



Breeding behaviour of certain hybrids and their parents of arecanut (*Areca catechu L.*)

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Abstract

An attempt was made to study the extent of variability with respect to floral biological traits in eight hybrids involving Hirehalli dwarf (HD) and released varieties and parents viz., Mangala, Sumangala, Sreemangala, Mohitnagar and Hirehalli dwarf at the CPCRI, RS Vittal. Inflorescence characteristics, duration of male and female phases and intra and inter spadix overlapping were recorded on individual palm basis for two consecutive flowering seasons. The cytology of dwarf and its hybrids was also studied. Hybrids and parents varied significantly for the inflorescence traits studied except for production of male flowers per rachilla. Hirehalli dwarf and hybrids recorded lower values for the inflorescence traits compared to tall parents. The Spadix length varied between 30.83cm and 66.89cm with a mean of 46.25cm. Hybrids Mohitnagar x HD and HD x Sumangala exhibited superiority for production of female flowers. Few bisexual flowers were found on the rachis of Mangala and Sumangala inflorescences where as in arecanut only monoecious inflorescence was expected. Overlapping of male and female phases which was observed in hybrids allows certain amount of selfing. Hybrids and tall parents (except Mohitnagar) showed inter-spadix overlapping. Dwarf hybrids exhibited higher values for floral traits except duration of female phase compared to parent Hirehalli dwarf. The somatic chromosome number of $2n=32$ both in HD and its hybrids was confirmed and there was no chromosomal aberrations observed due to dwarfness of the palm.

Key words: Arecanut, dwarf hybrids, monoecious, floral traits

Introduction

Hirehalli dwarf is the only source of dwarf in arecanut (Naidu, 1963) and is being exploited in arecanut breeding (Ananda, 2000). Hybrids involving Hirehalli dwarf and released varieties have been under evaluation for high yield and dwarfness. Arecanut (*Areca catechu L.*) palm is monoecious with male and female flowers occurring on the same spadix. It is essentially a cross-fertilized species (Bavappa and Ramachander, 1967). The periodicity of spadix opening, number of female flowers produced per inflorescence and nut set, vary in different cultivars under the given environmental conditions (Ananda and Rajesh, 2002). Hence, understanding of reproductive parameters in Hirehalli dwarf, tall parents and its hybrids is a prerequisite for further improvement of the crop. With this perspective, the present investigation was initiated, to study the extent of variability with respect

to inflorescence characteristics, duration of male and female phases and also intra and inter-spadix overlapping in dwarf hybrids and parents and also cytological studies to confirm the chromosome numbers and aberrations if any, in dwarf and its hybrids.

Materials and Methods

The present investigation was carried out during 2002-2004 at the Central Plantation Crops Research Institute, Regional Station Vittal (D.K) Karnataka in eight hybrids namely Mangala x Hirehalli Dwarf, HD x Mangala, Sumangala x HD, HD x Sumangala, Sreemangala x HD, HD x Sreemangala, Mohitnagar x HD and HD x Mohitnagar and five parents such as Hirehalli Dwarf (HD), Mangala, Sumangala, Sreemangala, Mohitnagar under evaluation for yield performance and dwarfness. The experiment was laid out in 1992 in randomised block design with three replications

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of eight palms each and recommended cultivation practices were followed. The inflorescence characters such as spadix length (cm), spadix breadth (cm), number of secondary rachillae, number of tertiary rachillae, number of female flowers per palm, length of secondary rachillae and number of male flowers per rachilla were recorded on individual palm basis for two consecutive flowering seasons. And also observed the duration of male phase (the duration between the opening of first male flower and shedding of the last male flower in the inflorescence) and female phase (the duration between the receptivity of the first female flower and receptivity of the last female flower in an inflorescence), gap between male and female phase and intra-spadix (the period of overlapping between the receptivity of the first female flower and pollen shedding of the last male flower in the same inflorescence) and inter-spadix (The period of overlapping between opening of the last male flower of the inflorescence and the receptivity of the first female flower of the preceding inflorescence) overlapping among the hybrids and parents. The recorded data were analyzed statistically. Also studied the mitosis by taking root tips of dwarf parent under light microscopy using the aceto-carmine dye.

Results and Discussion

Significant differences were observed among the hybrids and parents for all the inflorescence characters

except number of male flowers per rachilla (Table 1). The spadix length varied between 30.83cm and 66.89cm with a mean of 46.25cm among the hybrids and parents. Hybrid HD x Mangala recorded maximum spadix length of 39.33cm followed by HD x Sumangala (38.80cm) and HD x Mohitnagar (38.75cm). Among the tall parents, maximum spadix length was noticed in Mohitnagar (66.89cm) and minimum of 62.43cm in Sreemangala. However, the mean spadix length of tall parents was high (65.59cm) compared to dwarf parent (30.83cm) and hybrids (37.88cm).

