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Short communication

Breeding for cytoplasmic male sterility in broccoli (*Brassica oleracea* L. *var. italica* Plenck)

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A male sterile line of kale EC 173419 with Ogura cytoplasm was crossed in 1990-91 and back crossed in 1991-92 with Green Sprouting Broccoli (GSB) to transfer male sterile cytoplasm into broccoli (*Brassica oleracea* L. *var. italica* Plenck) at IARI Regional Station, Katrain, located in Kullu valley, Himachal Pradesh at an altitude of 1500 m. Backcrossing was not attempted during 1992-93 and 1993-1994. However, in 1994-95 and 1995-96 because of poor quality of GSB, it was substituted by another breeding line 005559 as recurrent parent. Since kale has chilling requirement for flowering a male sterile back cross progeny (kale EC 173419 $\times$ GSB^2 $\times$ 005559^2) from Katrain was used as source of male sterile cytoplasm.

Five different genotypes of broccoli *viz.* 621001, 663102, 663213, 603127 and 663022 were crossed with the male sterile progeny in 1996-97 at Delhi. Normally broccoli is sown in September-October in North Indian Plains and planted in October-November when average daily temperature is around 22 degree Celsius. However, the five genotypes selected for transferring male sterility can form good quality heads under slightly higher temperature i.e. can be planted in August-September when temperature is around 25-28 degree Celsius. This was done with a view to develop hybrids for comparatively higher temperature. The crossed progenies were raised in 1997-98 and BC_1, BC_2 and BC_3 generations were raised in 1998-99, 1999-2000 and 2000-01 respectively.

Ogura cytoplasmic male sterility is associated with chlorosis at low temperatures, several floral deformities like petaloid anther, poorly developed nectaries, non opening of flower buds and low female fertility (1, 2). The male sterile progeny received from IARI regional station, Katrain, used as source of male sterile cytoplasm had all such abnormalities. In the first crossed generation with CMS progeny at IARI, New Delhi, all the plants were found to be male sterile in all the five genotypes. However, several floral deformities were observed but chlorosis was not seen in any of the genotypes. Flowers with petaloid as well as rudimentary anthers were observed. Other floral abnormalities seen were crooked style, open carpels and semi open flowers. Another effect of Ogura CMS was the reduction in flower size. All the plants with petaloid anthers and severe floral deformalities were rejected. The undesirable characteristics associated with Ogura cytoplasm when transferred in *Brassica* germplasm are usually considered consequence of an incongruity between nucleus and cytoplasm (3).

In BC_1 and subsequent back crossed generations, not a single plant with petaloid flowers was found. All the plants were male sterile with rudimentary anthers (Fig. 1 and 2). In BC_1 as well as BC_2 selection was

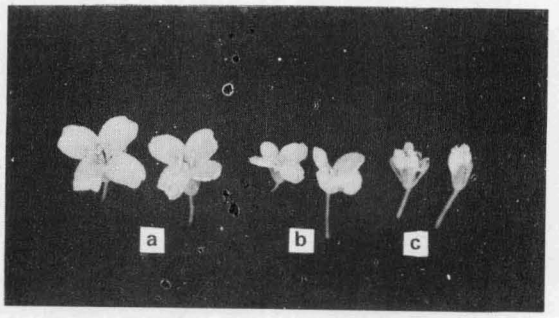

Fig. 1. (a) Normal fertile flowers (b) normal male sterile flowers (c) male sterile flowers with floral deformities

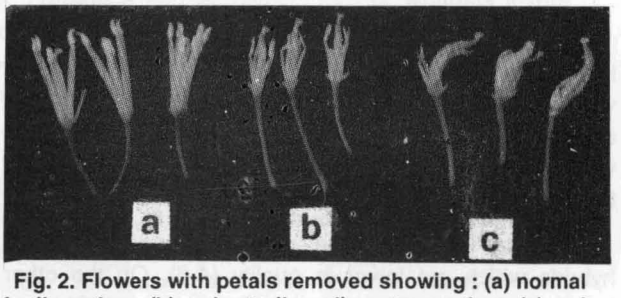

Fig. 2. Flowers with petals removed showing : (a) normal fertile anthers (b) male sterile rudimentory anthers (c) male sterile rudimentory anthers with crtrooked style and carpel

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made for desirable vegetative as well as floral characters. In BC_2 most of the plants in all the genotypes except in 663102 were devoid of severe floral deformities. Most of the plants were found with normal or near normal flower with rudimentary anthers. This shows that selection for normal flower structure is effective.

A prerequisite for hybrid seed production is the ability of the CMS lines to have normal seed set under open pollinated conditions. Selected plants with normal or near normal floral characteristics had good seed setting under open pollinated conditions. (Fig. 3). The flowers were also frequently visited by honeybees since they had functional nectaries.

Fig. 3. Male sterile plant with normal pod setting under open pollination

In BC_3 generation, characteristics of economic importance appeared normal (Table 1). There was variation in head colour, compactness and head size and bead size amongst the genotypes. Head colour varied from green to purple, solidness from compact to very compact and bead size from small to medium.

Ogura CMS has been used in cabbage to produce hybrids which are lower in quality (4-6). On the other hand, Wei & Li (7) produced Ogura based Chinese cabbage hybrids that showed no maternal effects on plant weight, head diameter, number of leaves, core length and heading index. Melo & Giordano (1) showed

Table 1. Vegetative and floral characteristics of male sterile genotypes in BC_3 generation

Genotype	621001	663102	663213	603127	663022
Character					
Bead size	Medium	Medium	Medium	Small	Medium
Head compact-ness	Medium	Compact	Compact	Very compact	Very compact
Head colour	Greenish purple	Purple	Green	Green	Green
Petal colour	Light yellow	Light yellow	Light yellow	Yellow	Yellow
Flower size	Medium	Medium	Medium	Medium	Medium
Style	Straight to slightly curved	Curved	Straight or slightly curved	Slightly curved	Straight
Ovary	Normal	Distorted	Normal	Normal	Normal

that Ogura cytoplasm had an effect on reducing plant and head weight, core length, head length and width, however no effect was seen on grading index, shape and core indexes and head compactness in cabbage hybrids. It appears that with suitable selection of parental lineages it is possible to develop normal, good quality hybrids. The CMS lines, which we are developing are suitable for cultivation under subtropical condition i.e. in temperature range of 20-27 degree Celsius in North Indian Plains and can be utilised to develop hybrids in future after further evaluation.

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