BREEDING Brassica napus FOR WIDE ADAPTABILITY

M.W. Zaman[1], H. Svensk[2]

[1]Bangladesh Agricultural Research Institute
Joydebpur 1701, Bangladesh
[2]W.Weibullsholm Plant Breeding Institute
26124 Landskrona, Sweden

INTRODUCTION

Oleiferous Brassica, an important source of vegetable fats comprises Brassica napus L. (4x = 38), B. campestris (2x = 20), B. juncea Czern and Coss (2x = 36) and B. carinata Braun (2x = 34). Among these species, B. napus originating from temperate regions remains constantly in vegetative stage or switch over to the generative stage too late to become a successful crop in the subtropics, e.g. Bangladesh. Delayed flowering, however, is also a limiting factor for expansion of B. napus acreage in temperate regions having short summer. On the other hand, the diploid species, B. campestris, B. nigra and B. oleracea, have a much wider climatic adaptability irrespective of whether they are appreciated for their seeds, leaves, stems, flowers or roots in many parts of the world. It may be assumed that the adaptive limitation of the tetraploids is largely determined by ecologically restricted gene pool of the diploid progenitors involved. A programme was, therefore, undertaken to introgress photoperiod insensitivity and earliness in B. napus from the related early species.

MATERIALS AND METHODS

The Brassica species are interrelated in a way often described by the well-known U triangle (U, 1935). B. napus (AACC) is an amphidiploid between B. campestris (AA) and B. oleracea (CC). B. campestris having summer habit of growth is a widely cultivated crop during the winter season in Bangladesh. B. alboglabra (CC) and some B. oleracea var. botrytis (CC) are also represented by types that flower in the short winter days in Bangladesh. This adaptation of the diploid Brassica species and their role as progenitors suggest that their adaptation to short days and earliness could be transferred to B. napus as well. Process of introgression of genes for adaptation of B. napus in Bangladesh has been reported elsewhere (Zaman, 1989). In this study, genotypes selected and adapted in Bangladesh (24^{0}0'N lat.) were tested to see their reaction in long days at Landskrona, Sweden (55^{0}55'N lat.). Performance of some promising lines of B. napus was also evaluated in replicated yield trials in both countries. The environmental conditions of the two countries are presented in figure 1.

RESULTS

Photoperiodic reaction of introgressed B. napus

Plants with B. napus appearance and with satisfactory fertility were selected from the F_4-F_6 generations of the interspecific crosses -- B. napus x B. campestris, B. napus x B. juncea, B. napus x B. carinata, and B. napus x B. alboglabra. Sixty selected lines were tested in long days of Sweden and short days of Bangladesh. It was observed that early genotypes in Bangladesh were also early (r=0.74) in Sweden (Fig.2). They showed almost the same duration in flowering indicating photoinsensitivity. A slight delay in flowering in Sweden may be due to influence of cool temperature.

Performance of B. napus in Bangladesh

Some promising, photoinsensitive B. napus lines were evaluated in regional yield trials, 1986-89 in different locations of Bangladesh. Two local varieties of B. campestris Tori-7 and Sonali were used as checks. Tori-7 is a widely cultivated and very early variety. Sonali is a new cultivar characterized by high yields but it is late in maturity. Rai-5, belonging to B. juncea cultivated in Bangladesh, is tolerant to Alternaria sps. All the B. napus lines out-yielded not only Tori-7 but also Sonali (Table 1). Performance of nap-3 and nap-8509 was also tested at farmers' plots in different locations of Bangladesh in rabi seasons of 1988-89 and 1989-90. The rabi season of 1988-89 was very unfavourable due to freak rains resulting in temporary water pool in the fields. The B. campestris cultivars were often heavily damaged in fields with clay soils and showed poor performance on light soils. In contrast, B. napus lines survived well and gave higher yields (20-50%) in both years. The B. napus lines exhibited better tolerance to Alternaria sps. and Lipaphis erysimi which are major disease and pest, respectively, in Bangladesh (Table 1).

Performance of B. napus in Sweden

Early B. napus lines from the interspecific recombination programme were put under yield trials at the W. Weibullsholm Plant Breeding Institute, Landskrona, Sweden together with lines obtained from intraspecific crosses for earliness. Results from some of the better lines of either category are presented in table 2. The introgressed B. napus lines implicit a gain in earliness with an acceptable yield performance and a better tolerance to Sclerotinia. However, they contain more erucic acid and glucosinolate than acceptable in Sweden. Therefore, their direct use for commercial utilization is limited. They may, however, function as an important source for earliness.

