TEMPERATURE EFFECTS ON SEED COAT COLOR IN BRASSICA NAPUS

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INTRODUCTION

Since their development in the 1970's, the use of canola quality rapeseed cultivars has been adopted world wide. Canadian grown rapeseed is limited to spring types thus to lower oil concentration than the European grown winter types (Olsson 1960). Improved oil concentration is thus a primary breeding objective in Canada. It can be improved by developing yellow seeded rapeseed cultivars that are associated with higher oil and protein concentration and lower fibre content than dark seeded cultivars (Jonsson 1977). The partially yellow seeded turnip rape (Brassica campestris) cultivars Candle and Tobin were released in Canada in 1977 and 1983, respectively. These cultivars have 2.5% higher oil concentration and 1.0% higher protein concentration then dark seeded cultivars (Daun 1988). In summer rape (B. napus), yellow seeded genotypes showed a 2.6% advantage in total oil and protein over black seeded genotypes (Shirzadegan and Robbelen 1985).

Yellow seeded turnip rape and summer rape genotypes may have 5 and 3-4% lower fibre content, respectively, than corresponding black seeded genotypes (Stringam et al. 1974; Shirzadegan and Robbelen 1985; Porter 1991). High fibre in rapeseed meal decreases its digestability by pigs (Lee et al. 1984) thus decreasing its value as an animal feed.

Although B. napus makes up to 50% of the rapeseed grown in Canada, yellow seeded cultivars have not been released to date. Introgression of genes controlling yellow seed pigmentation in summer rape is complicated by allotetraploidy, genotypic maternal inheritance and multiple gene inheritance. Variation in seed color is observed even within the same pod. Studies on segregating progenies of dark and light seeds from single plants indicate that environmental factors are the cause of such variation (Shirzadegan 1986). Recent work at the University of Guelph indicates that genes controlling this trait have poor expressitivity under different environments. The objective of this research is to determine the effect of temperature on the expressitivity of seed coat color in summer rape.

MATERIALS AND METHODS

A yellow seeded doubled haploid summer rape (B. napus) line was obtained from microspore culture of a yellow seeded line selected from a B. oleracea and B. campestris cross. Three plants each were planted in six inch pots in growth cabinets at 15/12, 19/16, 20/17, 21/18, 24/21 and 27/22°C day/night temperatures under a 16 hour day photoperiod. These plants were selfed and the seed harvested when all the pods reached physiological maturity. Seed color was then classified visually as brown, light brown or yellow.

RESULTS AND DISCUSSION

Flowering and maturity was hastened at high temperatures. Generally, as temperature increased above 21°C, seed quantity and seed size decreased. Brown seeds were observed at daytime temperatures below 21°C. Daytime temperatures of 21°C to 27°C produced light brown seeds (Table 1).

Table 1. Temperature effects on seed coat color of *Brassica napus*

Temperature Day/night °C	Color	Temperature Day/night °C	Color
15/12	Brown	21/18	Light brown
19/16	Brown	24/21	Light brown
20/17	Brown	27/22	Light brown

In rapeseed, seed pigments are deposited in the palisade and crushed parenchyma layers of the testa (Vaughan 1970). The major constituents are condensed polyphenols, i.e. polymers of leucocyanidins (Leung et al. 1979). These were found to be more abundant in dark seeded than in yellow seeded turnip rape genotypes (Theander et al. 1977).

The palisade layer is derived from the outer integument. In turnip rape, at 20 days after pollination (DAP), cell organelles involved in secondary thickening of the palisade walls are disrupted and secondary thickening ceases. Seed coat development is complete 25 DAP (Van Caeseele et al. 1982).

The maturity of the summer rape cultivar Westar was hastened with increasing temperatures from 5 to 30°C. Temperatures over 25°C resulted in reduced pod and seed development in both field and greenhouse experiments (Norton and Harris 1975; Morrisson et al. 1989).

The production of lignin and pigments share a common biochemical pathway (Theander et al. 1977), thus their development would coincide. High temperatures may disrupt biochemical processes involved in production of pigments and secondary thickening. Studies on turnip rape indicated that yellow seed coats have reduced palisade layers and smaller cells, decreasing the proportion of testa to whole seed (Stringam et al. 1974).

Seed color of *Brassiceae* is associated with geographical distribution. Species with Saharo-Sindian distribution have yellow seeds, with few exceptions. Mediterranean species are brownish and Euro-Siberian species are usually black. Seeds of *Conringia orientalis* collected in Spain showed darker seed color than samples of the same species collected in Algeria (Gomez-Campo 1980). These results indicate that high temperatures are associated with light seed coats.

Temperature effects are common in seed quality traits of rapeseed. Canvin (1965) found that oil concentration and the level of polyunsaturates in rapeseed decreased with increasing temperature. This suggests a disruption in seed development since both these quality traits increase as the seed develops (Fowler and Downey 1970). The results of this experiment agree with the above observations in that light seed coats in rapeseed are associated with high temperature environments.

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