PAMI Project No. RP0293
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FINAL REPORT

CHLOROPHYLL REDUCTION

IN HARVESTED CANOLA

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TABLE OF CONTENTS

1. INTRODUCTION

Canola is now Saskatchewan's second largest crop. Annual production in 1991 was about 1.9 million tons (1.7 million tonnes), valued at $403 million. The acreage devoted to Canola is quickly increasing as prices hold steady or increase and export markets open up. In 1991 Canola acreage was 3.4 million acres (1.4 million ha) compared to an estimated 6.7 million acres (2.7 million ha) in 1994. About 50 to 55% of Canada's Canola and Canola oil is exported. Canola is recognized as a superior oilseed product producing top quality oil.

Some customers have expressed concern over the high levels of chlorophyll in the seed or crude oil of Canadian Canola. Chlorophyll is difficult and expensive to remove during oil processing. The price differential between grades 1 and 2 Canola, currently around $25/tonne could cost Saskatchewan growers up to $17 million, using 1991 production figures and assuming 40% of the crop was down-graded due to chlorophyll such as occurred in 1987. At the same level of down-grading and given 1994's acreage the potential losses are staggering.

A post-harvest control or chlorophyll reduction technique would help farmers to achieve optimum grades while still harvesting within the constraints of Saskatchewan's weather. A few researchers have done limited trials on various storage methods in trying to reduce the chlorophyll content. Results have been inconsistent at best.

While conducting a project - Guidelines for Improved Storage Life of Lentils - PAMI personnel found that green lentils would deteriorate in quality by changing to a brown colour when subjected to light and warm conditions. This change in colour probably corresponded to a breakdown of the chlorophyll in the seeds as it also occurred when oxygen was excluded. It was felt that the parameters of heat and light may have an interconnected affect in this process. Should this be correct, modified storage may allow the natural breakdown of the chlorophyll in Canola and eliminate the necessity of expensive oil filtering techniques.

The Saskatchewan Canola Development Commission (SCDC) contracted the Prairie Agricultural Machinery Institute (PAMI) to investigate the effect of various storage conditions on Canola with a high initial chlorophyll content.

2. EXECUTIVE SUMMARY

A study was done to determine the effects of various temperatures, light levels and moisture contents on retained chlorophyll on stored Canola. Samples of Canola with high levels of retained chlorophyll were stored under different levels of these variables for a six month period. Crush plate tests were done at the beginning, periodically throughout, and at the end of the storage period. Although none of the storage conditions could definitely be shown to reduce the chlorophyll levels, there may have been a slight trend in the higher moisture Canola stored at 15°C. It is recommended that more research be carried out with a minimum storage temperature of 15°C. Less emphasis could be put on different levels of light and moisture. If higher moisture levels (+9%) are used some means of preventing spoilage such as a controlled atmosphere, will be needed.

3. PROJECT DESCRIPTION

Samples of Canola with a high initial chlorophyll content were stored in the laboratory under various conditions. For this test, two different moisture contents, three temperatures, and two conditions of light were used (See Project Scope). A crush plate was used to determine initial and final chlorophyll contents. An average chlorophyll content was calculated from three samples for each condition and from these averages a determination was made as to the degree of effectiveness of the storage condition in reducing the chlorophyll content. All samples were stored for six months in the conditions indicated.

4. PROJECT OBJECTIVES

The objective of the project was to determine the effect of seed moisture content, seed temperature and light on the breakdown of retained chlorophyll in harvested Canola.

From this determination, a set of guidelines for storing Canola with high rates of initial chlorophyll contents could be established which would lower the chlorophyll during storage.

5. PROJECT SCOPE

Samples of Canola with high levels of retained chlorophyll were stored in clear plastic bags for a six month period under various storage conditions. They were stored at two moisture contents (9.3 and 6.1%), three temperatures (-5, +5, and +15°C), and two light conditions (complete darkness and under grow light). Sample size was 2.2 lb (1.0 kg), and three replicates of each sample were stored in each of the conditions above.

A refrigerator and two freezers were used to store the samples. Moisture contents were determined with a Labtronics 919 moisture meter. Temperatures inside the compartments were controlled with a data logger and controller. The dark stored samples were placed in opaque plastic bags. The samples stored in light were placed continuously under 60 Watt grow lights, and were mixed periodically so that the whole sample would be exposed to the light at some point.

