Mutation Breeding in Citrus

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ABSTRACT

As a technology, mutation breeding is generally accepted and employed in breeding programs. Because oranges and grapefruits are very polyembryonic, producing enough zygotic offspring to select superior genotypes is practically impossible; thus, the majority of economically important cultivars of these species have evolved through natural or artificial mutation.

INTRODUCTION

Mutants through Gamma Irradiation-

In citrus breeding, gamma radiation has indeed been extensively used to develop seedless cultivars. The significance of the plant material resides in the susceptibility of its cells to gamma irradiation as well as the plant material's inclination to form chimeras rather than completely altered organisms. In February 2007, 400 Kinnow buds were irradiated at 30 Gy and budded on rough lemon rootstock. The 188 MV1 plants that resulted in their study were planted in the field in October 2009, and observations in the current study were taken from 2015 to 2018. In the population derived from irradiation buds, the number of bold seeds per fruit ranged from 0.4 to 30.8. Out of all the branches, 6.4 percent had bold seed numbers less than 10.3, 39.4 percent had bold seed numbers between 10.3 and 20.3 per fruit, and 54.7 percent had bold seed numbers greater than 20.3 per fruit. Among the 188 MV1 plants that resulted, 11 Kinnow mutants (seven solid mutant trees and four mutant branches) with a mean seed number of fewer than eight were found, exhibited different favorable traits, and were thoroughly contrasted with the parent variety Kinnow. One of the low seeded mutations was recognized as a new variety called 'PAU Kinnow-1' for growing in the Indian state of Punjab. Fruit production was lowered by 66 percent in the G18 and G20 grown from 30Gy, while fruit yield was reduced by more than 50 percent in the E6 and E8 generated from an intermediate dosage of 0.1 percent EMS. The response of leaf gas exchange data measured throughout various seasons of the year (April, August, and December) differed. Photosynthetic efficiency was lowered in the mutagenic population contrasted to the wild type, with the greatest reduction found without seasonal fluctuation within G12(4.92, 5.20, and 4.92 mol m2 s1) and G13(4.98, 5.04, and 4.96 mol m2 s1) produced from 25 Gy. 'Meiguicheng' orange

(Citrus sinensis) using -rays and also its wild type were tested. The analysis indicate also that the seedless mutant and its wild type were diploid, generating blooms that were quite identical. Radiation-induced chromosomal abnormalities lowered pollen quantity and viability in the seedless mutant substantially Pollen study revealed that 'Zaomi' generated more damaged, nonviable pollen grains. Studies with self-and cross-pollination revealed that 'Zaomi's self-incompatibility leads to the seedlessness of 'Zaomi'. A fruit quality study revealed that the 'Zaomi' mutant was a high-sugar mutant that was unaffected by the pollination combination.

In Vitro and Ex Vitro mutagenesis by gamma radiation

To enhance the resistance of Banyuwangi (SB) Siam orange to HLB disease. SB embryos were irradiated with gamma rays at dosages of 0, 45, 50, and 55 Gray. Each process was carried out five times involving 20 embryos. After 24 weeks, HLB pathogen suspension was used to test in vitro selection of potential mutant shoots. The outcomes of in vitro selection for a potential mutant at dosages of 45, 50, and 55 demonstrated resistance to the HLB pathogen following selection.

Table 1: Different mutagens used and their efficacy

Crop name	Mutagen used	Dose	Effect / result	Reference
lemon cultivars ‘Fino 49’ & ‘Verna 51’, the mandarin cultivar ‘Nova’and the lime cultivar 7 ‘Bearss’	Gamma rays	0.125 kGy h−1 8	F49 (57 Gy in W, 49 Gy in S)	(Perez *et al.*, 2020)
Kinnow (Citrus nobilis Lour × C. deliciosa Tenora)	Gamma rays	30 Gy	188 MV1, PAU Kinnow 1	(Rattan *et al.*, 2019)
Kinnow mandarin (C. nobilis Lour × C. deliciosa Tenora)	Gamma rays, ethyl methane sulfonate (EMS)	5,10,15, 20 Gy	high relative water content (RWC) with lower leaf membrane injury	(Mallick *et al.*, 2016)
‘Meiguicheng’ orange (Citrus sinensis)	Gamma rays	60 Co - rays	seedless mutant	(Huang *et al.*, 2017)

