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Short Communication

Male sterile line in Asiatic carrot developed

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Male sterility in crop plants has always been admired by the plant breeders for their usefulness in hybrid seed production. The male sterility in temperate carrot has been available since long [1, 2]. There are two main sources of cytoplasmic male sterility (CMS) identified in carrots: i) Petaloid and carpeloid CMS system which was found in wild stocks of carrot where, stamens get modified to petals [3] or to carpels [4]. ii) Brown anther type CMS, where, anthers get dried and deformed due to degeneration [5]. Newer sources for both types of CMS have been found in the recent years. However, there are no reports of male sterile lines in Asiatic carrot. Therefore, attempts were made to isolate male sterile line(s) from the carrot material collected from the local markets. A number of male sterile plants were identified in a seed lot of 'ameri red' cultivar, a local cultivar from Amber region, Jaipur, Rajasthan, India. Sterile plants were noticed for their grossly different umbel morphology. The umbels were devoid of petals and looked sepaloid. The close microscopic examination revealed absence of anthers (Figs. 1 and 2). In order to recover seeds and establish nature of sterility one umbel of each of these plants was covered by butter paper selfing bag for selfing and one was hand pollinated, while other umbels were allowed to open pollination with the same population. While there was no seed set in covered umbels whereas, open pollinated umbels had normal seed set (approximately 90%). Seed set was lesser in hand pollinated umbel (50 %) may be due to differences in flower receptivity time of different florets in the umbel or single pollination attempt could not pollinate all the florets. The plants raised from crossed seed showed complete sterility in next generation.

In the next generation a total of 120 sterile plants were raised in six rows each row having 20 plants. One row each was sown with six different populations (Ameri Red, Pusa Kesar, Sriganganagar, Delhi, Sadhuwali selection and Super Red) while maintaining proper distance between each group to avoid cross pollination. Five umbels from different plants were selfed and another five were hand pollinated while others were allowed to cross. All of the plants (about 100 from each type of cross) raised from these crosses showed complete sterility over three generations in crosses with different populations while seed set completely failed upon selfing. No segregation on crossing with various populations suggests cytoplasmic nature of the male sterility under study. Moreover, the recovery of sterile plants from crosses with various populations involving more than 5 plants each in addition to from open pollination suggests non-availability of restorers for it. However, being a root crop this type of male sterility may efficiently be used for commercial hybrid production in carrot. All but one of these crosses yielded sterile plants resembling to original type (carpeloid) in next generation thus leading to development of CMS lines in different backgrounds. However, cross with genotypes, Sadhuwali, Sriganaganagar and Rajasthan, produced brown anther type sterile progeny. The sterile plants were maintained by their respective male counterparts.

Plants of CMS lines obtained in different backgrounds and in its original genotype were otherwise normal growing. However, cross with var. Super Red (CR 27) produced genotypes with most desirable type root characters resembling to its recurrent parent and was further evaluated and maintained in abundance