DISCUSSION

The adaptive limitation of the allotetraploid B. napus appears largely to be determined by the ecologically restricted gene pool of the diploid progenitor representatives involved. The general observation is that Brassica species are always able to flower and mature in the long day summer climate of Sweden. Inability to switch from vegetative to generative phase was, however, often met under the pronounced short days of the winter season in Bangladesh. Evidently, a genetic control of photosensitivity must be involved.

Friend and Helson (1966) observed that exposure to long days encouraged flowering of Brassica representatives which had remained in vegetative stage under short day condition. Hodgson (1978) found the phenological response of B. napus prior to flowering to be influenced not only by genotype and temperature but also by photoperiod. The possibility to shorten the vegetative phase and predominantly the stem elongation process by subjecting B. napus to long days was reported by Thurling and Das (1980). Major (1980) found 17 hours or more to be the optimum photoperiod for investigated lines belonging to B. napus or B. campestris. There are thus ample evidences that photoperiodic sensitivity is involved in the adaptive pattern of B. napus as in most other widespread plant species. Adaptation of B. napus in Bangladesh is achieved by introgression of photoinsensitivity from related species. Intra- and intergenomic relationships in Brassica (Richharia, 1937 a,b; and Robbelen, 1960) make such transfer possible. Transfers of genes for earliness (Shiga, 1970 and Zaman, 1989), black leg resistance (Roy, 1984) and self incompatibility (Mackay, 1977) were achieved by similar approaches.

The materials, especially those selected for earliness, reacted more or less similarly in the Bangladesh winter with its short days and in the Swedish summer with its long days. This trend proved true for all studied interspecific crosses. In spite of some differences in earliness between B. campestris and B. juncea used, introgressed B. napus lines from them were very similar in maturity. This circumstance is easiest explained by anticipating a major and perhaps, even similar gene for photoinsensitivity being involved. Representatives of B. alboglabra and B. carinata were late in Bangladesh. Their ability to flower and set seeds during short day exposure could, however, be transferred to B. napus with similar gain in earliness.

For summer rapeseed, earliness is important also in Sweden. The observations made indicate that short day reaction offers a neutral photoperiodic response, and that genes controlling ability to flower and mature under short days behave like genes for earliness under long day conditions. This is of course not to say that all genes for earliness also must influence photoperiodic response. At the same time it should not be ruled out that genes for lateness never have consequences upon reaction to day length. Such a surmise was also expressed after inheritance studies on flowering and maturity based on interspecific Brassica crosses in long days of the Swedish summer (Zaman, 1989).

CONCLUSION

Interspecific recombination breeding as a means to introduce photinsensitivity to B. napus has offered Bangladesh with its short day rabi season a new promising oil crop. The same genetic constitution has proved to offer additional earliness to summer rapeseed grown in the long day in Sweden. The genetic control of photoinsensitivity promotes merely earliness when not needed to induce flowering .

ACKNOWLEDGEMENT

We wish to thank Prof. Emer. James Mac Key, Department of Plant Breeding , Swedish University of Agricultural Sciences, Uppsala, Sweden, for assistance in planning the work.

REFERENCES

FRIEND, D.J.C. and HELSON, V.A. 1966. B. campestris L. Floral induction by long day. Science 153:1115-1116.

HODGSON, A.S. 1978. Rapeseed adaptation in North New South Wales. I. Phenological response to vernalization, Temperature and photoperiod by annual and biennial cultivars of Brassica campestris L. and wheat cv. Timgalen. Aust. J. Agric. Res. 29:693-710.

MAJOR, D.J. 1980. Photoperiod response characteristics controlling flowering of nine crop species. Cand. Jour. Pl. Sci. 60:777-784.

MACKAY, G.R. 1977. Introgression of S-alleles into forage rape, Brassica napus L. from turnip rape, B. campestris L. ssp. rapifera. Euphytica 26:511-519.

RICHHARIA, R.H. 1937a. Cytological investigation of Raphanus sativus, Brassica oleracea and their F_1 and F_2 hybrids. J. Genet. 34:19-44.

