

APPLICATION OF DOUBLED HAPLOIDY TO BRASSICA NAPUS BREEDING

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INTRODUCTION

The doubled haploid (DH) technique is an efficient method for the production of large numbers of completely homozygous inbred lines in Brassica napus. DH lines are useful in genetic studies as well as in breeding programs (Morrison and Evans 1988).

Before the DH technique can be used with confidence in Brassica napus breeding programs, the possible effects of this method on growth and yield of the resulting DH lines must be determined in a variety of genotypes. There is as yet little information on the field performance of DH lines in summer rape. A comparative field study of DH and single seed descent lines derived from two F₁ crosses revealed no major differences between the two populations of lines (Charne 1990). In the present study, we compared the field performance of DH lines and that of conventionally produced (through self-pollination) inbred lines, and provide information on DH lines derived from an F₁ cross.

MATERIALS AND METHODSa) Westar-derived DH Lines.

The agronomic performance of DH lines derived from the Canadian summer rape variety Westar was assessed in replicated yield trials in 1985 and 1986 at Saskatoon. Eighteen DH lines were evaluated in 1985 and 24 DH lines (including 4 DH lines from the 1985 trial) in 1986. Maturity, yield, and oil content were determined. This material originated from the Agriculture Canada canola breeding program at Saskatoon.

b) S₁-derived DH Lines.

Twenty DH lines each were produced from the first selfed generation (S₁) of the Canadian varieties Regent and Westar and the Danish strain DP3505-79, and 60 DH lines from the French strain R83-11 and the Swedish variety Karat. Each DH line was derived from a single S₁ inbred line. The DH lines and their respective inbred lines were field-tested in 1989 and 1990 at two locations in Manitoba. Maturity, yield, and oil content were measured. This research was conducted at the Plant Science Department, University of Manitoba, Winnipeg.

c) F₂ Microspore-derived DH Lines.

DH lines were also produced from F₂ microspores obtained from F₁ hybrid plants of the cross between the Swedish variety Topas and the Canadian variety Westar. 345 DH lines were grown in a 2 replicate single row test at Saskatoon in 1987 and maturity, yield, and oil content determined. Twelve superior lines were yield-tested at Saskatoon in 1988. Four lines were further tested at four locations in Saskatchewan in 1989 to

produce supporting data for entry into the official Canadian Co-op Tests. DH line 12864 was entered into the 1990 Co-op B test and will be further tested in the 1991 Co-op A Test. This work was conducted at the Agriculture Canada Research Station at Saskatoon.

RESULTS

a) Westar-derived DH Lines.

The DH lines of cv. Westar were significantly later maturing, lower yielding and contained less oil in their seeds than Westar in 1985, but the differences were not significant in 1986 (Table 1).

Table 1. Maturity, yield, and oil content of doubled haploid (DH) lines of cv. Westar in the 1985 and 1986 replicated yield trials at Saskatoon

Year	Line	N	Maturity (days)	Yield (kg/ha)	Oil (%)
1985	DH	18	102 *	1837 *	41.2 *
	Westar	1	100	2393	43.6
1986	DH	24	94	1516	45.1
	Westar	1	93	1576	45.6

* Differences significant between DH lines and Westar at $P < 0.05$ according to LSD test

b) S_i Derived DH Lines.

Maturity. In the 1989 trials, the majority (60%) of the R83-11 DH lines were later maturing than the inbred line parents (Table 2); the mean maturity of the R83-11 DH lines was significantly later than the mean of the inbred lines. In Karat, the mean of the DH lines was not significantly different from that of the inbred lines; the range in Karat was from 3 days earlier to 4 days later, with 49% of the DH lines later than their inbred parent.

In the 1990 trials, the mean maturity of the DH lines and of the inbred parents was significantly different in strain DP3505-79 where the majority (66%) of the lines were earlier than their inbred parents and 33% were equal in maturity. There were no significant differences between the mean of the DH lines and the mean of the inbred lines for the four other strains/varieties. In Westar, the majority of the DH lines (72%) were later than their inbred parent. In Regent, 75% of the DH lines were earlier than their inbred parent and 20% of the DH lines were later. In Karat and R83-11, the majority of the lines, 86% and 82% respectively, were equal to the parental lines in maturity and the remaining lines were later.

Yield. Over the combined locations in 1989, the mean yield of the DH lines in Karat and R83-11 was not significantly different from that of the inbred lines (Table 2). The range of the DH lines was similar to that of the parental inbred lines (Fig. 1).

