EFFECT OF SWATHING AND MOISTURE CONTENT ON SEED PROPERTIES OF LAIRD LENTIL

The influence of harvest date and time in the swath on seed moisture content, physical characteristics and cooking quality of lentil was detemined over a 22-d harvest period in August 1988. Swathing effectively reduced seed moisture content from nearly 60 to 14% in 10 d except under conditions of prolonged rainfall. Reductions in moisture content resulted in increased bulk density along with proportional decreases in seed mass. Susceptibility to seed breakage also increased with decrease in moisture content, especially at seed moisture levels below 15% or when the experiment was conducted at −25°C. Harvest date and seed moisture content had no apparent effect on cooking quality or kernel density.

Key words: Lentil, harvesting, swathing, cooking quality, breakage susceptibility, bulk density, kernel density

[Effets de l'andainage et de la teneur en eau sur les propriétés des grains de la lentille Laird.]

Titre abrégé: Propriétés des grains de lentille pendant la récolte.

Nous avons étudié les effets de la date de récolte et de la durée de la mise en andains sur la teneur en eau des grains, les caractéristiques physiques et la qualité culinaire de la lentille, durant une période de récolte de 22 jours en août 1988. En dix jours (sauf en périodes de précipitations prolongées), l'andainage a réduit la teneur en eau des grains, d'environ 60% à 14%. Cette réduction de la teneur en eau a provoqué une augmentation de la densité apparente ainsi qu'une réduction proportionnelle de la masse des grains. La sensibilité des grains à la rupture a également augmenté sous l'effet de la réduction de la teneur en eau, notamment à une teneur inférieure à 15% ou lorsque les essais ont été effectués à une température de −25°C. La date de la récolte et la teneur en eau des grains n'ont eu aucun effet apparent sur la qualité de cuisson ni sur la densité des grains.

Mots clés: Lentille, récolte, andainage, qualité culinaire, sensibilité à la rupture, densité apparente, densité du grain

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Lentil (*Lens culinaris* Medik) is a relatively new crop in Canada and nearly 80% of the total production is exported to traditional pulse-consuming countries in the Middle and Far East. Two genotypes of lentil are grown in Canada. The large-seeded, late-maturing Laird is the most popular cultivar while the small-seeded, early-maturing Eston occupies only a small portion of the acreage (less than 20%). The annual lentil is planted in early May and harvested during August and early September.

Lentil plants have an indeterminate growth habit so that new flowers and pods are produced continuously until plant growth ceases due to heat, drought or early frosts (Saskatchewan Agricultural Services Coordinating Committee, 1987). At harvest, plants may contain immature pods as well as over-ripe pods which tend to shatter. In order to reduce shattering losses, the crop may be desiccated to initiate rapid and uniform drying before being combined. Smaller farm operators usually swath the crop when the earliest pods have turned light brown. After about a week of maturing and drying, the swaths are lifted and threshed. At this stage, the moisture contents of lentil seeds should be low enough to enable mechanical threshing but yet high enough so that the seeds are not susceptible to mechanical damage. The harvested seeds are then artificially dried to below 14% moisture content for safe storage. Farm operators who lack drying facilities must delay picking

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up the swath until the safe moisture level is reached, taking the risk of crop losses due to adverse weather conditions.

Moisture content is one of the major factors affecting properties and qualities of grain during handling and storage. Reduction in moisture content increases bulk density so that dry grain occupies less shipping and storage space, and grain flows more readily. Also, grain at low moisture content stores for a longer period without deteriorating. However, grains with low moisture content are more brittle, and suffer more physical damage during mechanical handling. Damaged grains are vulnerable to attack by insects and molds, and have a lower market value. The Canadian grain grading system (Canadian Grain Commission 1987) specifies that the maximum levels of split and broken seeds in No. 1 and No. 2 lentil are 2.0% and 3.5%, respectively. For better management of lentil during harvesting, handling, and storage, an understanding of variations in moisture content during the harvesting process, and the relationships between moisture content and relevant physical properties is essential.

Cooking characteristics are an important criterion in lentil quality evaluation (Bhatty 1988). However, little is known about the effect of harvest date or seed moisture content at harvest on cooking properties of lentil. The objectives of the present study were to determine the influence of harvest date and time in the swath on seed moisture content and seed characteristics such as seed mass, density, susceptibility to mechanical damage, and cooking quality of Laird lentil.

Harvest

The harvest experiments were conducted on a commercial field of Laird lentil near Saskatoon during 1988. The cooperative grower did not use any desiccants on his lentil crop. Between 4 and 26 Aug., 3×6-m plots of lentil were sampled every other day and swathed about every four days. Samples of the swathed crop from each harvest date were also taken every two days for periods of up to 15 d. The harvested plants were threshed quickly and the moisture content of the seeds was determined by the oven method (130°C for 20 h) as specified by the American Society of Agricultural Engineering (1987).