A crush plate was used to determine the percentage of green Canola seeds in each sample before the test, every month for the first three months, and at the conclusion of the six month storage period. The summarized results are given in Results and Discussion and all of the data is presented in the APPENDIX. Due to the large amount of variability in the green seed counts various sampling methods were attempted. These included large numbers of crush plate tests from each sample; and combining the three samples, thoroughly mixing, and doing crush plate tests from the composite sample. These attempts to remove the variability were largely unsuccessful. The method of sampling is recorded on the raw data sheets in the APPENDIX.

The crush plate test tends to be very subjective as the technician must assess the degree of 'greenness' in individual seeds. However, there are usually many shades of green in Canola samples with a large amount of retained chlorophyll. For this project a technician trained in grain grading at a primary elevator, analyzed the samples in the same manner as that used at the elevators to assess producers' Canola. The only deviation to the primary elevator test procedure was that a larger number of samples were analyzed to decrease the variability in the data.

6. RESULTS AND DISCUSSION

TABLE 1 shows the initial, monthly and final percentages of green seeds in the samples under various storage conditions.

TABLE 1. Percentage of Green Seeds in Canola Samples Stored Under Various Conditions.

CONDITIONS			FEB 1	FEB 22	MAR 23	APR 25	AUG 22
MC (%)	DARK/LIGHT	TEMP (°C)					
9.3	DARK	-5	31	28	35	40	39
		+5	37	28	36	33	34
		+15	36	29	35	36	31
	LIGHT	-5	33	33	36	45	35
		+5	34	25	34	43	36
		+15	34	27	31	37	27
6.1	DARK	-5	29	25	30	39	32
		+5	28	33	33	30	37
		+15	30	29	32	37	35
	LIGHT	-5	27	28	31	39	36
		+5	34	30	32	26	36
		+15	29	29	34	40	38

There was a large amount of variation in the number of green Canola seeds both in the individual samples and in the averages for any of the storage conditions. No significant trends were obvious in the summarized data. It is possible that the higher moisture Canola stored at 15°C shows a slight trend toward fewer green seeds, but the data is so variable that more research would be needed to prove that this set of conditions does in fact reduce the chlorophyll content. None of the storage conditions can be said to reduce retained chlorophyll in the Canola more than the other storage conditions with any degree of certainty.

There also does not appear to be a general trend in the entire population of seed as the storage period progresses. Thus time alone does not appear sufficient to change the colour of the seed. The number of green seeds at the second count (February 22) generally appears lower than at the other counts. However, it is extremely unlikely if not impossible for the percentage of green seeds to decrease over time and then increase again. In all of the samples the seeds were of varying shades of green and yellow. In many cases it was difficult to distinguish the colour. On this date the technician counting the green seeds may have inadvertently counted more of the light green seeds as yellow compared to later on in the test. To reduce the risk of experimenter error the same technician analyzed all of the samples, and if possible all of the samples were analyzed on the same day.

The technician observed that the samples which were stored at a lower moisture content were of a more consistent colour. That is, even though the percentage of green seeds did not change significantly over time, there were fewer seeds in the dark green range and more in the light green range than at the beginning of the storage period. This change was not sufficient to cause a change in the grade.

As mentioned in the proposal for this project, Swedish researchers, Larsson and Gottfridsson in the early 1970's determined that chlorophyll levels could be reduced in post-harvest Canola using earlier cutting dates and storing the grain at higher temperatures (20°C). However, fungi became prolific, and they recommended further work on combining elevated temperatures with aeration to control spoilage. Also, their study involved lab samples of only a few seeds.

It would appear from this current project that the storage temperature must be greater than 15°C to have a significant affect on the chlorophyll content. Also, it would appear that the presence of light has no effect at these low temperatures. Perhaps there may be some advantage to the presence of light at storage temperatures above 20°C.

Cenkowski et al reported that drying temperatures of 20^0-40^0 C were the best for samples with moisture contents less than 30% as far as reducing the number green seeds. They also reported that when Tobin Canola was harvested at stages from 52 to 16% seed moisture, the percentage of green seeds decreased from 64 to 2% respectively. Leaving the same plants in swaths for 4 days reduced the moisture content and green seed count substantially at each stage. Thus, careful selection of windrowing and harvesting dates along with proper warm air drying (if required) would still appear to provide the greatest potential for minimizing the chlorophyll content in Canola.