RICHHARIA, R.H. 1937b. Cytological investigation of 10-chromosome species of Brassica and their F_1 hybrids. J. Genet.34:45-55.

ROY, N.N. 1984. Interspecific transfer of Brassica juncea-type high blackleg resistance to Brassica napus. Euphytica 33:295-303.

RÖBBELEN, G. 1960. Beitrage zur Analyse des Brassica-genomes. Chromosoma 11:205-228.

SHIGA, T. 1970. Rape breeding by interspecific crossing between Brassica napus and B. campestris in Japan. JARQ 5(4):5-10.

THURLING, N. and Das, L.D. 1980. The relationship between pre-anthesis development and seed yield of spring rape (Brassica napus L.). Aust. J. Agric. Res. 31:25-36.

U, N. 1935. Genomic analysis in Brassica with special reference to the experimental formation of B. napus and peculiar mode of fertilization. Japan J. Bot. 7:389-452.

ZAMAN, M.W. 1989. Introgression in Brassica napus for adaptation to the growing condition in Bangladesh. Theo. Appl. Genet. 77:721-728.

Table 1. Three years average performance of photoinsensitive B.napus lines tested in regional trials in Bangladesh,1986-89

Variety with introgression form	Yield (kg/ha)	Days to		Oil percentage	Diseasee reaction*
		flowering	maturity		
Tori-7 (check)**	1000	26	80	43	8
Sonali „	1182	39	96	45	6
nap-1(juncea)	1369	30	87	45	3
nap-3(carinata)	1454	36	96	43	2
nap-8501(oleracea)	1233	32	92	44	2
nap-8509 „	1537	29	88	45	3
nap-8559 „	1493	29	87	44	3
rai-5 (check)	1265	36	100	39	2

* Score: 0 = free from disease, 9 = heavily infested

Table 2. Comparative performance of early B. napus lines in Sweden developed in two different ways

Genotype	Yield (kg/ha)	Relative position	Days to		Disease reaction
			flowering	maturity	
Westar	1755 c	100	40 a	95	7.3 b
B x O x G*	2334 a	133	38 b	97	6.8 c
B x O x G*	2035 b	116	38 b	97	7.5 a
Tower x 1233*	2300 a	131	40 a	97	6.5 d
WW 22/86**	1755 c	100	34 e	93	4.8 e
WW 95/86**	2035 b	116	36 c	95	3.5 f
WW 5/86**	1983 bc	113	35 d	95	3.5 f

* Intra- and ** interspecific crosses

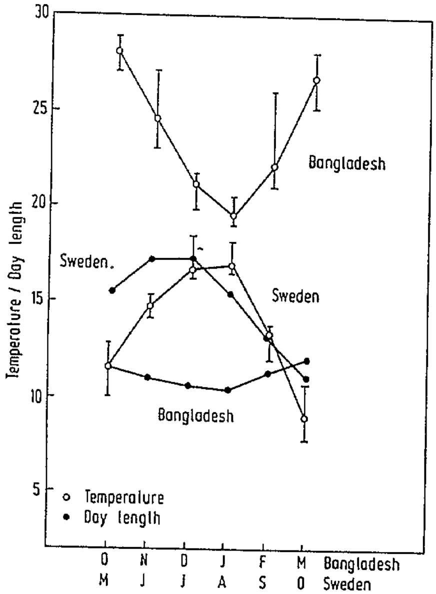

Fig. 1. Monthly average temperature (°C) and day length (h) in corresponding growing period (1979–1985) for oleiferous *Brassica* in Bangladesh and Sweden

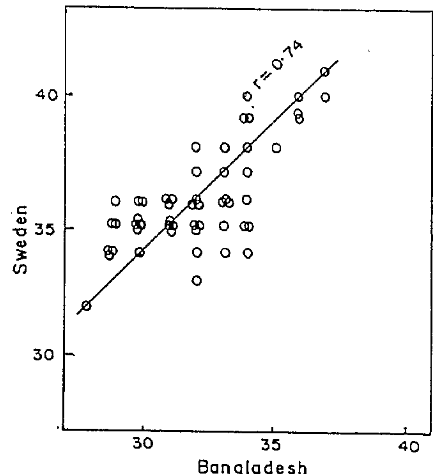

Fig. 2. Selected photoinsensitive lines of Brassica napus showing close relation for days to flowering in Bangladesh and Sweden