POTENTIAL OF LOW TEMPERATURE DRYING FOR REDUCING GREEN SEEDS IN CANOLA

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INTRODUCTION

A major problem with canola quality has been the presence of green seeds. The green colour in canola seed is caused by chlorophyll which is extracted with the oil during processing and increases the cost of refining the oil (Yuen and Kelly 1980). If not removed, the colour detracts from the appearance of the oil and chlorophyll degradation products reduce shelf life of the oil (Daun 1982).

The tolerances for distinctly green seeds in No. 1 and No. 2 Canada Canola Grades are only 2% and 6%, respectively (Canadian Grain Commission 1987). Daun (1987) showed that in order to maintain the top grade oil, the maximum level of chlorophyll content in oil should not exceed 25 mg/kg and the upper limit for chlorophyll in top grade seed should be only 22 mg/kg dry matter, which corresponding to 2% distinctly green seeds.

Salunkhe and Desai (1986) reported that chlorophyll content of immature rapeseed can be reduced by ambient air drying whereas rapid drying with hot air resulted in retention of green colour. The study by Cenkowski et al. (1989a, 1989b) reported the effect of the artificial drying on colour of canola seeds and of conditioning with the ambient air at 25°C and 90% RH (relative humidity) on chlorophyll content of canola seed (Cenkowski et al. 1990). Based on the requirement that chlorophyll for extracted oil in the top canola grade should not exceed 25 mg/kg it was apparent that artificial drying of freshly-harvested seed was only partially successful in improving canola grades.

The objectives of this investigation were: to determine the effects of plant maturity on the moisture content and chlorophyll content of canola seeds, and to determine the effect of conditioning canola seeds with air at 25°C and 90% RH on their chlorophyll content.

PLANT MATERIALS AND SAMPLING

The experiments were conducted for two successive years: 1989 and 1990. For experiments, canola (Brassica napus L. cv. Westar) was planted in a 4 ha field at the Glenlea Research Station of the University of Manitoba.

Planting dates were May 31, 1989 and June 1, 1990. Canola was planted in a 4 ha field divided into 600 subplots in 1989 (2.5 x 3.0 m) in the center. Harvesting was daily (1989) and twice weekly (1990) beginning after 82 days. Samples were harvested between 9:00 am and 1:00 pm. Harvesting continued until frost in 1989 (104 day) and until moisture was 7% in 1990 (99 day). (Data on 1989 and 1990 swath can be obtained from the authors).

In 1990, one randomized strip (2 m wide) was swathed across the field each week. Samples from the standing plants were harvested from 3 x 3 m plots using a hand-held scythe along the swath at three different arbitrarily chosen locations. The harvested samples in both years 1989 and 1990 were handled identically for threshing, cleaning and analysis.

Plants were threshed using a Vogel Plot Thresher and seeds were cleaned using a blow type cleaner. A 50-g subsample was stored in a sealed plastic bag in a deep freezer at a temperature below -10°C for determination of chlorophyll content. The rest of the sample was conditioned by forcing air at 25°C and 90% relative humidity in a horizontal thin layer dryer (Shatadal et al. 1990). About 100 g of seed was placed between two metal screens in a layer approximately 2-3 seeds thick. After 24 h of conditioning the canola sample was placed in a sealed plastic bag and stored in the deep freezer until analysis of chlorophyll content.

In 1990 harvest year, the samples harvested on the same day from different plots were not mixed prior to testing. In this year, apart from one sample placed in the thin-layer dryer, two other subsamples were placed in the sealed plastic bags and left for 24 h at two different temperatures: 10 and 25°C. After conditioning, all samples were placed in the deep freezer for about 2 months, when further analysis was done.

Seed Analysis

The moisture contents of fresh and conditioned samples were determined by drying triplicate samples at 130°C for 4 h in a convection oven as outlined in ASAE Standard S352.1 (ASAE 1989) and are reported on a wet mass basis.

Chlorophyll contents of the seeds were determined by the modified "Swedish extraction procedure (Daun et al., 1989). A 4-g seed sample was ground and extracted using 30 ml solvent (heptane-isopropanol-methanol solution, 1.5:1.5:1 v/v). Optical density of the solvent/oil solution was read using a Spectronic 1001 spectrophotometer. Two replicate measurements were made for each sample.

RESULTS AND DISCUSSION

Moisture Contents of Canola Samples from the Field

The moisture contents of the seeds from standing plants for both years (1989 and 1990) are presented in Fig. 1. Each data point, for the 1989 experiment, represents an average moisture content of mixed sample from three randomized plots. For the 1990 experiment, each data point represents average values from 4 to 5 samples and the bars indicate the confidence interval at 95% confidence.

