GENOTYPIC AND ENVIRONMENTAL EFFECTS ON SEED CHLOROPHYLL LEVELS IN CANOLA (BRASSICA NAPUS)

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INTRODUCTION

High levels of chlorophyll in canola seed at harvest result in the downgrading of the crop and a considerable loss of revenue. Chlorophyll pigments cause a number of problems including:

1) Hydrogenation reactions are impaired (Abraham and deMan 1986);
2) Chlorophyll promotes oxidation of the oil reducing the shelf life (Clear and Daun 1987);
3) Green coloured end products are produced (Clear and Daun 1987); and
4) Refining, bleaching and deodorizing is more expensive (Clear and Daun 1987).

OBJECTIVES

Limited information is available on the factors that contribute to high seed chlorophyll levels and how these can be modified to reduce the green seed problem. This research examines the influence of genotype and environment on the chlorophyll content of canola seed.

MATERIAL AND METHODS

Genotypic and Environmental Effects on Final Chlorophyll Levels in Harvested Canola Seed

All registered canola cultivars of both Brassica napus and B. campestris were grown at 10 to 11 sites throughout Manitoba in each of two years. Seeds were harvested at maturity and chlorophyll was measured using a near infrared reflectance spectrophotometer (NIR) (Tkachuk et al. 1988). Genotype and environmental effects on seed chlorophyll levels were determined.

Chlorophyll Degradation Rates in Ripening B. napus Seed

Four cultivars of B. napus (Westar, Tribute, Regent and Global) were grown in a RCBD in two years. Seed samples were taken from the main stems at weekly intervals beginning at physiological maturity, when the seed begins to turn from green to brown, and continuing until the plants were fully senescent (Harper and Berkenkamp 1975). Seed chlorophyll was measured by extraction and absorbance (Daun 1989). Rates of seed chlorophyll degradation were determined for each cultivar and the influence of temperature was investigated.

RESULTS AND DISCUSSION

Genotypic and Environmental Effects on Final Chlorophyll Levels in Harvested Canola Seed

Genotypic Effect. B. napus cultivars contained higher seed chlorophyll levels than B. campestris cultivars. This may be due to a faster rate of chlorophyll breakdown in B. campestris or due to the earlier maturity of the species (Fig. 1).

All B. campestris cultivars contained similar levels of seed chlorophyll at harvest. B. campestris cultivars mature in less than 90 days so all cultivars reach low chlorophyll levels prior to harvest (Fig. 1).

B. napus cultivars produced a wide range of chlorophyll levels. Triazine tolerant cultivars (TT) were just as variable as the normal canola cultivars (Fig. 1).

Table 1. Comparison of Average Chlorophyll Levels and Days to Maturity for Selected Canola Cultivars in 1989.

Cultivar	Average Chlorophyll (ppm)	Days to Maturity (*)
B. napus		
Global	31.2	100
Regent	29.5	94
Triumph(TT)	24.0	96
Westar	24.0	92
Triton(TT)	22.9	94
Tribute(TT)	19.3	93
Hero	16.5	89
B. campestris		
Tobin	9.0	82
Colt	8.2	82
Parkland	7.9	78

(*) Days to maturity is averaged over a 2-5 year period.
(TT) designates a triazine tolerant cultivar.

The correlation between average chlorophyll content at harvest and the number of days required to reach maturity was determined for each cultivar (Table 1). The overall correlation coefficient was 0.80. Cultivars that require longer growing seasons are more likely to be harvested prematurely or to ripen under adverse conditions. Therefore they are more likely to have high chlorophyll levels in the harvested seed.

Environmental Effect. Locations and years were both significant at the 5% level. Among the B. napus cultivars GxE interactions were also significant. Therefore cultivars must be tested over a wide range of sites over a number of years and their performance determined in all growing areas of interest (Ward 1990).

Chlorophyll Degradation Rates in Ripening B. napus Seed

The slope of each line represents the rate of chlorophyll breakdown in that cultivar. All slopes are similar indicating that within the same sowing all four cultivars have similar rates of seed chlorophyll degradation (Fig. 2).

Rates of seed chlorophyll breakdown were slower in the later seeding date.

The effect of temperature was investigated by converting to growing degree days (GDD) which provides a measure of the heat units accumulated throughout the ripening period (Morrison et al. 1989).

Table 2. Paired T-Test Results Comparing Chlorophyll Degradation Rates Between Years - Days After Sampling vs. GDD.