Hybridization breeding in citrus-

Somaticcombinations of ‘Milam’ lemon (Citrus jambhiri Lush.) + Sour orange (C. aurantium L Osb.), Calamondin (C. madurensis Lour.) + ‘Keen’ sour orange (C. aurantium L.), Calamondin + ‘Femminello‘lemon (C. limon L. Burm. F.) and Cleopatra mandarin (C. reshni Hort. ex Tan.) + ‘Femminello’ lemon, were examined fortheir reaction to Citrus tristeza virus.In either CTV strain, the Calamondin+' Keen' sour orange genotype did not represent replication. Somatic hybridization has been demonstrated to be a successful method for obtaining substantially novel rootstocks. Citrus canker resistant 'Meiwa' kumquat (Fortunellacrassifolia Swingle snym. Citrus japonicaThunb.) & vulnerable grapefruit (Citrus paradise Macfad) cultivars were cybridized using cybridization, a somatic hybridization methodology that integrates the organelle and nuclear genomes from distinct species. The fusions resulted in cybrids having grapefruit nucleus, kumquat mitochondria, plus kumquat chloroplasts, as well as cybrids having grapefruit nucleus, kumquat mitochondria, and grapefruit chloroplasts.All cybrids responded differently to citrus canker, however, all cybrids with kumquat chloroplasts exhibited fewer lesions and smaller Xanthomonas citri subsp. citri populations versus grapefruit controls. Grapefruit chloroplast-containing hybrids developed substantially more lesions compared kumquat chloroplast-containing hybrids. These cybrids may improve citrus canker tolerance in commercial grapefruit crops. The most widely utilized rootstock in Nagpur mandarin (Citrus reticulata Blanco) is rough lemon (Citrus jambhir Lush.), however,

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it is susceptible to Phytophthora (root and foot rot) diseases and citrus nematode. A hybridization program has been conducted out to unite the vigor and high producing attributes of rough lemon with the tolerance to Phytophthora and citrus nematode of trifoliate orange (Poncirus trifoliata L.) and Troyer citrange (Citrus sinensis x Poncirus trifoliata). Segregation for many features was noted in the F1. Rapid development in the nursery is required for a rootstock to be effective, as well as the hybrids 2.6 (rough lemon x Troyer citrange) and 3.1 (rough lemon x trifoliate orange) are aggressively expanding in the nursery. Bud's take was excellent on all rootstock hybrids. Once assessed for biotic and abiotic stress tolerance/resistance, the hybrids created (2.6 and 3.1) will widen the genetic foundation of our citrus sector. Moreover, hybrids 2.6 and 3.1 are identical to rough lemon in every way and contain relatively few trifoliate leaves (0.01 percent). These are doing well in the farm and nursery, and their progress is comparable to that of rough lemon.

Table 2: Different hybrids used and their traits.

Crop name	**Hybrid name**	**Parents**	**Traits/ feature**
Mandarin(*Citrus reticulata*)	Genotype "33-6"	Clementine' × 'Orlando	large fruits (175 g), dark orange rind color, and early maturity (October)
Orange(*Citrus sinensis*)	genotype "20-2"	Clementine' × 'Valencia	late maturing (April) and it has large fruits and a good appearance
Grapefruit (*Citrus paradisi*)	hybrid "39-9"	Clementine' × 'Cocktail	large fruits (244 g) and attractive shape and it is harvested in November
Grapefruit (*Citrus paradisi*)	Cookie and Aliza	pummelo and mandarin	low furanocoumarin levels

CONCLUSION

Somatic hybridization is a remarkable biotechnology approach that aids in the creation of novel somatic genotypes that combine desirable features through both parents Its application is now an essential component of plant breeding strategies. Citrus breeding programme cross hybridizations between pummelo and mandarin parents were employed in Israel to develop two new grape-fruit like cultivars with low furanocoumarin levels, termed cookie and Aliza

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