Response of yield and oil fatty acid composition to the temperature and intercepted solar radiation of traditional and high oleic canola sown in Argentine : New findings of the behaviour of spring canola

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New findings of the behaviour of spring canola

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Text

Vegetable oils with a high relative amount of unsaturated fatty acids are of great significance for human health. As in other crops, rapeseed genotypes were developed to produce oils with differentiated quality. Canola (Canadian Oil Low Acid) is one of the most widespread and is characterized by low concentrations of erucic acid, low glucosinolate concentration and low content of saturated fatty acids. But there are also other canola varieties like high oleic, low linolenic, and so on. Previous works showed that fatty acid composition and yield are affected by environmental conditions in winter traditional rapeseed, being the main factors the temperature and the intercepted photosynthetically active radiation (PAR). There are not data about the effects of these factors on fatty acid composition of spring traditional and high oleic rapeseed genotypes. Thereby the objective was to study the effect of temperature and intercepted PAR during seed filling on the fatty acid composition of rapeseed oil in spring traditional and high oleic cultivars.

Experiments were performed at different latitudes, Balcarce (Buenos Aires Argentine, 37ºS; 58ºW) and Córdoba (Córdoba, Argentina, 32ºS; 64ºW), and sowing dates in order to modify the solar radiation and temperature. Four spring rapeseed cultivars were grown at these locations, one traditional genotype, Hyola 61, provided by Advanta Semillas SAIC, and three high oleic genotypes, Nexera 8450, Nexera 170 and DN05 1874, provided by Dow AgroSciences. There were three sowing dates in Balcarce (12 May 2011, 1 June 2011 and 11 July 2011) and one sowing date in Córdoba (31 May 2011). In Córdoba and the third sowing date of Balcarce three treatments to modify the intercepted PAR were applied: shading 80%, thinning plants and control. Treatments were applied in G2 according to the phenological CETIOM scale. The cultivars were isolated to prevent cross-pollination. Experiments were performed under optimum water and nutrient conditions. Weeds, insects and diseases were adequately controlled. Samples were collected at maturity and fatty acid composition was analysed by gas chromatography and the yield and weight per grain were calculated.

Yield for the traditional cultivar ranged between 106.7 and 167.28 gr/m^2 and between 72.0 and 138.6 gr/m^2 for the high oleic cultivars depending on the location, sowing date and genotype. Also weight per grain in the high oleic cultivars differed between locations but not between sowing dates. Nevertheless shading treatments in Balcarce reduced almost 30% yield and grain weight per plant in all genotypes. Also, in Córdoba weight per grain was reduced significantly by shading in both genotypes; however yield only showed significantly differences among radiation treatments in the traditional one.
The oleic acid concentration ranged in Balcarce between 68.7 and 71.0% for the traditional cultivar and between 79.4 and 82.7% for high oleic cultivars depending on the genotype and sowing date. For each genotype, these variations were not associated to mean temperature during grain filling. In Córdoba, cultivars Hyola 61 and Nexera 8450, both sown in the two studied locations, presented similar fatty acid composition than in Balcarce, although there was a difference of 2 °C between locations. In all genotypes, a higher concentration of oleic acid was associated with a lower concentrations of linoleic acid. Saturated fatty acids presented narrow ranges of variation, between 3.16-3.8% (palmitic) and 1.2-2.4 (stearic) respectively. In both locations, shading treatments did not modify the concentrations of oleic and linoleic fatty acids. However, there was an increase of three and two percentage points in palmitic and stearic fatty acids respectively in both, traditional and high oleic varieties, when the shading treatments were applied.

The stability of oil composition as it was shown by the studied genotypes, regardless of the environmental conditions and yields, suggest that to obtain a given oil quality would be only necessary to select the appropriate cultivar, considering also its potential illness, crop cycle and tolerance to different biotic and abiotic stresses. Management practices could be adapted to this purpose.

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Introduction

- Canola represents a promising alternative to diversify crop production in Argentina. Previous work showed that fatty acid composition and yield of winter traditional canola are affected by environmental conditions during crop cycle, being the main factor the temperature. The effects of this factor and also the intercepted photosynthetically solar radiation on the oil fatty acid composition of spring traditional and high oleic canola genotypes is, at the best of our knowledge, still unknown.

Objective

- To study the effect of temperature and PAR during seed filling on the fatty acid composition of canola oil in spring traditional and high oleic cultivars as well as the oil quality/yield relationships.

Materials and Methods

Locations and sowing dates

Location	Coordinates	Sowing date
Balcarce (B), Buenos Aires, Argentina	37°S ; 58°W	12th May ; 1th June ; 11th July - 2011
Córdoba (C), Córdoba, Argentina	32°S ; 64°W	31st May - 2011

Genotypes , treatments and design

- **Genotypes**: H61 (B and C) (traditional); N8450 (B and C), N1700 (B) and DN05 (B) (high oleic).
- **Treatments**: Shading 80% (Sh80) and control (C).
- **Design**: Randomized complete blocks with three replicates. The main plot corresponded to the sowing date and the subplot to the genotype (seedling density of 6kg/ha). Experiments were performed under optimum water and nutrient conditions.

