Morphology of Sterile Anthers and Inheritance of Cytoplasmic-genetic Male Sterility in Zygotic Seedlings of Polyembryonic Acid Citrus

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Abstract	In acid citrus, genetic control of male sterility, an important characteristic for breeding seedless fruit cultivars, is not precisely known because of the presence of barriers such as polyembryony and a long juvenile phase. In this study, 22 crosses with 16 male-fertile acid citrus cultivars were carried out and the zygotic seedlings were grafted onto adult satsuma mandarin trees to enhance flowering. Four crosses with two monoembryonic and male-sterile citrus plants (HY16 and 'Kiyomi') were also carried out and zygotic seedlings showing precocious flowering were used to examine the inheritance of male sterility. Of the 26 crosses, 21 with six cultivars as seed parents generated male-sterile and male-fertile zygotic seedlings with various segregation ratios, whereas live crosses with 'Sudachi' as a seed parent generated only male-fertile zygotic seedlings. The sterile anthers were categorized into undeveloped and underdeveloped by their size in most progenies. The result of these crosses showed that eight cultivars with male-sterile cytoplasmic factors of 'Yuzu', lemon, or satsuma mandarin generated male-sterile zygotic seedlings, while 'Sudachi' with male-fertile cytoplasmic factors of pummel generated only male fertile zygotic seedlings. The result also suggested that a dominant nuclear fertility-restorer gene system comprising one epistatic gene R-1 and two complementary genes R-2 and R-3 controls the restoration of male fertility and male-sterile anther size in acid citrus plants with sterile cytoplasm (S). The complementary gene R-3 is located downstream from R-2, and gene R-1 is epistatic to R-2 and R-3 genes. Genotypes (S)r(1)r(1)r(2)r(2)-- are responsible for undeveloped anthers while genotypes (S)r(1)r(1)R(2)-r(3)r(3) are responsible for underdeveloped anthers. The identified genotypes for male sterility in major acid citrus cultivars will contribute to breeding seedless acid cultivars.
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