
Safe storage guidelines for rye

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Sathya, G., Jayas, D.S. and White, N.D.G. 2008. **Safe storage guidelines for rye.** Canadian Biosystems Engineering/Le génie des biosystèmes au Canada **50**: 3.1-3.8. Safe storage guidelines for grains at different moisture contents and storage temperatures are essential to know how long seed can be held without deterioration. Rye samples with 10.0, 12.5, 15.0, and 17.5% moisture content (wet basis) were stored at 10, 20, 30, and 40°C for 16 weeks. Germination, moisture content, visible and invisible microflora, and free fatty acid (FFA) values were monitored periodically. Germination rate decreased significantly with increase in moisture content, temperature, and storage period ($\alpha=0.05$). Moisture content of the samples stored at 10°C increased with time, whereas that of samples stored at 30 and 40°C decreased. Visible mold appeared in all the 17.5% moisture samples and in all the samples stored at 40°C. *Penicillium spp.* and *Aspergillus glaucus* group were the predominant fungi in almost all samples throughout the study. Fat Acidity Value (FAV) increased with increasing moisture content, temperature, and storage time ($\alpha=0.05$). Safe storage guidelines with respect to initial moisture content and temperature were developed based on the drop in germination and appearance of visible mold. Rye with $\leq 12.5\%$ moisture content stored at $\leq 20^\circ\text{C}$ would be safe for at least 15 weeks, whereas rye with $\geq 15\%$ moisture content stored at 40°C would have less than a week to complete drying and cooling. **Keywords:** rye, moisture content, temperature, safe storage guidelines.

Des recommandations pour l'entreposage sécuritaire des grains à différentes teneurs en eau et températures d'entreposage sont essentielles pour savoir combien de temps les grains peuvent être conservés sans détérioration. Des échantillons de seigle ayant une teneur en eau de 10,0, 12,5, 15,0 et 17,5% (base humide) ont été entreposés à 10, 20, 30 et 40°C pendant 16 semaines. Les paramètres suivants ont été mesurés périodiquement : germination, teneur en eau, microflore visible et invisible et acides gras libres. Le taux de germination a diminué de façon significative avec des augmentations de la teneur en eau, de la température et de la durée d'entreposage ($\alpha=0,05$). La teneur en eau des échantillons entreposés à 10°C a augmenté avec le temps, contrairement à celles des échantillons entreposés à 30 et 40°C qui ont plutôt diminué. De la moisissure visible est apparue parmi tous les échantillons à une teneur en eau de 17,5% ainsi que dans tous les échantillons entreposés à 40°C. Les groupes *Penicillium spp.* et *Aspergillus glaucus* étaient les espèces prédominantes dans presque tous les échantillons de cette étude. Les valeurs d'acide gras augmentaient avec une augmentation de la teneur en eau, de la température et de la période d'entreposage ($\alpha=0,05$). Des recommandations pour un entreposage sécuritaire qui tiennent compte de la teneur en eau initiale et de la température ont été développées en considérant la réduction de la germination et l'apparence de moisissure visible. L'entreposage du seigle à une teneur en eau inférieure ou égale à 12,5% et à une température de 20°C ou moins s'est avéré sécuritaire pour une période d'au moins 15 semaines. Toutefois du seigle entreposé à une teneur en eau supérieure ou égale à 15% et à 40°C se conserverait moins d'une semaine sans séchage et refroidissement. **Mots clés:** seigle, teneur en eau, température, recommandations d'entreposage sécuritaire.

INTRODUCTION

In Canada, most cereal crops are seeded in April or May and harvested in the autumn (fall). Sometimes unexpected weather conditions during harvest cause the crop to be harvested at high moisture levels which are not suitable for safe and prolonged storage, or occasionally, farmers may not even complete the harvest before winter. For example, in 1996 only 50% of the cultivated wheat crop was harvested because of wet autumn weather (Anonymous 1997).

Moisture content and temperature of the grain during harvest determine the safe storage period. Drying and cooling of freshly harvested, moist, warm grain is an important operation before it goes for processing or storage (Bala 1997). The grain can be dried in a heated air dryer and cooled or ambient air can be used to slightly dry and cool the grain within the bin. The choice of either of the conditioning systems depends on the grain condition and weather patterns. If the harvested grain can be held for a long enough period at the harvested moisture and temperature conditions without any significant spoilage, then the farmer can use ambient air drying and reduce the energy cost. However, this may not be effective for moist and warm grain as the use of ambient air is slower than heated-air drying. Rates of drying and of cooling also depend on the available time for that particular operation. Even grain with safe initial moisture content can spoil if the storage conditions are poor. Therefore, guidelines must be developed for all the common grains at all possible moisture and temperature conditions the grain may be subjected to after harvest, to provide farmers information on the number of days available for completion of post-harvest conditioning operations.

Rye (*Secale cereale* L.) accounts for 1.2% of the total world cereal production and is the second major raw material for the bread industry next to wheat. Canada has a substantial share in the world's rye trade. Although it is not a major producer, Canada exports more than half of its production every year. Swathing of fall rye may begin at around 45% seed moisture content, which is called the milk stage. Rye has no virtual dormancy, therefore, this can result in pre-harvest sprouting. Delayed swathing may increase the risk of shattered grain heads. Hence, judgment must be made to balance the risks of sprouting and shattering. Swathed rye is field dried and threshed at around 22% moisture content (Hartman 1999). It should have 14% or less moisture content and for long term storage it needs to be dried further to 12% moisture content. Rye which goes for milling and baking has to meet specified commercial and hygienic standards. Therefore, early harvesting and proper drying before storage are necessary (Weipert 1996).

