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FLORAL AND POLLINATION BIOLOGY OF THE BETEL NUT PALM *ARECA CATECHU* L.

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ABSTRACT

The literature on flowering, pollination, anthesis, and fruit set of the betel nut palm *Areca catechu* L. is reviewed. The palm flowers after 3-7 years and produces about 3-4 spadices in an year. It is monoecious with a spadix containing about 0-644 female flowers and 15,000-48,000 male flowers. The palm is generally cross-fertilized. Flowers open generally in the mornings, male flowers opening at 6.00-10.00 AM and female flowers opening at 2.00-10.00 AM.

The betel nut palm is used in south and south-east Asia and the Pacific Ocean islands for the endosperm of the seed which is used as a masticatory alone and in combination with the betel leaf, lime, and tobacco. It belongs to the family Aracaceae Tribe Arecoidae. The Tribe consists of 88 genera and about 780 species.

This palm is a single, straight, unbranched cylindrical tree reaching a height of 12-30 meters in 25-50 years. The stem bears scars of fallen leaves in regular annulated form. The crown is compact with 7-12 pinnate leaves of 2-3 metres length whose basal region comprises of a broad leaf sheath completely encircling the stem. The average number of leaves shed per year is 6.4, but this may go upto 8-9 leaves in young vigourous palms and go down similarly in older palms. The palm is characterized by infrafloral flowering, i.e., the inflorescence emerges after the leaf which subtends it falls off. It is considered as an advance towards cauliflory or stem flowering, which occurs in many dicotyledonous plants (Corner, 1966).

The palm begins to flower from the third to seventh year. Murthy and Bavappa (1960*a*) have studied the mechanics of flowering. The first inflorescence is found at about the tenth internode. Rarely, it has been found as early as at the sixth node. The mean number of spadices produced annually by young, middle aged, and old palms has been estimated to be 3.8, 3.5, and 3.1, respectively. The periodicity of spadix opening varies with the season. More inflorescences emerge during December-April than at other times (Percentage of total spadices production in December: 10.3, January: 16.0, February: 16.2, March: 17.1, April: 13.2, May: 7.5, June: 2.3, July: 1.5, August: 1.3, September: 1.9, October: 4.4, and November: 8.3). The crown of 32 middle aged bearing palms were dissected and it was found that in the case of 30 crowns, 1-5 inflorescences (mean: 2.8) in the axils of the first six opened leaves (commencing next from the unopened leaf) were showing symptoms of abortion. The differentiation of the inflorescence primordium commences when it is at the axil of the fourth unopened leaf. Initiation of male flowers takes place when the inflorescence is in the axil of the first

unopened leaf (spindle leaf) and the female flowers when in the first opened leaf. Inflorescences located in the sixth leaf axils in February-May appear to get mostly aborted. Abortion initiates at a stage when inflorescence starts its development rapidly. Murthy and Bavappa (loc. cit.) recorded the average number of leaves shed and the number of inflorescences emerged every month in 1575 palms for two years. The percentage of inflorescence developed vis-a-vis leaf fall was found to be lowest during June-September (June: 24.2, July: 18.2, August: 15.9, and September: 21.9). Thus, age of palms, management conditions, and season may influence abortion of inflorescence.

Murthy and Bavappa (1960*a*) have also worked out the flowering behaviour and anthesis of this palm. The inflorescence is a spadix. It is enclosed completely in a boat shaped spathe. The spadix is about 65 cm long and much branched with close-set secondary spikes. A single spadix may contain 0-644 female flowers, confined to the distal end of the secondary branches, and 15,000-48,000 male flowers. Some palms in Malnad have been observed to produce upto 1,457 female flowers. Male flowers are small (0.5×0.3 cm) lateral, uniseriate, and alternate. Their perianth consists of a small outer whorl of 3 sepals and a large inner whorl of 3 petals. There are 6 short, stalked stamens and a pistillode, tripartite to the base. The female flowers are sessile and solitary or they occur in groups of 2 or 3. They are much larger than the male flowers (1.2×0.8 cm). The acrescent or orbiculate perianth is two whorls of $3+3$. The outer whorl is cordate, rigid, and fleshy and the inner whorl is ovate. The ovary is avoid globular with a trifid sessile stigma.

The arecanut palm is essentially cross fertilized (Bavappa and Ramachander, 1967*a*) Male flowers genereally begin to open 1-7 days after the spadix forces itself out of the spathe. They open between 6.00 A.M. to 10.00 A.M. The sequence of opening is from tip of rachillae downwards. They take about 26 days to complete opening. Female flowers open starting from the bottom of the rachillae to the top. This happens 1-6 days afterwards when all the male flowers will have been shed. They open between 2.00 A.M. to 10.00 A.M. The stigma remain receptive for about 6 days. However, cases of intraspadix and inter-spadix overlapping in the opening of male and female flowers resulting in selfing have also been observed (Murthy and Bavappa, 1960*a*).

