YIELD POTENTIAL IN SPRING AND WINTER RAPESEED GENOTYPES

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Introduction

The yield potential of a crop can be defined as its expected yield, in an adapted environment with nutrients or water non-limiting, and under full control of any kind of adversity or stress.

Rapeseed winter cultivars usually out-yield the spring types; that is why introgression of winter germplasm into spring hybrids has achieved an increase in the yield of the latter.

In our region there have been yield differences between winter and spring cultivars; however it seems unclear whether these are actually due to differences in their yield potential.

The objective of this paper was to assess 4 rapeseed cultivars, 2 winter types and 2 spring types, under non-limiting conditions, to verify their yield differences.

Materials and Methods

The tests were implemented in 2008, on the grounds of the Estación Experimental Agropecuaria Balcarce (Balcarce Agricultural Experimental Station) (37°45' S, 58°18' W, 130 m.a.s.l.), and of the Estación Experimental Agropecuaria Integrada Barrow (Barrow Integrated Experimental Station) (38°19' S, 60°14' W) in the province of Buenos Aires, Argentina, belonging to INTA (National Institute of Agricultural Technology).

To choose the materials (treatments) we used the data provided by the Red Nacional de Evaluación de Cultivares de Colza (Argentinean Network of Rapeseed Cultivars), among which the winter type cultivars (winter) SWGospel (variety) and Pulsar (hybrid), and the spring type cultivars (spring) Biolza440 (variety) and SW2797 (hybrid) were chosen for their productive aptitude.

Table 1 shows the sowing date for each cultivar according to location.

Table 1: Sowing dates for different cultivars in experimental locations corresponding to the 2008 campaign.

Cultivars	Balcarce	Barrow
Pulsar (winter)	03-Jun	06-May
SWGospel (winter)	03-Jun	06-May
SW2797 (spring)	10-Jul	02-Jun
Biolza440 (spring)	10-Jul	02-Jun

Implantation in the plots was done with an experimental fine grain seeder in both locations; the sowing density was 5 kg ha^{-1}, obtaining a final number of 108 (± 30) plants m^{-2}. Details of the plots are summarized in Table 2. The experimental design used was randomized complete blocks with four repetitions.

Table 2: Dimensions, number of furrows, and distance between furrows (DBF) in the plots at different locations.

	Plot			
	Width (m)	Length (m)	Nº furrows	DBF (m)
Balcarce	1.4	11	7	0.2
Barrow	2.6	6	8	0.32

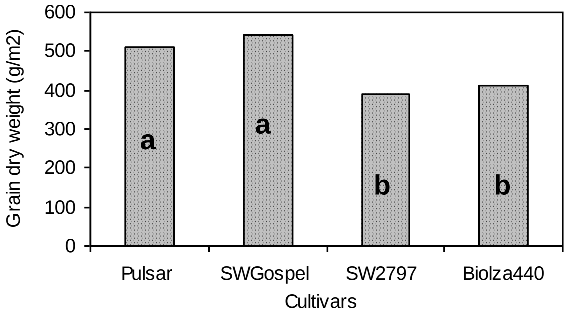
The fertilization plan for both tests included an initial fertilization of 90 kg diammonium phosphate ha^{-1}, which was incorporated into the soil before sowing. Then 170 kg N ha^{-1} was applied in a fractionated way from the rosette stage till the visible flower bud; the application was broadcast on the total surface. In addition, 35 kg S in the form of calcium sulphate ha^{-1} was applied together with the N applications. With the applied quantities, nutrient limitations for growth and yield levels should not be expected in the current tests.

Both tests had supplementary irrigation and full control of biotic adversities.

The yield of each cultivar and their numerical components were assessed at physiological maturity.

Results and Discussion

In both locations the winter cultivars had a significantly higher yield than the spring types (Fig. 1). These types of cultivars yielded on average 31 and 76% more than the spring types in Balcarce and Barrow respectively. The highest yield (540 g m^{-2}) was reached in Balcarce with the SWGospel winter cultivar.



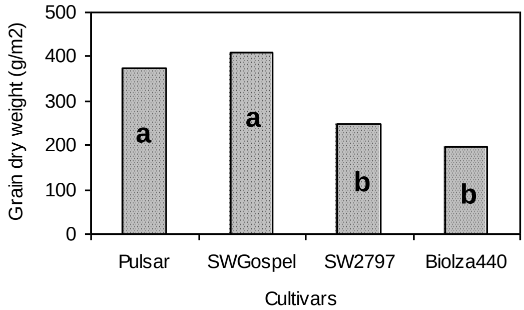


Fig. 1: Yield, expressed in g m^{-2}, of 2 winter rapeseed cultivars and 2 spring cultivars, in Balcarce (left) and Barrow (right); in each location, different letters indicate significant difference between treatments (α=0.05). LSD=94.7 and 60.3 for Balcarce and Barrow respectively.

The higher grain production in the winter cultivars was firstly due to a higher number of siliquas m^{-2} which was translated, by means of a strong association, into a higher number of grains (GN) per surface unit, and not to a higher number of grains per siliqua (Table 3).

Table 3: main numerical components of yield: grain number (GN) and number of siliquas, both expressed in surface unit, and number or grains per siliquas for the four rapeseed cultivars in Balcarce and Barrow; in the same column, different letters indicate significant difference between treatments (α=0.05, LSD).

