Brassica napus – a new oilseed crop in India

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ABSTRACT

Rapeseed –*Brassica napus* is not traditionally grown in India. Introduction of exotic accessions from Canada and Europe was not a success because of their very late flowering and very poor seed set. Artificial synthesis using early and productive indigenous strains of *B. rapa* ssp. *oleifera* and *B. oleracea* var *botrytis* generated a spectrum of morphological and physiological variants including early and productive forms of *B. napus* which form the basis of breeding programs in India. Varieties suitable to Indian conditions have been bred and released with a yield potential of 2 t/ha. Hybrids such as PGHS-21 and Hyola PAC401 have been marketed with 20 percent yield advantage. More CMS-fertility restoration systems of alloplasmic origin based on diverse cytoplasms are in various stages of development. The current researches are aimed at developing hybrid cultivars with less vegetative growth, yellow seed colour, resistance to pod shatter and canola quality. At present *B.napus* is cultivated on a very limited area in India and is likely to be grown for quality oil and cake in niche areas in north-western part of the country.

Key words: *Brassica napus* – artificial synthesis – hybrid cultivars – cytoplasmic male sterility

INTRODUCTION

Traditionally rapeseed – *Brassica napus* is not grown in India. The idea to cultivate it as an oilseed crop in India was initiated around 1967 because of its resistance to fungal disease – white rust and high seed productivity. A number of accessions from Europe and Canada were screened in 1968 for their suitability to cultivation in India. These exotic accessions were found to possess high degree of resistance to white rust but being very late to flower (115 – 125 days against 45 – 50 days in *Brassica juncea*) resulted in poor or no seed set. Many of the strains did not flower and remained in vegetative state due to their thermo- and photo-senstivity. Thus, there was a need to create new plant variability suitable to Indian conditions (Prakash,1980).

One of the approaches was to artificially synthesize strains of *B. napus* from early indigenous constituent parents to develop early maturing productive strains of *B.napus* (Prakash and Raut, 1983). Accessions of *B. rapa ssp. oleifera* were hybridized to *B. oleracea* var *botrytis* and a spectrum of variations was obtained following chromosome doubling of AC hybrids. The hybridization success rate was very low (0.29 %) and hybrids were obtained only in one direction viz. *B.rapa x B.oleracea*. . As a result synthetics have only *B.rapa* cytoplasm. Additional variability was obtained by allowing open pollination on F_1 interspecific hybrids. Non-homologous recombination between A and C genome chromosomes has been implicated in their origin, since these hybrids have up to 8 bivalents and some of these are of allosyndetic origin. Synthetics had very poor seed set in early generations (7-29%) because of disturbed meiosis and genetic incompatibilities between A and C genomes. Univalents (2-4) and multivalents (3 quadrivalents) were frequent and persisted up to A4 generations. Seed fertility gradually improved and A6 generation plants had normal seed set (90-94%) as a result of more regular meiosis and high selection pressure. These synthetics, in general, closely resembled natural *B. napus* forms in morphology. One of the typical features was the very long nature of inflorescence axis. The desired plant type in the synthetics have early to medium flowering period, high number of siliques, less vegetative growth and mature in 145 – 155 days (Prakash and Raut, 1983). These experiments were the beginning of introduction of *B. napus* as an oil crop in India and these synthetics became the integral part of Indian breeding programmes.

At present, *B. napus* is cultivated on a limited area (around 40,000 ha) in north-western part of India in the states of Punjab, Rajasthan, Himachal Pradesh and Jammu and Kashmir where the winter temperatures are quite low. The crop is grown mostly as a pure crop. Major factors which prevent its further spread are the low economic returns in comparison to wheat, pod shattering at maturity and susceptibility to alternaria blight and mustard aphid. However, high degree of resistance to white rust and higher oil content favour its cultivation in comparison to *B.juncea*. Currently, the major improvement goals include enhancing productivity (F_1 hybrids), reduced production costs (herbicide resistance) and value addition (canola quality, extra high oleic acid).

In late seventies, the first variety of *B. napus* GSL-1 was introduced which had an yield potential of about 2.0 t / ha with a maturity period of 165 days and containing 44 % oil content. Later in 1995, GSL-2 was released with the added advantage of resistance to atrazine herbicide. This was developed in the background of herbicide resistant Canadian variety Triton. Two more varieties Neelam and Sheetal were also released for cultivation. Subsequent attempts to develop a variety having canola quality, early maturity and high harvest index resulted in the release of the variety GSC-5. It has higher yield potential (2.5 t / ha) and matures 15 days earlier than the current varieties and is much shorter.

Simultaneous efforts to develop F_1 hybrids were initiated during late eighties. *Polima* and *tournefortii* based CMS systems were used as initial cytoplasmic male sterility sources. But due to its environmental instability and unacceptable yield penalty *polima* system was not pursued. However, a synthetic strain ISN-706 developed by Prakash and Raut (1983) has now been identified as a stable maintainer for *polima* CMS (Sodhi et al. 1993). Intensive test crossing of CMS (*tournefortii*) *B. napus* with a large germplasm collection has helped in identification of fertility restorers for this CMS system in the primary gene pool of *B. napus* (Banga 1995). Fertility restoration was later found to be governed by two complementary *Rf* genes (designated as *Rft1* and *Rft2*). It was also possible to identify AFLP marker (EACC/MCCT 105), located close (18.1cM) to the major gene *Rft1*. Diversification of CMS lines based on *B. oxyrrhina, Diplotaxis catholica, D. erucoides*, *Moricandia arvensis, Enarthrocarpus lyratus* and *Erucastrum canariense* cytoplasms are at various stages of completion (Prakash 2001). These male sterile lines exhibit normal growth, bear flowers with excellent nectarines and possess high female fertility. Introgression of restorer genes is in progress from respective cytoplasmic donors through chromosome engineering. CMS systems are also being extended to ‘00’ inbreds.

Identification of Rf genes helped in commercial release of first CMS based hybrid PGSH 51 of *B. napus* in 1994 with a yield potential of about 2.2 t/ha, 15 to 20 percent higher than the predominant pure line variety GSL-1. Besides the public sector, private sector is also actively involved in promoting cultivation of *B. napus* hybrids. Hyola PAC401 of Advanta India has been released for general cultivation in northern parts of India. Its characteristics such as tolerance to white rust, resistant to frost, high yield (3.0 t/ha) and high oil content (41-44%) and a maturity period of 150 days make it an ideal crop in place of wheat. Further, the nutritious oil cake of *B. napus* with very low levels of antinutritional glucocinolates is sought after by the animal feed industry and thus fetches the farmer a higher return on his investments.

In conclusion, *B. napus* as a crop has only limited prospects in the Indian context as it can be grown only in low temperature regime with assured irrigation. Since a large proportion of the area under mustard in India is under rainfed conditions, replacement of the hardy, well adapted *B. juncea* with *B. napus* does not seem feasible in the near future. However, *B. napus* holds promise for the production of canola quality varieties because of the ready availability of ‘00’ genotypes. Such ‘00’ genotypes are not yet available in *B. juncea*.

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