Among the hybrids and parents, spadix breadth varied significantly which ranged from 13.36 to 19.43cm with a mean of 16.26cm. Hybrid HD x Sumangala showed maximum breadth of 19.43cm and HD x Mangala recorded minimum of 15.55cm breadth of spadix. Tall parents Sumangala recorded maximum spadix breadth (16.96cm) and Mohitnagar measured lowest (14.24cm) value for the trait. However, dwarf hybrids showed higher mean values for spadix breadth (17.01cm) compared to tall parents (15.75cm).

Among the dwarf hybrids, production of secondary rachillae was maximum in HD x Sumangala (21.97) and minimum in HD x Sreemangala (18.53) while Sreemangala produced more number of secondary rachillae (24.38) among the tall parents. Among the hybrids maximum values for production of tertiary

Table 1. Inflorescence characteristics of dwarf hybrids and parents

Hybrids/parents	Spadix length (cm)	Spadix breadth (cm)	No. of secondary rachillae	No. of tertiary rachillae	No. of female flowers / inflorescence	Length of secondary rachilla (cm)	No. of male flowers/rachilla
MangalaxHD	37.48	16.16	19.33	379.33	226.70	18.37	75.50
HDxMangala	39.95	15.55	21.05	487.00	254.00	18.67	71.73
SumangalaxHD	37.39	16.29	20.83	528.50	215.00	18.85	71.67
HDxSumangala	38.80	19.43	21.97	427.93	266.50	19.53	82.87
SreemangalaxHD	37.81	16.34	19.30	372.33	211.80	17.90	66.60
HDxSreemangala	36.00	16.60	18.53	441.00	241.50	17.73	68.83
MohitnagarxHD	36.80	16.77	20.89	591.33	275.50	18.17	68.25
HDxMohitnagar	38.75	18.87	21.75	434.43	281.00	19.70	72.20
HD	30.83	13.36	18.61	395.83	196.09	15.97	61.17
Mangala	66.31	15.66	20.81	408.24	229.08	24.13	74.72
Sumangala	66.74	16.96	21.03	518.68	286.30	25.08	77.07
Sreemangala	62.43	16.14	24.38	475.23	261.23	24.22	67.95
Mohitnagar	66.89	14.24	24.02	409.01	264.35	24.99	62.26
Grand mean	46.25	16.26	21.04	459.14	249.93	20.10	70.83
CV (%)	7.68	11.15	9.36	20.26	20.55	7.85	11.55
CD (0.05)	8.63	5.02	2.06	74.09	11.56	5.83	NS

rachillae (591.33) was noticed in Mohitnagar x HD and minimum in Sreemangala x HD (372.33) while tall parent Sumangala produced maximum number of tertiary rachillae (518.68). In arecanut inflorescence traits also helps in characterization of varieties/hybrids.

The production of female flowers per inflorescence varied significantly among the hybrids and parents which ranged from 196.09 to 286.30 with a mean of 249.93 female flowers per inflorescence. Among the dwarf hybrids, maximum production of female flowers was noticed in Mohitnagar x HD (275.50) followed by HD x Sumangala (266.50) and HD x Mangala (254.00) while Sumangala produced maximum of 286.30 female flowers while Mangala exhibited low production of female flowers/inflorescence among the tall parents. However, high mean value was observed in tall parents (260.24) for production of female flowers compared to dwarf (196.09) and hybrids (245.25). An average of 294.00 female flowers production per spadix in grown up palm of SK Local was noticed by Murthy and Bavappa (1960). It is also reported that the arecanut varieties recorded mean production of 287.60 female flowers per inflorescence (Ananda and Rajesh, 2002).

The length of secondary rachilla was maximum in HD x Sumangala (19.53cm) and minimum in HD x Mohitnagar (17.70cm) among the dwarf hybrids. However, tall parents recorded more values for the trait and Sumangala exhibited higher (25.08cm) and Mangala measured lower length of secondary rachilla. However, Sumangala produced more number of male flowers (77.07) and least numbers (62.26) were observed in Mohitnagar among the tall parents. Hybrid HD x Sumangala produced maximum 82.87 male flowers per rachilla and Sreemangala X HD showed minimum 66.60 male flowers among the dwarf hybrids.

