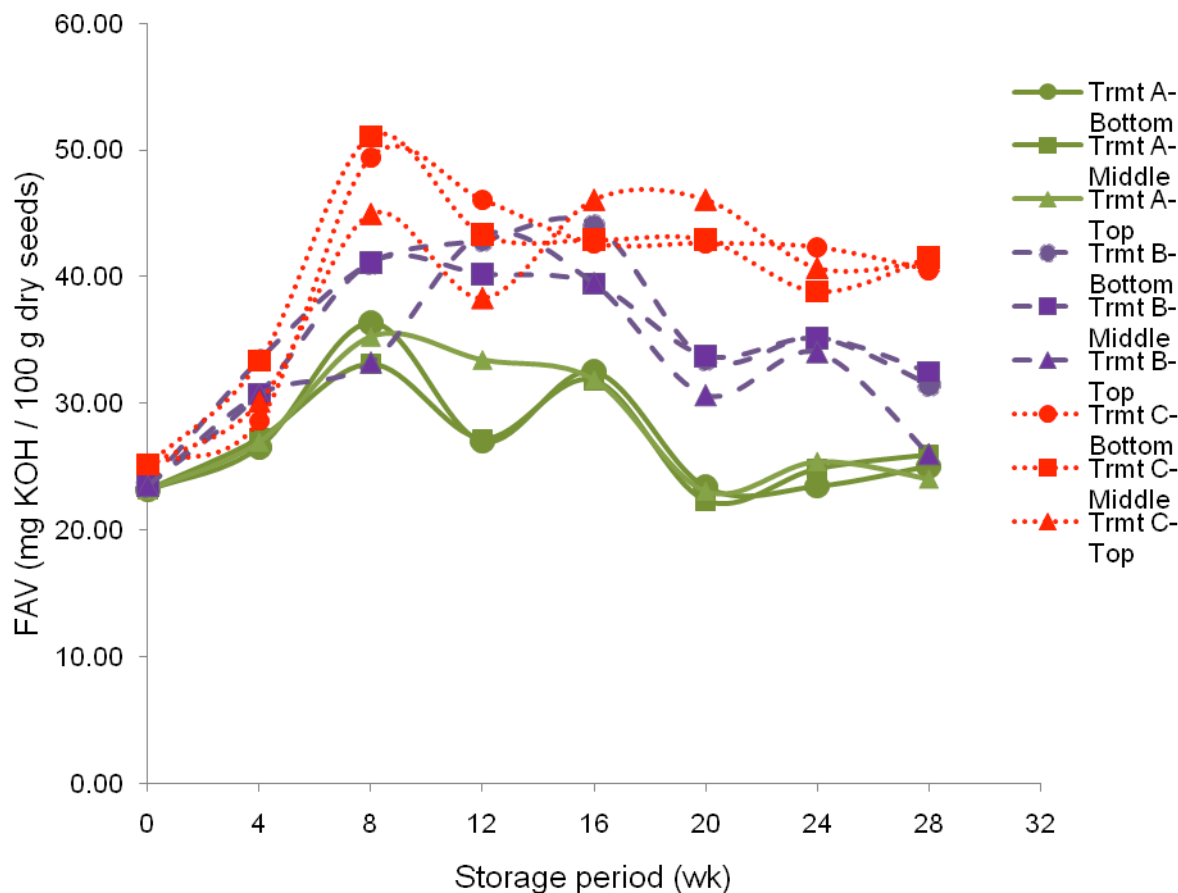


Figure 4. FAV of canola seeds with respect to storage time at different parts of silo bags

Carbon dioxide composition The intergranular CO₂ concentrations at different locations inside the silo bags are given in Figure 5. The CO₂ concentrations of treatments A, B and C were 3.57-4.04, 7.51-9.38, and 18.97-20.90%, respectively at different locations of the silo bags after 4 wk of storage. The higher level of CO₂ concentration in treatment C indicates the high amount of biological activity inside the wet seed bulk. After 32 wk of storage, CO₂ concentrations were 1.05 - 1.22, 1.11-1.34, and 2.44-2.87%, respectively for treatments A, B and C. Ochandio et al. (2010) also found the same trend in CO₂ concentrations of canola seeds stored in silo bags in Argentinean weather conditions.