Table 2. Maturity, yield, and oil content of doubled haploid (DH) and inbred lines of cultivars Karat, R83-11, Westar, DP3505-79, and Regent in 1989 and 1990 trials at 2 locations in Manitoba

Cultivar	Year	N	Maturity (days)		Yield (kg/ha)		Oil content (%)	
			DH	Inbred	DH	Inbred	DH	Inbred
Karat	1989	60	101.8	101.6	1851	1674	41.9	41.8
	1990	20	94.0	93.7	1803	1409	42.4	42.7
R83-11	1989	60	110.6	100.0*	1622	1576	39.9	39.9
	1990	20	94.3	93.3	1441	1177	42.6	43.0
Westar	1990	20	88.2	87.4	1361	959 *	45.1.	44.9
DP3505-79	1990	20	89.4	91.0*	1740	1748	46.0	46.3
Regent	1990	20	91.6	91.0	1761	1835	44.6	42.9*

* Differences significant between DH lines and parental inbred lines at P<0.05 according to LSD test

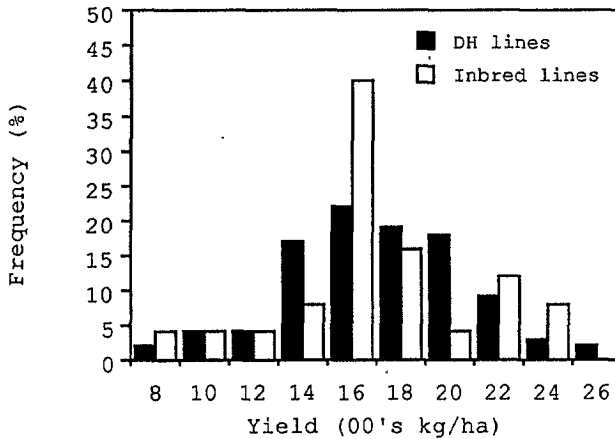


Fig. 1. Yield of DH lines and parental inbred lines in the 1989 field trials

In the 1990 trials, the mean yields of the DH and the inbred lines from all varieties, with the exception of Westar, were not significantly different (Table 2). The mean yield of the Westar DH lines was significantly higher than the mean of the parental inbred lines. The range in yield of the DH lines was similar to that of the inbred lines (Fig. 2).

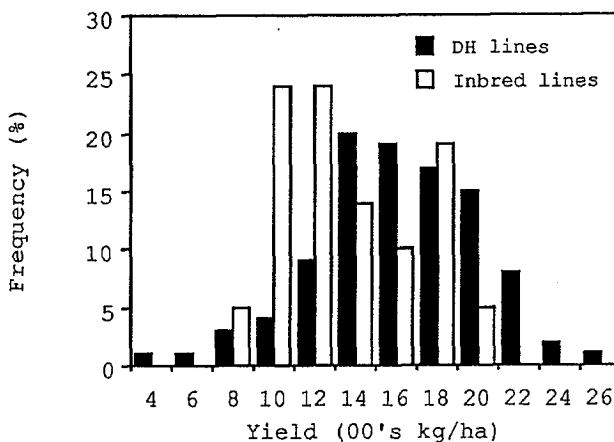


Fig. 2. Yield of DH lines and parental inbred lines in the 1990 field trials

Oil Content. The variation in oil content among the DH lines from Karat and R83-11 was relatively low in the 1989 trials and there was no significant difference between the means of the DH lines and the inbred parents (Table 2). One DH line from R83-11 was 5% higher in oil content than the inbred line from which it was derived. There was a wider range of variation in the 1990 trials, but the mean oil content of the DH lines was not significantly different from the mean of the inbred lines for all cultivars, except Regent (Table 2). The Regent DH lines had a significantly higher oil content than their parental inbred lines.

c) F₂ Microspore-derived DH Lines.

Early maturing, high yielding and high oil content DH lines were extracted from the Topas X Westar cross (Table 3). The best line (12864) performed also well in the 1990 Co-op Test.

Table 3. Maturity, yield, and oil content of four DH lines derived from F₂ microspores of the cross Topas X Westar and the variety Westar grown at four locations in 1989 in Saskatchewan and of DH line 12864 and Westar at nine locations in 1990 (Co-op B) across western Canada

Year	Entry	Maturity (days)	Yield		Oil content (%)
			(kg/ha)	% Westar	
1989	(Preliminary Test)				
	12747	86	1476	95	42.8
	12752	86	1519	98	43.4
	12864	86	1581	102	43.6
	12891	88	1430	92	43.0
	Westar	84	1552	100	42.8
1990	(Co-op B Test)				
	12864	97	2080	97	42.3
	Westar	95	2140	100	41.7

DISCUSSION

The results of these studies indicated that the performance of DH lines from open-pollinated cultivars was generally similar to that of their parents and, hence, that the *in vitro* culture process did not appear to have affected performance. There was no evidence of yield depression among the DH lines and mean oil and maturity were similar to those of the parents. The results also indicated strong genotype x environment interactions for the DH lines which may be expected for completely homozygous inbreds. Further studies will be necessary to determine whether stable, higher yielding DH varieties can be extracted from the open-pollinated cultivars grown in western Canada.

DH lines with improved earliness, straw strength and oil content were identified among the material tested. The DH technology appeared to be particularly useful for the rapid identification of lines with such characteristics.

ACKNOWLEDGEMENTS

Research support from the Natural Sciences and Engineering Research Council and from Agriculture Canada is gratefully acknowledged.

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