Weather information for the month of August 1988 was obtained from a local weather station. The information included average daily temperature, relative humidity, precipitation, and hours of bright sunshine.

Sample Preparation

Laird samples were bulked into six moisture levels, varying from 18.6 to 8.2% wet basis. The three samples with highest moisture contents were obtained directly from swathed plots. The three samples at lower moisture levels were prepared by drying the 14.9% moisture sample for various periods of time in a thin-layer dryer with drying air at 30°C and 5% relative humidity. The samples were sealed in plastic bags and stored at 4°C until used for bulk and kernel densities, weight, breakage susceptibility, and cooking quality evaluations.

Bulk and Kernel Densities and Mass of Lentil

Bulk density, defined as the mass of grain per unit volume occupied by grain and intergranular space, was measured according to the procedure specified by the Canadian Grain Commission (1987). The kernel volume of a known mass of seeds were measured with an air comparison pycnometer (Model 930, Beckman Instruments Inc. Calif.). The kernel density was calculated as a ratio of mass over volume. Mass of 1000 seeds was measured by counting and weighing the seeds on an electronic balance (±0.01 g).

Each of the above tests was conducted at room temperature of 22°C±1°C, and relative humidity of about 12%. A randomized design was employed with four replications.

Seed Breakage

To simulate the type of forces that grain would be subject to in normal harvest and postharvest handling, transport and storage, the breakage susceptibility of lentil was conducted on the Stein Breakage Tester (Model CK-2M Stein Laboratories, Kansas). This equipment

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consists of a two-blade impeller rotating at a speed of 1725 rpm inside a 92-mm-diam. by 90-mm-deep cup. One hundred grams of clean, sound lentil seeds were placed into the cup and subjected to impact and shear forces for 4 min. The samples were removed and sieved on a 4.76 mm-round hole sieve for 40 strokes and the overs weighed. The difference between the weight of the original sample and of the overs was used to calculate percentage of breakage.

The effects of moisture on breakage susceptibility were evaluated at room temperature of 22±1°C and at a winter temperature of −25±1°C in an environmental chamber. The tests were conducted in triplicates.

Cooking Quality

Ten-gram samples of seed were added to 50 mL of distilled, deionized water in 250-mL Erlenmeyer flasks, covered with tin foil, and held in a boiling water bath for 60 min (Bhatty et al. 1983). After cooking, water was drained off through fine sieves, and the samples were cooled to room temperature. The texture of the sample was then measured with a Kramer shear press (Model TP-1, Food Technology Corporation, Reston, Va.) fitted with a thin multi-blade shear compression cell. The maximum compression-shear force experienced in the test, expressed as kg g^{-1}, was used as the index of cooking quality. A four-replicate randomized experimental design was employed.

Effect of Swathing on Moisture Content

On standing plants, seeds moisture contents decreased from 59% on 4 August to 32% on 14 August (Fig. 1). Thereafter, rainfall (Fig. 2) and high humidities (Fig. 3) resulted in higher seed moisture levels until 22 Aug. The final and lowest moisture content reached by mature seeds on standing plants was 22% on 26 Aug.

Swathed lentil dried much more rapidly than seeds on standing plants (Fig. 1). For example, the moisture content of seeds from the swath made on 4 Aug. decreased from 58 to 14% within 10 d. A period of sustained rainfall between 16 and 22 Aug. (Fig. 2)