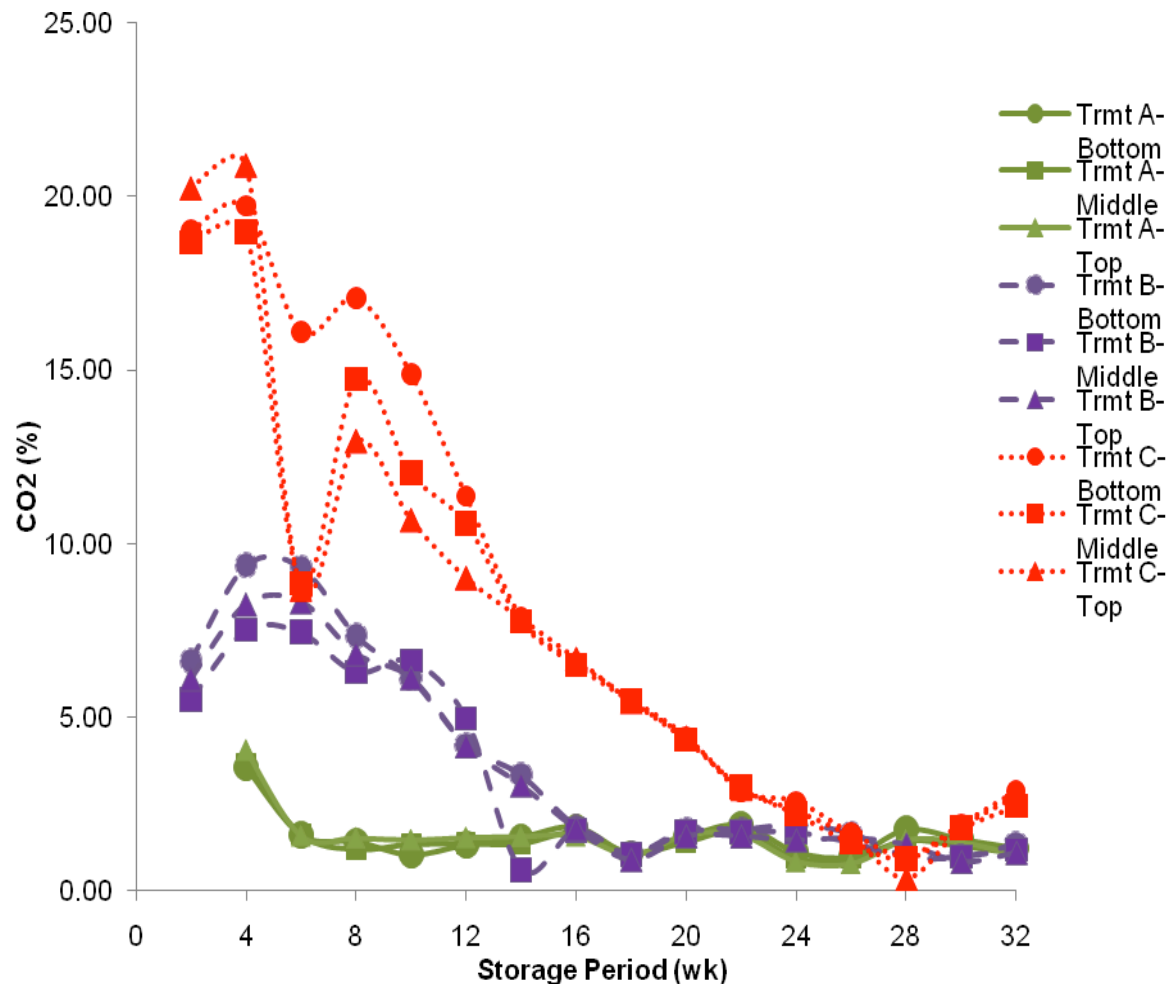


Figure 5. CO₂ concentrations with respect to storage time at different parts of silo bags

Temperature Temperatures of canola seeds at different locations in the silo bags are given in Figure 6. In all three treatments, temperature of seeds near the bottom of bags was always higher than other parts of the bag, and seeds near the top of bags were close to the ambient temperature. Temperature of the location near the localized hotspot (middle of the bag) is higher than other parts in treatment C.