Sowing	Cultivar	DF	|T|(days)	|T|(GDD)
Early	Global	6	0.08 -	0.36 -
Early	Regent	6	1.13 -	1.75 -
Early	Tribute	5	2.66 *	1.93 -
Early	Westar	4	0.89 -	1.58 -
Late	Global	3	3.39 *	2.53 -
Late	Regent	9	3.51 *	2.10 -
Late	Tribute	9	4.75 *	1.91 -
Late	Westar	9	2.73 *	1.16 -

* significant at the 5% level

Paired t-tests compared chlorophyll breakdown rates in 1988 and 1989. When the slopes of log chl versus days after sampling were used many cultivars indicated different rates of chlorophyll degradation in the two years. The conversion to GDD eliminated most of these differences (Table 2). Therefore different rates of chlorophyll breakdown between years are largely a result of temperature differences during seed ripening (Ward et al. 1991).

From Figure 2 it is apparent that the four cultivars do not reach physiological maturity at the same time. Cultivars which require longer growing seasons to mature also initiate seed chlorophyll breakdown later, increasing the probability that high levels of chlorophyll will remain when the seed is harvested.

SUMMARY AND CONCLUSIONS

1) B. napus cultivars produced seed with higher chlorophyll levels than B. campestris cultivars;
2) B. campestris cultivars tested were uniform for seed chlorophyll levels;
3) B. napus cultivars produced variable seed chlorophyll levels;
4) Triazine tolerant cultivars showed the same range of seed chlorophyll levels as normal canola cultivars;
5) A correlation exists between final chlorophyll content and the length of growing season required;
6) The environment affects seed chlorophyll levels and there is a significant GxE interaction;
7) The rates of seed chlorophyll degradation were the same among the four cultivars of B. napus tested;
8) Cultivars that require longer growing seasons are more likely to contain high chlorophyll levels at harvest; and
9) The rate of seed chlorophyll degradation is affected by temperatures during seed ripening.

ACKNOWLEDGEMENTS

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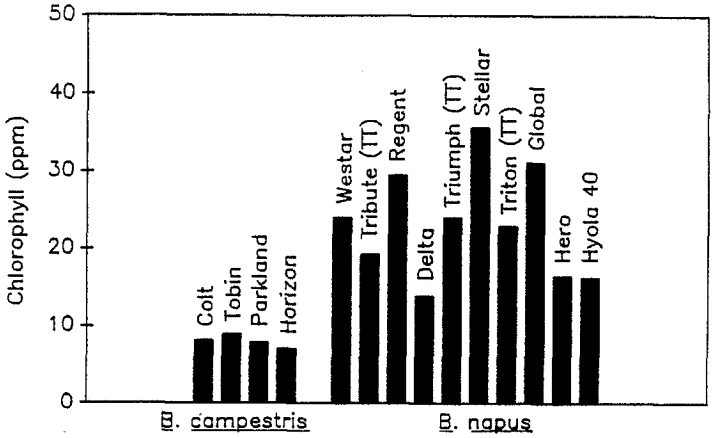

Fig. 1. Final Chlorophyll Levels in Selected Canola Cultivars in 1989

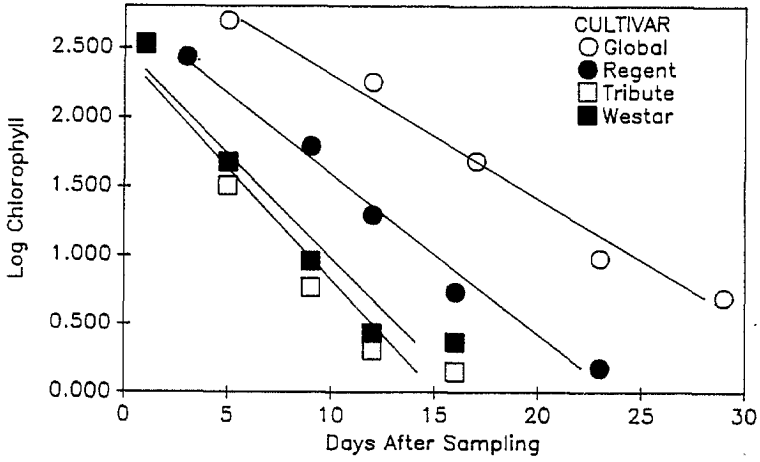

Fig. 2. Chlorophyll Degradation Rates in Four Cultivars of B. napus. Early Sowing 1989.