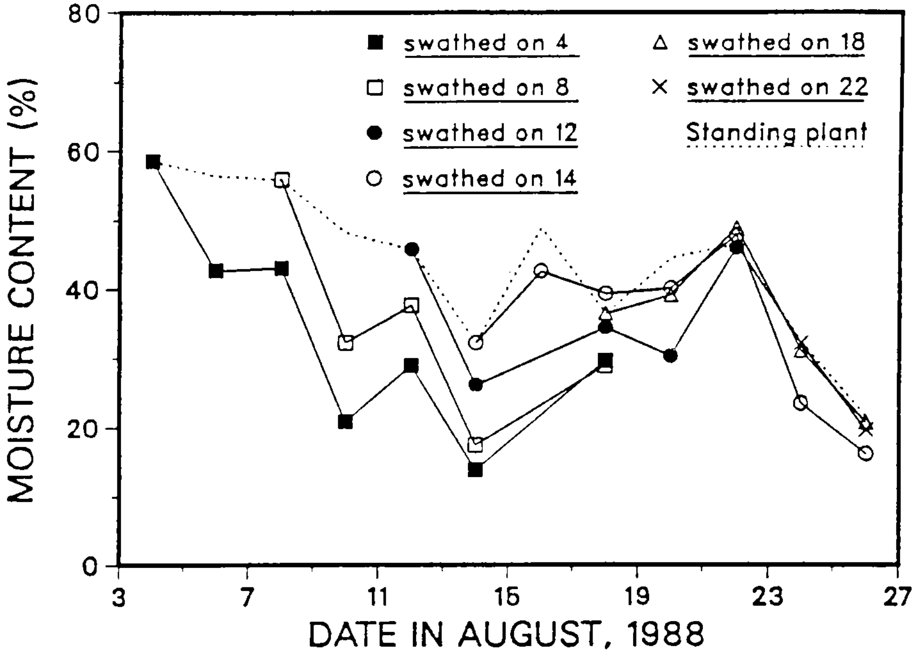

Fig. 1. Effect of harvest date of standing plants and days in swath on moisture content of lentil seeds during August 1988, mean of triplicates, SD <2.0%.

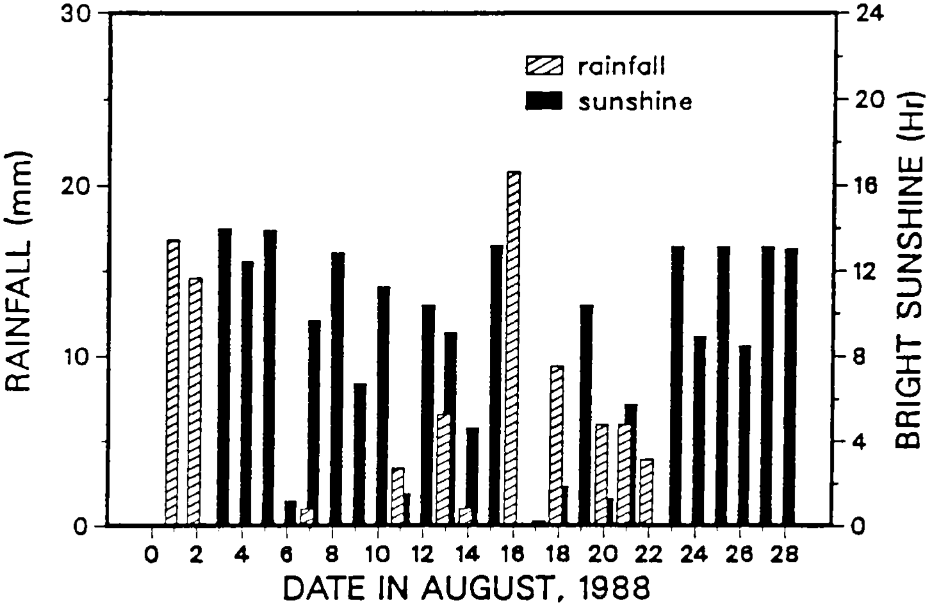

Fig. 2. Local daily precipitation and hours of sunshine during August 1989.

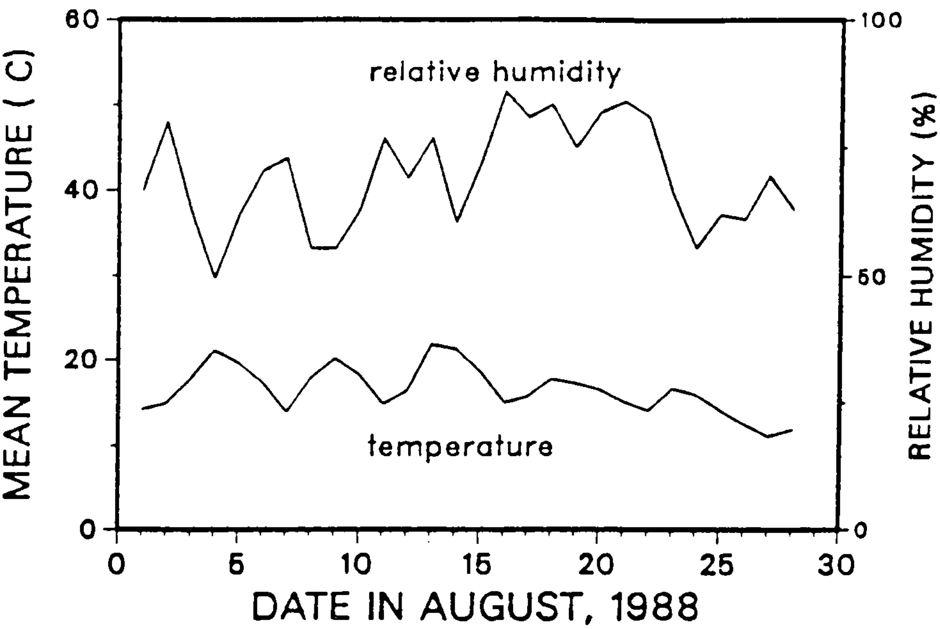

Fig. 3. Local daily mean temperature and relative humidity during August 1988.