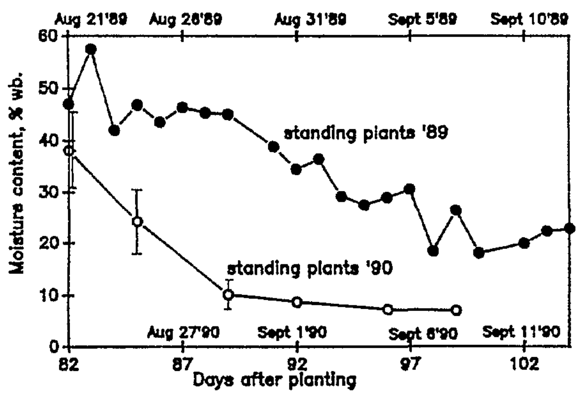

Fig. 1. Moisture contents of canola seeds harvested at different stages of maturity.

The moisture content of the seeds from standing plants (solid circles, Fig. 1) was approximately 47% on August 21, '89 (day 82) and increased to 57% by the next day because of the late afternoon rain on August 21, '89. The seed moisture contents from standing plants did not change appreciably between August 23 (82 days) and August 28 (87 days), remaining at 44% to 46% moisture and immature and green in appearance. From August 29 (88 days) to September 7 (98 days), the moisture content decreased slowly to about 18%. An increase in moisture content was also observed between September 8 (99 days) and September 12 (103 days) due to rainy weather and high humidity.

In the experiment conducted in 1990, the average moisture content of the seeds from standing plants (open circles, Fig. 1) had already decreased to 38% by August 22 (82 days after planting) and dropped to 10% by August 29 (day 89). The moisture content then continued to drop slowly until a final moisture content of 7% was reached on September 8 (99 days).

There was a significant difference in the pattern of moisture content reduction between the samples harvested in 1989 and those harvested in 1990. The warmer, drier weather in 1990 meant that samples reached the recommended moisture content for swathing (35%) by August 23 (83 days) while this was not reached until August 31 (92 days) in 1989. The continued cool moist weather in 1989 meant that seed in the standing crop had only reached 18% moisture by the time of the first frost on September 10 after 104 days. In 1990, the continued dry warm weather meant that seed in standing plants had reached physiological maturity (10% moisture) after 89 days. The lowest moisture content over the 1990 harvest period was approximately 7% (day 99) after which point sampling ceased.

Changes in Chlorophyll Contents of Canola Samples from the Field

The chlorophyll contents of the seeds from standing plants harvested in 1989 were in the range between 360 and 480 mg/kg in the first two days of harvesting (August 21, '89 and 22, '89) (Fig. 2). The differences up to 150 mg/kg in chlorophyll contents were observed in the first week of sampling in different spots of the field depending on the maturity of seeds. These differences decreased to about 70 mg/kg in the period between August 31, '89 and September 6, '89 (days 92 to 98). After September 6, '89, the differences in chlorophyll contents of seeds from standing plants in different areas of the field almost disappeared.

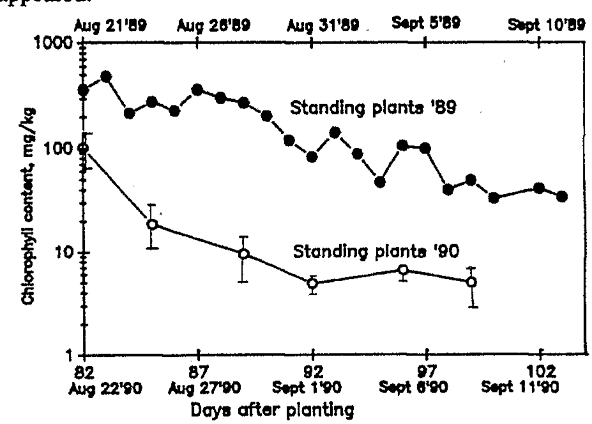

Fig. 2. Chlorophyll contents of canola seeds harvested at different stages of maturity.

The chlorophyll content of seeds from standing plants harvested in 1990 was approximately 100 mg/kg of dry seeds on August 22 '90 with a 95% confidence marked in the graph. After 3 days the chlorophyll content dropped to 19 mg/kg which is already below the required chlorophyll content level of 22 mg/kg dry seeds for canola grade No. 1 and finally, reached the level of approximately 7 mg/kg on September 5, '90.