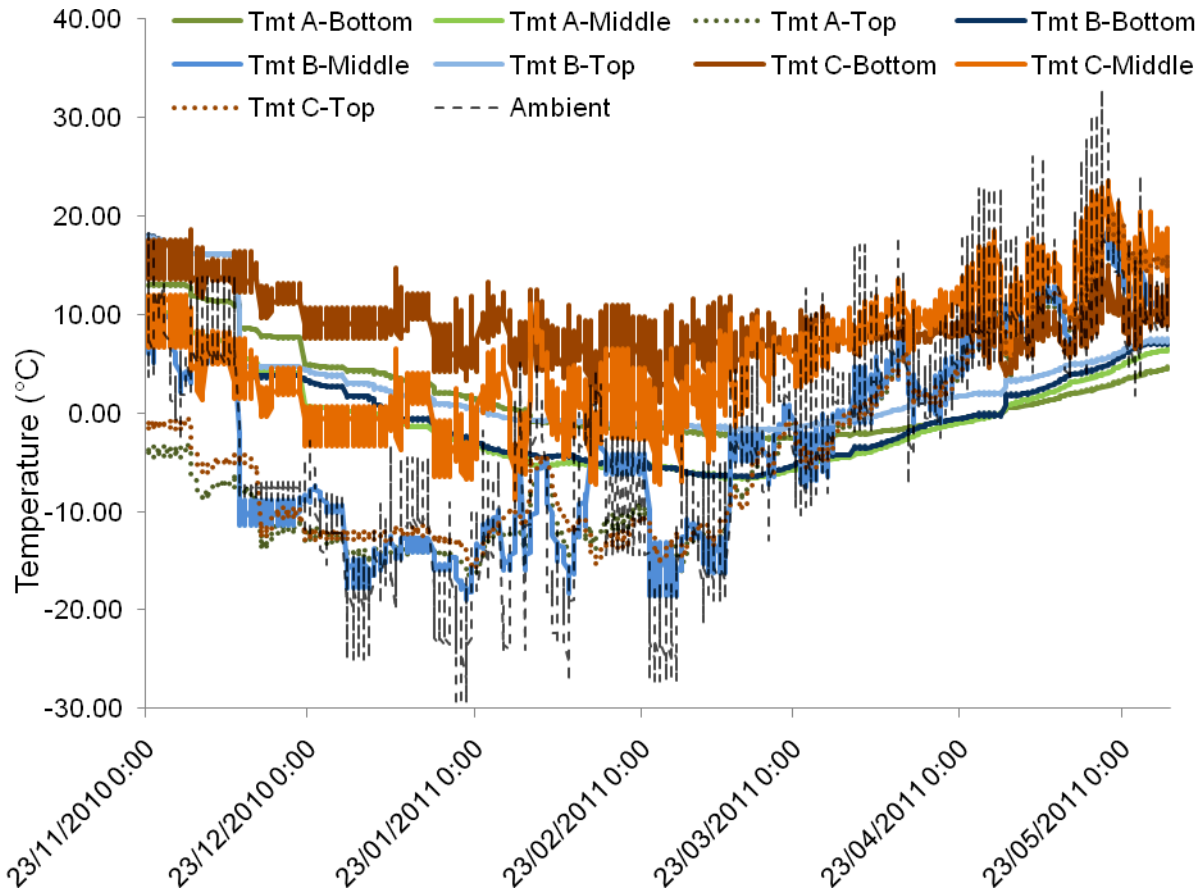


Figure 6. Temperature of canola seeds with respect to storage time

CONCLUSION Germination rate of 14% m.c. canola seeds reduced below 50% and FAV also increased twice the initial value, after 16 wk of storage, but there was no significant change in quality of dry seeds (8 or 10% m.c.) throughout the 32 wk storage period. With these preliminary results, we conclude that, canola seeds can be stored at low moisture contents (8 or 10% m.c.) in silo bags for 7 months without significant quality deterioration. But wet canola seeds can only store for a short time without any quality deterioration. This study will continue until the end of July 2011 (10 months of storage), and final recommendations will be drawn at the end of the experiment.

Acknowledgements. We thank the Canola Council of Canada for providing financial support for this study. Special thanks to James Richardson International for supplying seed, and Grain Bags Canada for providing silo bags and bag loader and facilitating the filling of bags.

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