	Balcarce			Barrow		
	thousand/m2			thousand/m2		
Cultivars	GN	Siliquas	GN/Siliquas	GN	Siliquas	GN/Siliquas
Pulsar (winter)	166 a	8,7 a	19.4	128 a	6.6 a	19.5
SWGospel (winter)	177 a	9,7 a	18.3	143 a	7.3 a	19.2
SW2797 (spring)	133 b	6.9 b	19.3	90 b	5.7 b	17.0
Biolza440 (spring)	134 b	6.5 b	20.6	72 b	3.9 c	18.7
LSD	32.7	1.1	n/s	16.6	0.8	n/s

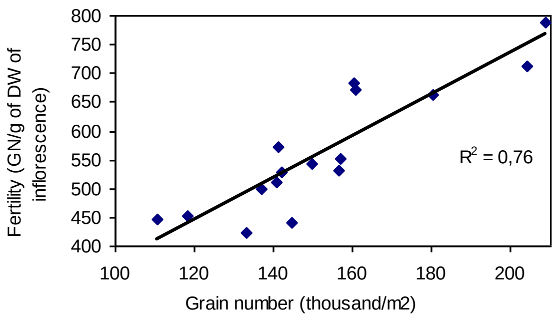
The relationships found between yield and the number of grains m^{-2} were very strong ($r^2 = 0.95$; $p < 0.0001$ and $r^2 = 0.98$; $p < 0.0001$), and very weak when the yield was associated with the dry weight of a thousand grains ($r^2 = 0.08$; $p < 0.0001$ and $r^2 = 0.33$; $p < 0.0001$), for Balcarce and Barrow respectively.

The highest number of grains achieved by the winter cultivars was mainly due to the fact that the inflorescence fertility (i.e. the number of grains produced per unit of inflorescence weight at full flowering) was higher than that of the spring cultivars (Table 4).

Table 4: Inflorescence fertility, expressed as number of grains obtained at maturity per dry weight of inflorescence at full flowering, for two winter rapeseed cultivars and two spring cultivars, in Balcarce and Barrow; in the same column, different letters indicate significant difference between treatments (α=0.05, LSD).

	Fertility (GN/g of DW of inflorescence)	
Cultivars	Balcarce	Barrow
Pulsar (winter)	594.9 a	57.2 a
SWGospel (winter)	678.2 a	576.7 a
SW2797 (spring)	455.0 b	468.0 b
Biolza440 (spring)	465.7 b	383.1 b
LSD	106.1	95.9

Therefore, the higher yield obtained by the SWGospel and Pulsar winter cultivars, by an increase in the final number of grains, was strongly explained by the high association between GN and inflorescence fertility (Fig. 3).



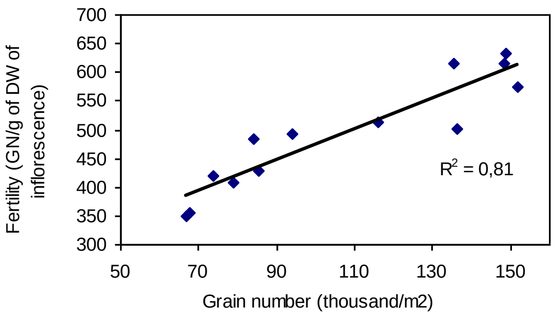


Fig. 3: Association between GN (thousand m^{-2}) and inflorescence fertility, for the four rapeseed cultivars tested in Balcarce (A) and Barrow (B).

These tests showed that in agricultural areas which are environmentally friendly for the sowing of different rapeseed cultivars, the winter types would have a productive advantage over the spring types; and that, as with most grain crops, there was a very strong adjustment between the number of grains per surface unit and the yield, which confirms their relative importance with regard to the unit grain weight.

References

BERRY, P.M.; SPINK, J. H. 2006. A physiological analysis of oilseed rape yields: Past and future. Journal of Agricultural Science 144: 381-392.

BUTRUILLE, D.V.; GURIES, R.P.; OSBORN, T.C. 1999. Increasing yield of spring oilseed rape hybrids through introgression of winter germplasm. Crop Sci. 39: 1491-1496.

EVANS, L; FISCHER, R. 1999. Yield Potential: Its Definition, Measurement, and Significance. Crop Sci. 39:1544–1551.

HABEKOTTÉ B. 1993. Quantitative analysis of pod formation, seed set and seed filling in winter oilseed rape (*Brassica napus* L.) under field condition. Field Crops Research 35: 119-124.

HABEKOTTÉ, B. 1997 a. Options for increasing seed yield of winter oilseed rape (*Brassica napus* L.): a simulation study. Field Crops Research 54: 127-136.

HABEKOTTÉ, B. 1997 b. A model of the phonological development of winter oilseed rape (*Brassica napus* L.). Field Crops Research 54: 127-136.

HABEKOTTÉ, B. 1997 c. Evaluation of seed yield determining factors of winter oilseed rape (*Brassica napus* L.) by means of crop growth modelling. Field Crops Research 54: 137-151.

HABEKOTTÉ, B. 1997 d. Identification of strong and weak yield determining components of winter oilseed rape compared with winter wheat. European J. Agronomy 7: 315-321.

WRIGHT, P.R., MORGAN, J.M., JESSOP, R.S.; CASS, A. 1995. Comparative adaptation of canola (*Brassica napus*) and Indian mustard (*B: juncea*) to soil water deficits: yield and yield components. Field Crops Research 42:1-3.