7. CONCLUSIONS AND RECOMMENDATIONS

From this study it can be concluded that the percentage of seeds with retained chlorophyll does not change in stored Canola due to the presence or absence of light, and at temperatures between -5 and +15°C. There may be some advantage to drying the Canola enough to reduce the risk of fungi and then storing it at temperatures above +20°C. It is recommended that any further research into reducing the retained chlorophyll in Canola do so with a minimum temperature of 15°C.

REFERENCES

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APPENDIX

RETAINED CHLOROPHYLL CANOLA SEED COUNTS

DATE Feb. 1, 1994

MOISTURE CONTENT 9.3 %

COMMENTS Five crush plate tests done on each of three samples, for each condition. One hundred seeds per crush plate (Values given are %)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	1	8	9	1	2	3	13	14	15	10	11	12	4	5	6	16	17	18
	27	27	21	34	34	33	32	35	46	22	37	26	24	37	33	33	49	33
	30	39	32	34	26	34	26	39	38	40	41	36	25	41	33	33	38	33
	39	36	26	35	40	43	40	39	38	26	38	32	35	43	32	32	32	32
	30	20	34	39	34	40	35	38	40	28	38	31	36	34	29	29	34	29
	33	34	33	44	37	48	26	29	35	32	33	27	38	30	38	38	33	38
AVERAGE	30.7%			37.0%			35.7%			32.5%			33.8%			34.4		

SIGNED Gerry Lowe

DATE FEB. 1, 1994

MOISTURE CONTENT 6.1 %

COMMENTS THREE SAMPLES COMBINED AND THOROUGHLY MIXED. FIVE CRUSH PLATE TESTS DONE ON COMPOSITE SAMPLE. ONE HUNDRED SEEDS / CRUSH PLATE ⇒ (%)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	25	26	27	19	20	21	31	32	33	28	29	30	22	23	24	34	35	36
		33			27			30			26			32			33	
		30			23			27			29			24			38	
		31			27			32			33			37			24	
		30			32			31			20			39			32	
		19			33			30			25			36			20	
AVERAGE	28.6%			28.4%			30.0%			26.6%			33.6%			29.4%		

SIGNED Terry Lowe

DATE FEB. 22, 1994

MOISTURE CONTENT 9.3%

COMMENTS TWO CRUSH PLATE TESTS DONE ON EACH OF THREE SAMPLES, FOR EACH CONDITION. ONE HUNDRED SEEDS PER CRUSH PLATE (VALUES GIVEN ARE %)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	7	8	9	1	2	3	13	14	15	10	11	12	4	5	6	16	17	18
	29	29	26	29	31	24	26	24	25	29	42	39	25	34	22	28	30	25
	28	22	36	29	21	33	38	33	25	35	36	19	20	30	20	27	22	29
AVERAGE	28.3%			28.0%			28.5%			33.3%			25.0%			26.8%		

SIGNED Penny Dawson

DATE Feb 22, 1994

MOISTURE CONTENT 6.1%

COMMENTS Two crush plate tests done on each of three samples, for each condition. One hundred seeds per crush plate. (Values given are %)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	25	26	27	19	20	21	31	32	33	28	29	30	22	23	24	34	35	36
	19	25	34	36	26	32	37	31	29	17	30	37	33	36	30	32	23	35
	23	24	25	30	39	31	22	29	28	37	28	24	25	29	28	30	32	24
AVERAGE	25.0%			33.0%			29.3%			28.0%			30.0%			29.3%		

SIGNED Terry Lawson

DATE Mar. 23, 1994

MOISTURE CONTENT 9.3 %

COMMENTS Five crush plate tests on each of three samples, for each condition. One hundred seeds per crush plate (%).

