TRANSFER OF CMS JUNCEA TO DOUBLE LOW WINTER RAPE (BRASSICA NAPUS L.)

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INTRODUCTION

Considering the increasing importance of winter oilseed rape as an oil-protein plant, intensive research is underway on the possibility of creating hybrid varieties with the use of geno-cytoplasmic male sterility (CMS). The sources of CMS occurring in Brassica napus as well as in related species are under investigation. One of the valuable sources of CMS is geno-cytoplasmic male sterility found in Brassica juncea (Rawat and Anand 1979), and therefore a program has been initiated to transfer this CMS into double low winter oilseed rape.

MATERIALS AND METHODS

The CMS system under investigation is of B. juncea origin and was received from the Seed-Company Van der Have in The Netherlands in the form of hybrids between CMS jun and 17 different lines of oilseed rape. Male sterile plants selected from these hybrids were repeatedly backcrossed with lines, strains and varieties of oilseed rape of different origins to introduce the genotypes of oilseed rape into the sterile cytoplasm of B. juncea and to select maintainers and restorers.

Observations on the expression and stability of male sterility were conducted in a phytotron at day/night temperatures of 15°C/10°C; 20°C/15°C; 25°C/20°C, altered every seven days throughout the flowering period, a day length of 16 hr., light intensity of 20,000 lux and humidity about 90 per cent. Observations of anther sections were made under light microscopy to determine the mechanism of the male sterility characteristic.

RESULTS

F_1 seeds from crosses between male sterile plants and double low lines of winter oilseed rape were characterized by a low oil content (mean 36.5%) and a high glucosinolate and erucic acid content (Table 1). The glucosinolate composition was characteristic of a mixture of B. juncea and B. napus since synigrin as well as gluconapin, glucobrassicanapin, progoitrin and napoleiferin were present. Synigrin constituted 39 per cent of the total glucosinolate content.

After three backcrosses of male sterile plants to double low oilseed rape, the oil content has been increased to a level characteristic of oilseed rape. Also, 25 per cent of male sterile lines with sterile cytoplasm from B. juncea possess traits typical for double low oilseed rape, i.e. glucosinolate content less than 20 μM/g ffm and erucic acid almost eliminated. Moreover, they are winter forms (Table 1).

Expression of male sterility, displayed by alloplasmic male sterile rapeseed plants, is the same as in CMS B. juncea. These plants are characterized by modified flowers: narrow petals, rudimentary and, in a few cases, carpeloid and petaloid anthers.

Stability of the male sterility characteristic under fluctuating temperatures in the phytotron varied with 50 per cent of CMS jun plants displaying male sterility at each temperature. At the highest day/night temperature, 25°C/20°C, only 47.1 per cent of the plants produced traces of pollen (Table 2). Thus stability of CMS jun male sterility is relatively good and better than CMS pol.

This expression of male sterility is typical for a structural type of male sterility. Histological observations of anther sections of male sterile plants revealed that the cause of CMS jun was the lack of differentiation of male archespores or the delay of this process. In partially male sterile plants, which produced a small amount of pollen at the end of the flowering period, anther development was slower than in male fertile plants, and only the development of one or two pollen cells were observed.

To select restorers and maintainers of CMS jun, 227 double low lines of winter oilseed rape were investigated in test crosses under field conditions. Two hundred and two of the lines were maintainers. The remaining 25 lines resulted in partially male sterile hybrids. Anthers of these plants produced a small amount of pollen at the end of the flowering period. An additional 68 varieties and strains of different origins were also investigated in test crosses with 46 being maintainers. Hybrid progeny from crosses with nine varieties produced traces of pollen over the whole flowering period. Twelve varieties produced heterogenous progeny consisting of male sterile and partially male sterile plants.

Only the fodder winter variety Arvor partially restored male fertility. The degree of restoration was higher in the greenhouse than in the field. In the F_2, progeny of hybrids between male sterile plants and the Arvor variety segregated male sterile to partially male sterile plants in a 1:3 ratio. These observations suggest that the Arvor variety possesses one of two or more genes required for complete male fertility.

DISCUSSION

The CMS in B. juncea is of interest because the expression of male sterility is stronger than in CMS pol. The structural type of the male sterility in CMS jun involves risks of pollen production under favourable environmental conditions, thus it is necessary to select maintainers under extremely high temperatures. The most difficult problem is the selection of restorer genotypes. Mathias (1985), in research on CMS jun, did not find any lines of B. napus with restoring genes. Anand (1987) reported many partially restoring lines in B. carinata and two lines of B. napus spring type with restoring genotypes. These results indicate that genes for partial restoration of CMS jun occur in B. napus but with a very low frequency.

REFERENCES

ANAND, I.J. 1987. Breeding hybrids in rapeseed and mustard. Proc. 7th Int. Rapeseed Congress. 1: 79-85.

MATHIAS, R. 1985. Transfer of cytoplasmic male sterility from brown sarson (Brassica juncea [L.] Coss) into rapeseed (Brassica napus L.). Z. Pflanzenzüchtg. 95 (4): 371-374.

RAWAT, D.S. and ANAND, I.J. 1979. Male sterility in Indian mustard. Indian J. Gen. Plant Breeding 39 (3): 412-414.

Table 1. Content of oil, erucic acid and glucosinolates in F_1 and BC_3 hybrids between male sterile lines of CMS jun and double low lines of winter oilseed rape.

Trait*	Maximum		Minimum		Mean	
	F_1	BC_3	F_1	BC_3	F_1	BC_3
Oil (%)	45.1	47.5	31.5	42.2	36.5	44.4
Erucic acid (%)	50.1	10.1	1.3	1.0	31.4	4.4
SY (µM/G ffm)	71.4	0.0	27.7	0.0	52.4	0.0
GLN (µM/G ffm)	49.8	10.1	19.3	1.0	36.5	3.6
GBN (µM/G ffm)	7.9	1.6	3.0	0.2	5.8	0.7
PR+NA (µM/G ffm)	108.7	11.1	19.7	2.6	40.1	7.0
SY+GLN+GBN+PR+NA (µM/G ffm)	183.0	18.8	71.0	5.6	134.8	11.3

* SY = synigrin, GLN = gluconapin, GBN = glucobrassicanapin, PR = progoitrin, NA = napoleiferin, [ffm] = fat free matter

Table 2. Comparison of stability of male sterility as expressed by CMS pol and CMS jun in a temperature test.

Type of Plant	CMS Type	
	CMS pol	CMS jun
No. plants observed	190	68
Thermostable MS plants %	21.1	50.0
Thermounstable pMS plants %	39.8	2.9
MS → pMS plants[1] %	27.8	47.1
pMS → MS[2] %	11.3	0.0

[1]MS → pMS Male sterile plants changing to partially male sterile plants at high temperature

[2]pMS → MS Partially male sterile plants changing to male sterile plants at high temperature