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Floral Biology and Sex Expression in Papaya

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Abstract

The papaya, *Carica papaya* L., is native totropical America and commercially cultivated throughout the tropical and sub-tropical regions of India. Propagation of papaya by seed is still the most commercial cultivation method. Generally, the number of male plants outnumbers the females in a plantation, which renders it unproductive. Growers are unaware of identifying the productive and unproductive plants at the nursery stage, So as to have male and female plants. The papaya is generally taken flowers within 75 to 150 days after transplanting. The gynodioecious varieties are preferred for commercial purpose, due to their high yield potential and occurrence of desirable types of sex expression among the flower types. So it is knowledge on selecting desirable papaya cultivars at the seedling stage that would help in raising the papaya orchard with the appropriate design.

Introduction

Papaya botanically known as *Carica papaya* with 2n=18 belongs to the family Caricaceae. Papaya has emerged from the status of home garden plants to that of commercial orchards and is popular with the farmers because it is one of the few fruits which fruits throughout the year, give quick and high returns, requires less area per tree and adopts itself to adverse soil and climatic conditions. Papaya is a small, herbaceous, evergreen, perennial dicotyledonous plant. Stem is simple, thick, spongy, hollow, soft wooded, with leaf scars, grows about a height of 1-10 m with a life span of 20 years and the economical life will not be more than 3 years.

Flower Biology

Papaya is dioecious but hermaphrodite forms also occur. Flowers are mainly three types, *i.e.,* male, female and hermaphrodite, usually borne in axillary panicles. They are produced profusely near the trunk apex. Its flowers are actinomorphic cymes arranged in inflorescences on main stem. Cymes of female and hermaphroditic plants bear a variable number of flowers (2-15). Flowers are fragrant, 5 sepals, 5 white petals, 5 or 10 stamens, and 5 carpellate pistil with 5 stigmatic rays having pariental placentation. Female and bisexual flowers are waxy, ivory white, and borne on short peduncles in leaf axils along the main stem. Female flowers are solitary or small cymes of 3 individuals. Female flowers have five free petals and a rounded superior ovary with parietal placentation. Ovary with large central cavity, fruit is a berry with many seeds, fleshy endosperm and straight embryo (Victor *et al*., 2014).

Prior to opening, bisexual flowers are tubular and female flowers are pear-shaped. Male plant produces in large number inflorescence on 60-90 cm long pendulous inflorescence. Male flowers are smaller, trumpet-shaped, and borne on

long racemes, thus quite easily distinguished from female or bisexual plants. Since bisexual plants produce the most desirable fruit and are self-pollinating, but female plant must be cross-pollinated by either bisexual or male plants. Wind is considered the main pollinating agent in papaya. Female and bisexual flowers sit close to the stem either singly or in small groups while male flowers hang on the long peduncles. Male and bisexual types produce flowers earlier and at a greater height than the female plants. The male flowers appear in the axil of the 24th leaf and that of female in 18-20th leaf. Female plants take days for flowering 80-90 days after transplanting. The male flower developed within 32 days and female flower within 42 days after bud initiation. The time of anthesis is between 8.00-11.00 AM. Dehiscence in staminate and hermaphrodite flowers takes place between 10 to 12 hours before anthesis. The pollen grains in papaya remain viable 2-3 days before to 2 days after anthesis with maximum on the same days of anthesis. The receptivity of stigma was found maximum on the day of anthesis. The stigma receptivity of female and hermaphrodite flowers remains two days before and two days after anthesis. Fruit is pyriform, cylindrical or grooved, pear-shaped on hermaphrodite trees and more rounds on female trees (Figure 2).

Figure 1: Types of papaya plants according to sex forms [a) Male plant; b) male plant – bearing male fruit (Teratological male plant)]

Sex Expression

In papaya, various sex forms are polygenically controlled and influenced by various environmental factors. Based on sex forms and flowers, Storey (1958) classified papaya flowers to 8 types *viz.,* (i) staminate, (ii) Teratological staminate, (iii) reduced elongate, (iv) elongate, (v) carpelloid elongate, (vi) pentandria (vii) carpelloidpentandria, and (viii) pistillate (Storey, 1941). Out of these, staminate flowers are produced by male plant, teratological staminate type by sex reversing male plants (Figure 1), type (iii) to (vii) by hermaphrodite plants and pistillate by female plant. In a segregating population, sex expression and ratio are expressed by interaction of three allelic genes *viz*., M_1 – for maleness, M_2 – for hermaphrodite and m – for femaleness (Storey, 1958). Among the 8 different sex forms, pistillate form is the only stable type and not influenced by climate. Male and hermaphrodite plants may be either phenotypically stable phenotypically ambivalent and going through seasonal sex reversals during which they produce varying proportions of staminate, perfect and pistillate flowers.

Figure 2: Papaya fruits according to sex type [A) Male flower; B) Hermaphrodite flower and fruit; C) Female flower and fruit]

The seedling progeny from self-pollinated, bisexual flowers is 2/3 bisexual and 1/3 female plants. Crosses between females and hermaphrodites will give all fruit-bearing progenies. Seedlings from females pollinated with males are 50/50 male and female plants, since papayas are normally propagated from seed; male plants are removed from planting to reduce the chance of male seed production. Female plants are grown mainly for papain production and male plants are not useful for economic purposes as they do not produced fruits and hence they should be removed from the field which increases production cost. However, female trees require presence of small number (10-15 %) of male trees in the field for pollination.

A change in the sex expression is accelerated by environmental factors such as low temperature to produce perfect flowers on the male plant. Fertile hermaphrodite types also have some pistillate flowers which may show male tendency in summer and female tendency in winter. A large difference between day and night temperatures can produce more female flowers than normal. Long day and night temperature has to promote the formation of female flowering in Hermaphrodite plants. Season of planting also affects the sex expression. Planting during February shows more male plants while planting in March/ April produces an equal number of staminate and pistillate plant in dioecious types. Modification in sex in papaya can be done with the use of growth regulators. GA3 spay at 50 ppm in dioecious plant increase the femaleness. Application

of GA3 on hermaphrodite plants increased the production of hermaphrodite and staminate flowers. GA at 25 ppm and ethrel at 200 ppm, SADH 250 ppm and phosphon-D 2500 ppm on 100-125 days old seedlings tended to produce more females in dioecious types. TIBA 100 ppm spray to papaya seedlings increased the femaleness. Defoliation has been reported to induce maleness.

Conclusion

Sex types of papaya are necessary for farmers that the sex type of papaya is desirable before planting. In tropical countries, gynoecious- and romonoecious varieties are preferred, *i.e.,* those consisting of female and hermaphrodite plants that produce marketable fruit for fresh consumption.

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