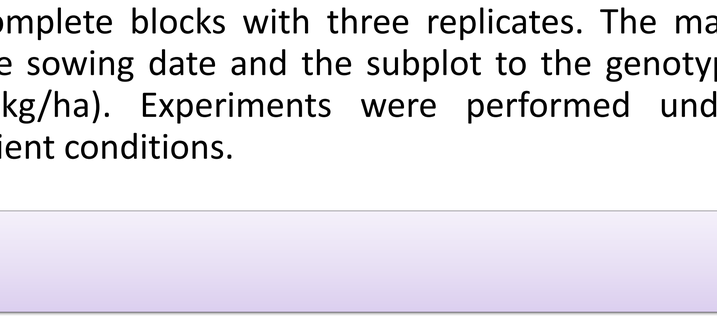
Analysis

- Samples were collected at physiological maturity.
- Fatty acid composition was analysed by gas chromatography.
- Yield and weight per grain were calculated.

Results

Environmental features (sowing dates and locations) of the experiments were selected in order to define the representative environmental conditions of Argentina. Mean temperature ranged from 16.5 to 19.5 °C, and PAR per plant, between 5 and 29 MJ/pl.

Shading treatment reduced yield and grain weight by almost 30% in all studied genotypes (Figure 1). Also genotypes showed lower values of yield at higher temperatures.



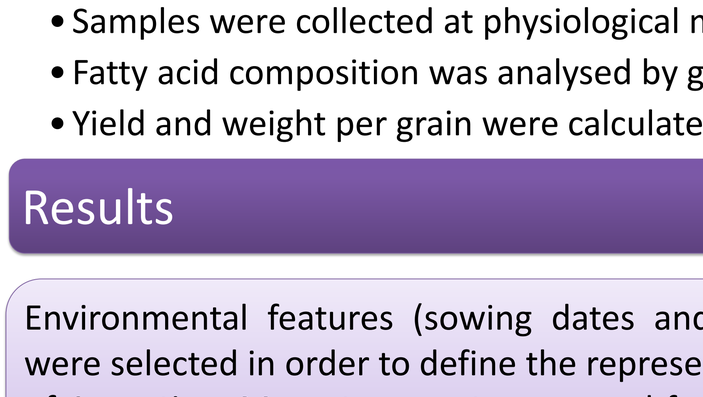
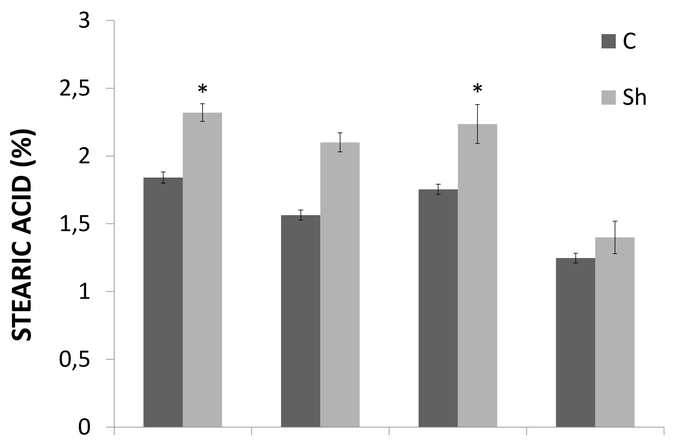


Figure 1: Yield and weight of one thousand grains. Stars represent significant diferences between control and shading 80%. p<0.05.

Stearic and palmitic acid increased with the shading treatment in the traditional genotype (H61) and the high oleic genotype (N1700) in Balcarce (Figure 2). However, the range of intercepted PAR explored between locations was not enough to see variations in oil quality (Figure 3).



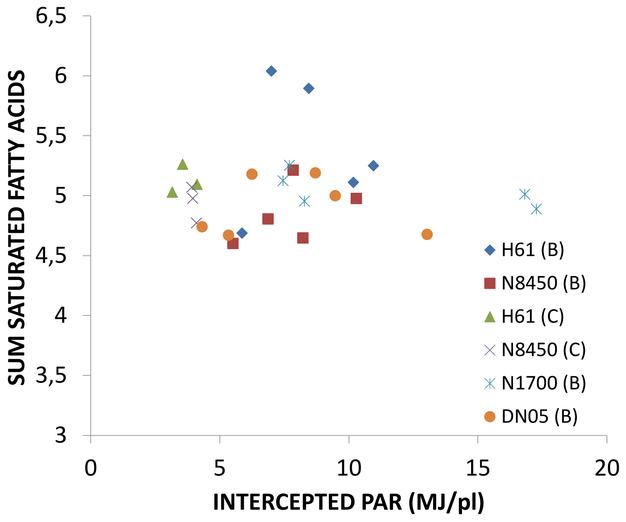


Figure 3: Relationship between the sum of saturated fatty acids and the intercepted PAR.