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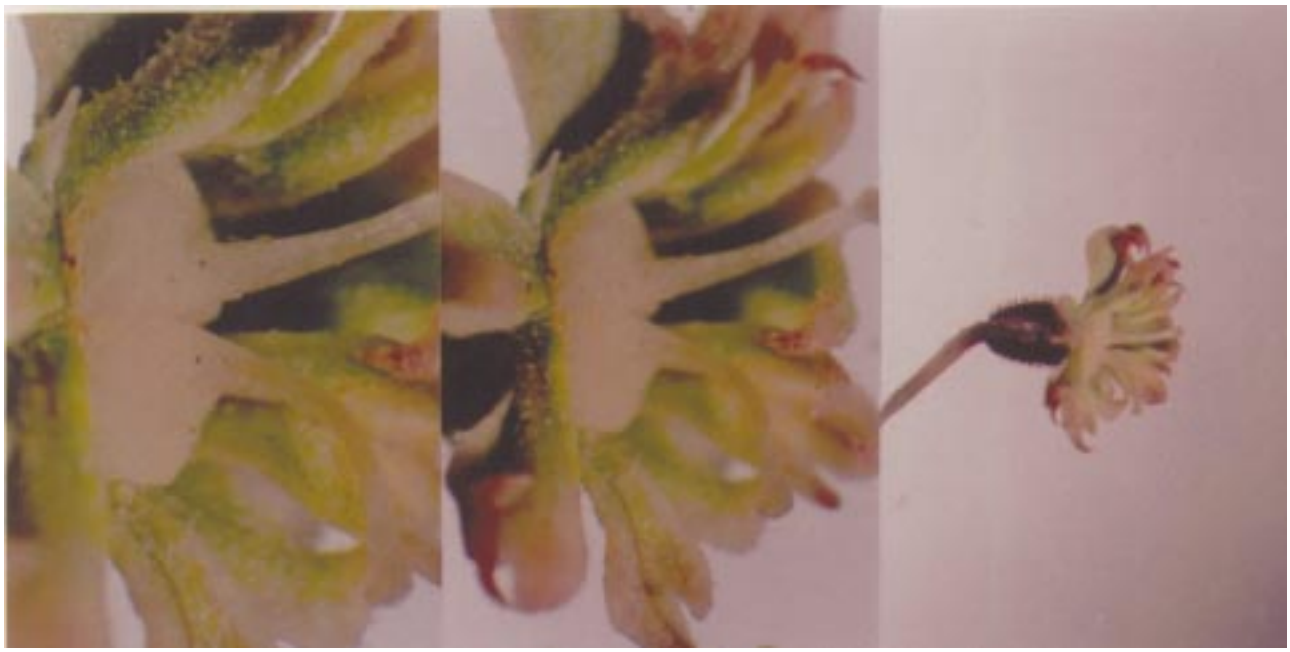

Fig. 1. Individual carrot flower showing absence of anthers

Fig. 2. Inflorescence showing sterility

(Table 1). The CMS line developed in the back ground of CR 27 was named as PK/RA CR-27S against the male fertile line CR27F.

The identified CMS system seems to be petaloid type. As specified earlier, in the 'petaloid' CMS type of carrot, stamens are replaced by petals. However, in the present CMS system even the petals get modified into sepaloid type and whole umbel look green (Figs. 1 and 2). This could be a newer class of male sterility that may be termed as sepaloid type of CMS. The florets thus resemble well-investigated homeotic flower mutants of *Arabidopsis* and *Antirrhinum,* in which organ identity is impaired because of the mutation of specific nuclear MADS box genes [4]. The CMS system reported could be of great importance to resolve genetic and molecular mechanism differentiating carpeloid/sepaloid and brown anther type CMS systems of carrot in addition to their use in hybrid seed production. This is critical as the inheritance of cytoplasmic male starility has not been considered simple and has not been completely resolved. Both types of CMS are dominant and may be determined by triplicated nuclear genes, one dominant (M), the two recessive (t and l), which interact with sterile cytoplasm [6]. Maternally inherited defects in the formation of male flower organs leading to cytoplasmic male sterility indicate the involvement of mitochondrial genes in the control of flower formation.

Table 1. The major morphological characters of PK/RA CR-27S (sterile cytoplasm) and male counterpart CR-27 F

Characters	PK/RA CR-27S (Sterile cytoplasm)	Male counterpart CR-27 F
Root length (cm)	20±2.6	20 ±2.5
Root girth	11.6±1.79	12.8±1.43
Days to maturity	10017.3.	90±4.7
Size of core	Medium self core	Medium self core
Root shape	Cylindrical tapering	Cylindrical tapering
Root surface	Smooth	Smooth
Root color	Dark red	Dark red
Sweetness	Juicy and sweet	Juicy and sweet
Plant height (cm)	58.6±6.4	66.3±5.9
No. of primary branches	6.3±0.55	6.0±0.62
No. of secondary branches	10.3±1.13	11.3±0.93
No. of umbel/ plant	15±1.4	23.6±1.71
Umbel size (L x W) cm^2	41.6±2.6	38.8±2.0

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