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resulted in a general increase in moisture contents of both swathed and standing plants (Fig. 1). However, early swathed showed less moisture uptake than later swaths, until the very end of the raining period when all swaths and the standing crop approached 50% moisture content once more. After sunny weather returned, no substantial differences were observed in the rapid drying rates of lentil samples from swaths and standing plants. Moisture contents of lentil seeds from the swathed and standing plants observed on 26 Aug. varied from 16 to 22%.

The rewetting of lentil caused distinct wrinkling of the seed coats and about 10% of seeds in the swaths sprouted by the end of the rainy period. Furthermore, the wet swaths sank into the stubble, making harvest very difficult.

The present data support the farm experience that natural drying in the field was slow and ineffective in reducing seed moisture content. It appeared that swathing was an efficient technique to facilitate early harvest of lentil. However, prolonged rainy and humid weather conditions could seriously damage the crop in swath, and cause considerable crop loss.

Densities and Mass of Lentil Seeds

Bulk densities increased from a measured value of 771.7 kg m^{-3} for the 18.6% moisture sample to 799.7 kg m^{-3} for the lowest moisture sample tested, 8.2% (Table 1). Variations in kernel densities were small in the moisture range used in the present study. The maximum kernel density of 1379.4 kg m^{-3} was obtained at the intermediate moisture level of 12.1%. In the mature seed at 18.6% moisture content or less, the weight of 1000 seeds decreased with a decrease in moisture content as would be expected.

Breakage Susceptibility

Under the shear and impact forces in the Stein Breakage Tester, there was almost no seed breakage in the lentil harvested at 18.6% moisture when tested at room temperature (Table 1). The breakage reached 4.9% at the 14.9% moisture level, but then increased markedly to 37% at 8.2% moisture level. In the cold environment of −25°C, lentil seeds were much more brittle at high moisture levels. Breakage at this low temperature was two to seven times greater than was obtained at room temperature in the moisture range from 18.6 to 12.1%. However, the damage was uniformly high in the 10.6 and 8.2% moisture samples at both temperatures.

The present data indicate that seed moisture content significantly affected the susceptibility of lentil to mechanical damages. Mechanical handling of lentil seeds at a moisture content of below 15% could result in a sharp increase in breakage. Furthermore, serious losses in grade are almost inevitable when lentil seeds are handled during cold

Table 1. Effects of harvest moisture content on seed quality

	Moisture content (%)					
Seed parameters	18.6	16.5	14.9	12.1	10.6	8.2
Bulk density (kg m^{-3})	771.7	778.2	779.4	793.4	796.0	799.7
SD	0.4	1.8	1.4	1.0	1.1	1.3
Kernel density (kg m^{-3})	1364.6	1365.7	1375.1	1379.4	1375.4	1371.2
SD	0.7	0.7	1.3	2.1	1.3	1.3
Weight of 1000 seeds (g)	81.0	80.0	78.5	76.1	74.9	73.2
SD	0.8	1.1	0.4	1.1	0.7	0.4
Breakage at 22°C (%)	0.5	3.9	4.9	15.9	23.7	36.9
SD	0.2	0.1	0.1	0.7	1.3	1.3
Breakage at −25°C (%)	3.5	16.7	18.3	27.0	27.5	32.7
SD	1.1	0.8	1.9	2.8	2.3	0.4
Seed hardness (kg g^{-3})	3.6	3.4	3.2	3.9	3.4	3.5
SD	0.1	0.0	0.1	0.1	0.0	0.1

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mid-winter temperatures which are commonly experienced in Western Canada.

The degrees of seed breakage in the present study are similar to those obtained with corn and soybean using the Stein Breakage Tester (Miller and Hughes 1979; Miller et al. 1981). These crops are rated as highly susceptible to breakage during handling and transport, and precautions taken with these crops may have applications in postharvest technology of lentil.

Cooking Quality

The maximum compression-shear forces for the six samples varied between 3.2 and 3.9 kg g^{-1} (Table 1) with no apparent effect of harvest or initial seed moisture content. Bhatty et al. (1983) considered that a shear force of less than 4.0 kg g^{-1} indicates a fully cooked condition in lentil. It appeared that lentil seeds harvested at 18.6% moisture content or less were normal with respect to cooking quality.

CONCLUSIONS

Swathing of lentil is necessary for rapid dehydration of seeds and early harvest. However, field drying of lentil below 15% may result in considerable damage during threshing and handling. Therefore, the practice of harvesting the swaths at 18–20% moisture content, and artificially drying the seed to 14% moisture content, is strongly recommended. At cold temperature, lentil seeds become very susceptible to mechanical damage, and mechanical handling of lentil under such conditions should be minimized. Cooking quality of lentil was not affected by the early swathing and field drying as practiced in this study.

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