Further, it was reported that the potentiality of the palms to produce female flowers has been found to vary considerably from tract to tract and ecotypes. Under the coastal conditions, production of only monoecious inflorescences were expected but in Mangala and Sumangala, a few numbers of bisexual flowers have been found on the same rachis between male and female flowers where as it was completely absent in dwarf hybrids. Similar observations were reported in S.K. Local cultivar (Raghavan and Murthy, 1964) and in Mangala (Ananda *et al.*, 2004).

It was observed that male flowers commence to open from tip of each of the slender filament and continue

downwards to its base in a fairly regular sequence until all the flowers are exhausted. Duration of male phase ranged between 19.00 and 25.83 days with a mean of 22.87 days among the hybrids and parents (Table 2). The

Table 2. Mean duration of male and female phases (days) in dwarf hybrids and parents

Hybrids/parents	Duration male phase	Duration female phase	Intra spadix over lapping	Intra spadix over lapping
	Mean	Mean	Mean	Mean
MangalaXHD	19.00	6.89	3.0	3.5
HDXMangala	21.33	7.33	2.5	2.6
SumangalaXHD	21.00	6.27	1.0	2.0
HDXSumangala	23.63	6.68	2.0	3.5
SreemangalaXHD	23.30	5.23	1.0	2.6
HDXSreemangala	22.37	6.73	2.0	4.0
MohitnagarXHD	23.03	6.80	2.5	3.6
HDXMohitnagar	22.67	6.53	1.5	4.6
HD	21.33	8.03	2.00	4.0
Mangala	25.83	5.06	2.33	1.16
Sumangala	25.14	5.26	-	0.83
Sreemangala	25.54	4.88	-	1.50
Mohitnagar	23.16	4.71	-	0.00
Grand Mean	22.87	6.19	-	2.76
CV (%)	6.19	16.22	-	-
CD (0.05)	2.63	2.04	-	-

duration of male phase was shorter in case of hybrid Mangala x HD (19.00 days) while it lasted for 23.63 days in HD x Sumangala. Among the tall parents, male phase lasted for a maximum of 25.83 days in Mangala and minimum of 23.16 days in Mohitnagar. In earlier studies, similar trend was observed in Local cultivars (Murthy and Bavappa, 1970) and released varieties (Ananda and Rajesh, 2002). In arecanut, when all the male flowers have completed the blooming and are shed, the female flowers begin to open from bottom to top. Among the hybrids and parents the female phase ranged from 4.71 days to 8.03 days with a mean of 6.19 days. Hirehalli dwarf and hybrid HD x Mangala (7.33) showed longer period of female phase and comparatively shorter duration of female phases were noticed in tall parents, which ranged from 4.71 to 5.26. It is reported that the female phase was shorter in case of arecanut tall varieties (Ananda and Rajesh, 2002) and South Kanara Local (Bavappa, 1980).

The intra-spadiX overlapping was observed which ranged from 1 day to 3 days among the hybrids. Among

the tall parents overlapping of male and female phases by 2.33 days was observed in Mangala palms. It is also observed that even though cross pollination is the rule in arecanut, selfing of flowers to a very small extent of 0.8% of the total number of nuts produced can take place (Murthy, 1977 and Ananda *et al.*, 2004).

Inter-spadix overlapping among the hybrids and tall parents have been studied in which the hybrid HD x Mohitnagar showed maximum of 4.60 days inter-spadix overlapping among the hybrids (Fig. 1). However, all

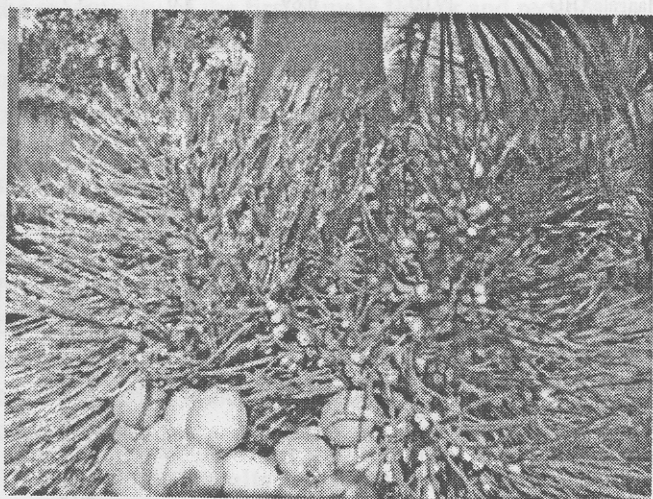


Fig. 1 Inter-spadix overlapping in dwarf hybrids

dwarf hybrids showed inter-spadix overlapping and overlapping between spadices of the same palms were also observed in tall parents except Mohitnagar indicating the complete out crossing nature. However, interspadix overlapping was observed from 0.83(Sumangala) to 1.50 days (Sreemangala). The inter spadix overlapping occur only during summer season (January to May) where the maximum spadices emerge with shorter intervals of succeeding spadices emergence. In general, dwarf hybrids exhibited higher values for floral traits studied except duration of female phase compared to parent Hirehalli dwarf (Table 3 and Fig. 2).

