Applications of genomic technologies for crop improvement

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ABSTRACT:

Papaya is a trioecious species with three sex forms: male, female, and hermaphrodite. There is no true breeding hermaphrodite papaya, and seeds from self-pollinated hermaphrodite fruit segregate 2 hermaphrodite : 1 female. Transgenic papaya singspot virus resistant hybrid seeds are produced from crosses between female and hermaphrodite with segregation ratio of 1 hermaphrodite to 1 female. Commercial papaya production requires planting multiple seedlings to ensure at least one hermaphrodite per hill. Genetic mapping and genome sequencing revealed that sex in papaya is controlled by a pair of nascent sex chromosomes with two slightly different Y chromosomes that distinguish males (XY) and hermaphrodites (XY^h). The papaya genome and three sex chromosomes have been sequenced. Twenty-four wild male genomes and 12 cultivated hermaphrodite genomes were re-sequenced and characterized. The male specific region of the Y (MSY) and hermaphrodite specific region of the Y^h (HSY) chromosomesare highly similar with shared gene content and structure and 99.6% sequence identity. The male Y chromosomes formed three distinct populations despite otherwise normal gene flow in the autosomes. Molecular dating suggests the hermaphrodite Y^h chromosome is diverged from a wild dioecious population in the north pacific region of Costa Rica about 4,000 years, coinciding with the rise of Mayan civilization, likely the result of human selection as no hermaphrodite papaya found in the wild. Male and hermaphrodite specific DNA markers have been developed for testing sex types at the seedling stage. Engineering true breeding hermaphrodite varieties will eliminate planting multiple seedlings that has been practiced since the domestication of papaya in Central America.