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	7	8	9	1	2	3	13	14	15	10	11	12	4	5	6	16	17	18
	45	41	40	40	40	43	33	31	30	34	39	29	54	39	32	28	36	28
	37	29	37	41	37	31	28	39	34	34	38	34	42	38	~~32~~ 22	31	39	42
	40	~~42~~ 42	27	34	33	35	36	40	39	38	28	37	33	32	35	27	31	36
	37	34	24	32	30	37	36	38	38	44	30	47	26	31	25	20	31	29
	34	37	25	41	33	28	28	42	32	40	30	32	36	31	24	22	26	33
AVERAGE	35.3%			35.6%			34.9%			35.6%			34.0%			30.6%		

SIGNED Terry Lowe

DATE Mar. 23, 1994

MOISTURE CONTENT 6.1 %

COMMENTS Five crush plate tests on each of three samples, for each condition. One hundred seeds per plate ⇒ (%).

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	25	26	27	19	20	21	31	32	33	28	29	30	22	23	24	34	35	36
	27	30	21	27	22	37	38	32	30	31	42	28	22	33	42	41	32	29
	26	31	25	28	32	32	30	40	33	26	29	33	28	37	27	35	27	40
	36	34	23	31	34	42	34	30	34	38	27	31	36	33	32	33	30	37
	25	30	28	37	29	38	29	28	20	30	26	32	28	33	28	30	41	28
	37	36	37	26	40	46	41	30	29	34	31	24	33	40	34	38	36	29
AVERAGE	29.1%			33.4%			31.8%			30.8%			32.4%			33.7%		

SIGNED Terry Dawe

DATE Apr 25, 1994

MOISTURE CONTENT 9.3 %

COMMENTS THREE SAMPLES COMBINED AND THOROUGHLY MIXED. FIVE CRUSH PLATE TESTS DONE ON COMPOSITE SAMPLE. ONE HUNDRED SEEDS / CRUSH PLATE ⇒ (%)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	7	8	9	1	2	3	13	14	15	10	11	12	4	5	6	16	17	18
		40			29			25			47			48			41	
		43			40			35			38			37			33	
		32			38			38			53			39			39	
		41			31			38			44			42			36	
		44			29			42			43			48			36	
AVERAGE	40.0%			33.4%			35.6%			45.0%			42.8%			37.0%		

SIGNED Leroy Davis

DATE Apr 25, 1994

MOISTURE CONTENT 6.1%

COMMENTS Three samples combined and thoroughly mixed. Five crush plate tests done on composite sample. One hundred seeds/crush plate ⇒ (%)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	25	26	27	19	20	21	31	32	33	28	29	30	22	23	24	34	35	36
		42			30			46			30			25			33	
		36			28			42			42			32			44	
		47			31			29			~~45~~			25			51	
		30			33			34			39			19			40	
		42			30			33			41			27			32	
AVERAGE	39.4%			30.4%			36.8%			39.4%			25.6%			40.0%		

SIGNED Jenny Lawn

DATE Aug. 17, 1994

MOISTURE CONTENT 9.3 %

COMMENTS THREE SAMPLES COMBINED AND THOROUGHLY MIXED. FIVE CRUSH PLATE TESTS DONE ON COMPOSITE SAMPLE. ONE HUNDRED SEEDS/CRUSH PLATE (%)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	7	8	9	1	2	3	13	14	15	10	11	12	4	5	6	16	17	18
		38			31			37			32			36			31	
		37			38			26			31			33			31	
		31			37			25			40			44			30	
		35			32			37			29			36			22	
		52			34			29			42			33			20	
AVERAGE	38.6 %			34.4 %			30.8 %			34.8 %			36.4 %			26.8 %		

SIGNED Lenny Dawn

DATE Aug 17, 1994

MOISTURE CONTENT 6.1 %

COMMENTS THREE SAMPLES COMBINED AND THOROUGHLY MIXED. FIVE CRUSH PLATE TESTS DONE ON COMPOSITE SAMPLE. ONE HUNDRED ~~FEEDS~~ CRUSH PLATE → (%)

	DARK									LIGHT								
TEMP	-5°C			+5°C			+15°C			-5°C			+5°C			+15°C		
SAMPLE	25	26	27	19	20	21	31	32	33	28	29	30	22	23	24	34	35	36
		38			38			27			40			27			27	
		32			39			36			38			40			32	
		24			38			37			32			38			44	
		35			36			36			35			34			45	
		34			33			39			33			40			41	
AVERAGE	32.3 %			36.8%			35.0%			35.6%			35.8%			37.8%		

SIGNED Terry Lawson