Though the betelnut palm is monoecious, variations in sex expression such as complete female flowers, a gradual change in the reproductive parts of the flowers of occurrence of bisexual flowers, etc. have also been reported (Raghavan and Murthy, 1964; Bavappa and Murthy, 1961).

Only a doubtful role has been given to insects as pollinating agents in this palm (Sands, 1926; Raghavan and Baruah, 1958). Murthy and Bavappa (1961) and Shama Bhat, Krishnamurthy, and Rao (1961) have observed honey bees, ants (red and black), flies, and two species of thrips visiting the flowers.

Murthy and Bavappa (1961) have worked out the dispersal of pollen in a garden isolated all around by about 5 km. For this, they devised an apparatus 'aeroscope' for catching pollen by impact method. These were hung on bamboo poles at the average height of palms in the garden (12 metres height) in all the four directions at intervals of 0.4 km to a total distance of 2 km and pollen catch at different periods of the day was estimated. Pollen catch was obtained upto a distance of 1.2 km. Pollen intensity was maximum at 8.00 A.M. This must be because the anthesis in this palm takes place during the early hours of the day. They observed a gradual reduction in total pollen catch from the first week of March to the last week of April. This was obviously because the number of

inflorescences produced in April was less than that produced in March. Maximum pollen catch (81) was obtained at 12 metres (which was the height of the palms) height and closest to the garden. When the lateral and vertical movements of pollen were observed immediately after anthesis, maximum catch was recorded at the level of the bunch followed by at 30 cm below, 30 cm above, 60 cm above, and 60 cm below. Further, the locations on the eastern side of the garden recorded the highest pollen catch. Incidentally, the wind direction for almost all the days of the study was also from west to east.

Various aspects of fruit set have been studied by a number of workers. Murthy and Bavappa (1960*c*) estimated the fruit set in South Kanara to be 32-43%. Raghavan and Baruah (1956) have attributed the fall of female flowers during premature stages to failure in pollination and fertilization. Murthy and Bavappa (1960*c*) obtained 28.0% fruit set by selfing, 34.7% by crossing, and 37.6% by open pollination in the same bunch. They inferred that pollination under controlled conditions did not improve fruit set thus showing that lack of pollination was not the main cause for button shedding. Shama Bhat (1963) has however obtained increased fruit set by spraying pollen suspension in 0.5% sucrose or 0.5% sucrose+0.1% agar. Addition of 500 ppm GA to the medium increased the seed set further (Anonymous, 1969). Increased fruit set was also reported after two sprayings with 100 ppm GA (130%), 50 ppm 2,4-D (113%), or 200 ppm B-995 (116%) (Yadava, Murthy, and Pillai, 1974).

Under normal conditions, the pollen remains viable for 8-9 hr (Raghavan and Baruah, 1956). Shama Bhat et al. (1962) reported increased longevity of pollen under room temperature from 15 days to 21 days by storing pollen in a desiccator.

The source and type of pollen also influences fruit set to a great extent. Pollination of palms using bulk-pollination (polycross) gave 60% fruit set against 32.0% fruit set obtained by open pollination (Pillai and Murthy, 1972). A palm producing only barren nuts (*Manikayee*) gave 50% fruit set when pollinated with pollen from another palm of the same source and 66% set with bulk pollination (polycross) (Pillai and Murthy, 1972*b*).

Raghavan and Baruah (1956) studied rate of germination of betel nut pollen using sucrose (0.75%) as basic medium to which a wide range of dilutions of the test substances was added (IAA, IBA, IPA, NAA, PABA, ascorbic acid, inositol, cobalt chloride, boric acid, lithium chloride, manganese sulphate, ammonium molybdate, zinc sulphate, and auric chloride).

There are only two reports of embryological studies in this palm. Swamy (1942) and Rao (1955) studied megasporogenesis and events leading to fertilization. The development of floral organs of both male and female flowers is acropetal. The ovules are amphitropous until fertilization, and later, become anotropous. Soon after fertilization, the integument sends off folds of ruminations which grow centripetally though they never meet in the centre. These form characteristic lamella of the endosperm giving them a marbled appearance in section. The development of embryo conforms to the onagraceae type of Johansen (Raghavan, 1958).

The review would indicate that our information on flowering and pollination is very inadequate, especially on factors relating to reduced fruit set and immature nut fall.

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