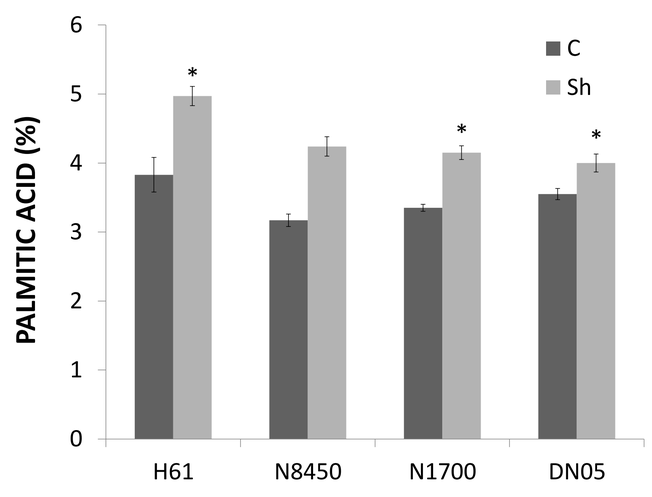


Figure 2: Stearic and palmitic acid percentages values. The graphs represent only the location of Balcarce. Stars represent significant diferences between control and shading 80%. p<0.05.

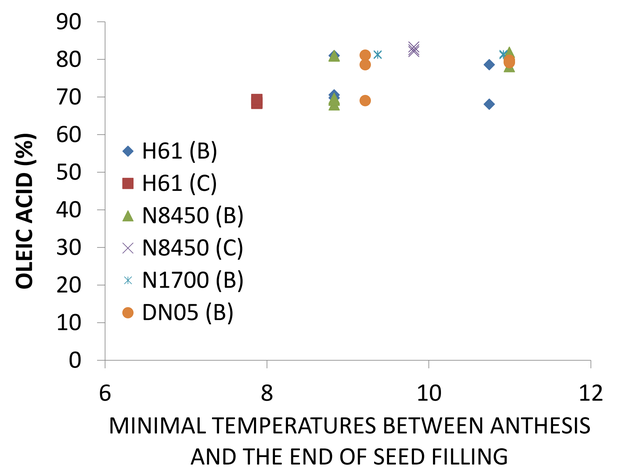


Figure 4: Relationship between the sum of saturated fatty acids and the intercepted PAR.

Oleic fatty acid tended to decrease with increasing yield, although this trend is not significant (Figure 5). Fatty acid composition behave stable against a wide range of yield not only for traditional, but also for high oleic cultivars.

No response of fatty acid composition of mature grains to temperature was detected for any of the genotypes (Figure 4). This lack of response may be explained as a response to typical values of temperature occurring in the sites explored in Argentina (Δt=3°C).

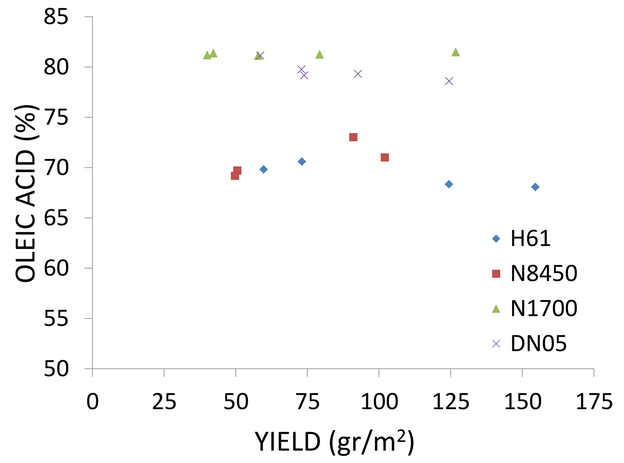


Figure 5: Relationship beetween the oleic fatty acid and yield.

The analysis of relationships between yield and quality of canola oil of high oleic and traditional spring cultivars sown in Argentinian conditions indicates that a stable quality could be obtain dispite of the wide range of yield explored.

Conclusions and perspectives

- The temperatures explored in the Argentinian conditions affected yield components, but it was not enough to affect fatty acid composition.
- The stability of fatty acid composition of the oil of these genotypes across the environmental conditions explored, could represent a major advantage when breeding for yield, since no physiological tradeoff between this trait and quality should be expected at the light of these results.
- Further and more precise experimentation is to be performed in the greenhouse and growth chambers in order to explore a wider range of temperatures than the ones reported here. This will allow a more thorough understanding of the ecophysiological behavior of spring canola quality components. This could help to separete genetic environmental and the interaction effects