Length of growing period and swathing date are two of the many factors that influence the chlorophyll levels in B. napus growing in Southern Manitoba. Seeds swathed after at least 94 growing days should average 14 mg/kg chlorophyll (Clear and Daun 1985). The optimal swathing period in the report by Clear and Daun (1985) was determined as August 16 to August 31. In our present study for 1989 crop, 94 growing days would indicate that canola should be swathed on September 2, '89, but chlorophyll content of seeds from different plots in the sub-field on that day were between 50 and 100 mg/kg. Even on September 12 '89 the chlorophyll contents of seeds were approximately 30 mg/kg. Because on September 10 and 12, '89 temperature dropped below zero, leaving canola on swath even at favourable conditions would not reduce the green seed colour. It means that this canola could not be graded as grade No. 1. For 1990 crop, canola seeds reached a desire level of chlorophyll content on August 27 which was the 87 growing day. The chloropyll level of this crop is below the average chlorophyll level for No. 1. Canadian Seed as reported by the Canadian Grain Commission (DeClercq et al., 1989, 1990).

Relationship between Moisture Content and Chlorophyll

There is a direct relation between decrease in moisture content and change in chlorophyll content of seeds. This relationship is shown in Fig. 3 where results of two harvest years for seeds from standing plants are pooled. At 95% confidence the individual values for chlorophyll content of seeds at 10% wb would be scattered in the range ±20 mg/kg.

Larsson and Gottfridson (1974) stated in their investigation that decrease in chlorophyll content after harvest is very much dependent on moisture content in the seeds. In our investigations it is confirmed by the semi-log plot (Fig. 3). Lowering the moisture content of seeds during maturation process reduces the rate of chlorophyll changes in seeds.

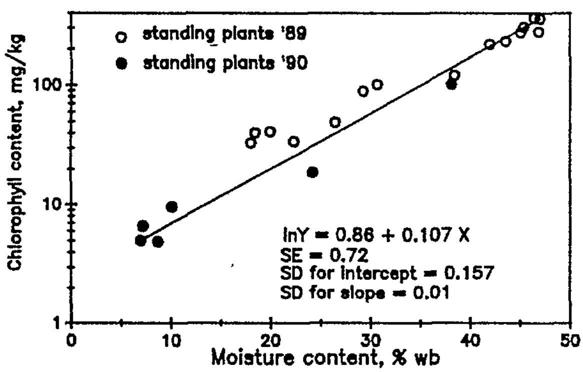

Fig. 3. Semi-log relationship between chlorophyll content of canola seeds at different stages of maturity.

Effect of Conditioning on Chlorophyll Content

The seeds from standing plants were conditioned for approximately 24 hours in the airstream at 25°C and 90% RH. After conditioning the seeds were checked for chlorophyll contents. The results of the chlorophyll contents of seeds from standing plants before and after conditioning are shown in Fig. 4. The solid line represents the regression line with a slope a = 0.83 and r^2=0.94. A slope less then one indicates the change in seed chlorophyll after conditioning. In the 1990 experiment canola seeds from standing plants were also kept for 24 h in the sealed plastic bags at two different temperature: 10°C and 25°C. The observed reduction in chlorophyll content of seeds in most cases was none or even an increase in chlorophyll content was noticed. This increase was observed particularly for low chlorophyll content samples (< 10 mg/kg) and could be due to the accuracy of the spectrophotometer at such a low range or possibly to incipient sprouting.

Larsson and Gottfridson (1974) reported that the decreases in chlorophyll contents is in relation to storage temperature and interaction between moisture content and temperature was noted. They showed that chlorophyll content can be markedly reduced at temperatures of 10 to 20°C, if the moisture content is above 25 per cent. Also in our present two year study, conditioning canola seeds at 25°C decreased chlorophyll contents on the average by approximately 16% with a standard deviation of 12%.

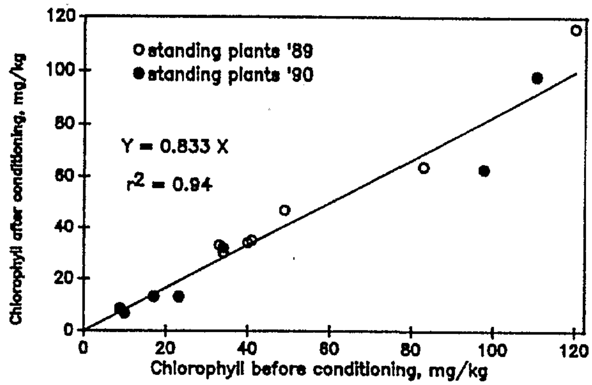

Fig. 4. Chlorophyll contents of canola seeds before and after conditioning at 25°C and 90% RH for 24 h.

CONCLUSIONS

Decreases in chlorophyll content in canola were directly related to the decrease in moisture content. Conditioning canola seeds at 25°C and 90% RH decreased the chlorophyll contents on the average by 16% with a standard deviation of 12%. These results indicate the need for further research under a wider range of conditioning parameters.

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