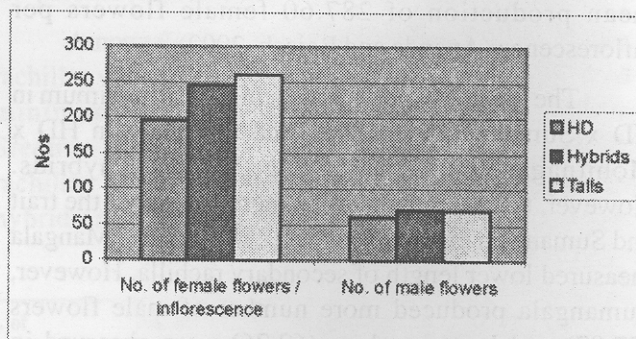
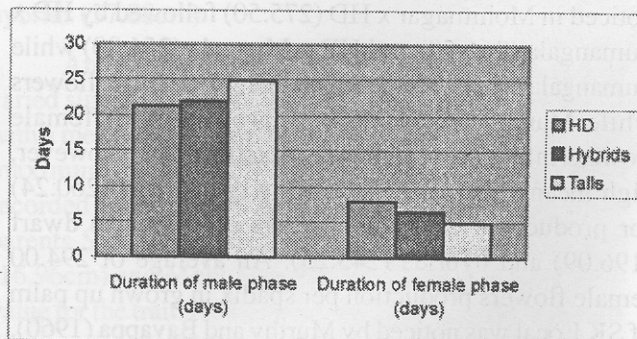
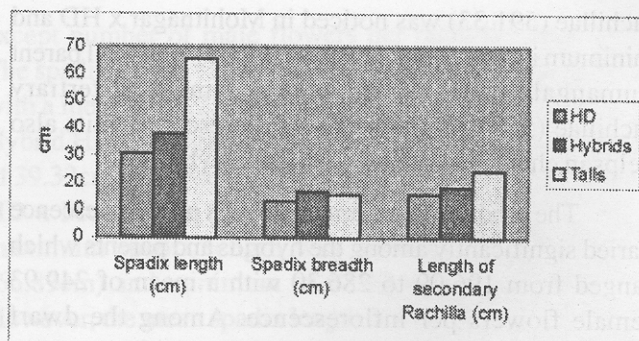


Fig. 2. Floral characters of Hirehalli dwarf, hybrids and tall parents of arecanut

In order to verify the changes in chromosomal number and structural changes, if any, the cytological study was carried out through mitosis using root tips of parent Hirehalli dwarf and its hybrids under light microscopy. The study confirmed the somatic chromosome number $2n=32$ both in parent Hirehalli dwarf

Table 3. Mean values of reproductive characters of tall parents, Hirehalli dwarf and dwarf hybrids

Hybrids/parents	Spadix length (cm)	Spadix breadth (cm)	No. of secondary rachillae	No. of secondary rachillae	No. of female flowers / inflorescence	Length of secondary Rachilla(cm)	No. of male flowers/rachilla	Duration of male phase (days)	Duration of female phase (days)	No. of bunches/palm
Hirehalli dwarf	30.83	13.36	18.61	395.83	196.09	15.97	61.17	21.33	8.03	2.15
Hybrids	37.88	17.01	20.45	457.73	245.25	18.61	72.20	22.04	6.55	3.22
Tall parents	65.59	15.75	22.56	452.77	260.24	24.61	70.50	24.92	4.98	3.59

and hybrids (Fig. 3). Though bivalents and tetravalents were noticed and there was no chromosomal aberrations observed due to dwarfness of the palm.

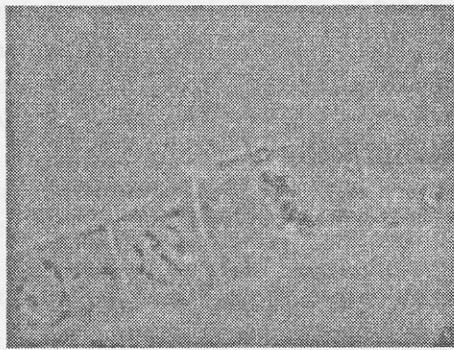


Fig. 3 Somatic chromosome in Hirehalli dwarf

In this study, the hybrids Mohitnagar x HD and HD x Sumangala exhibited superiority for the production of more number of female flowers. There were few numbers of bisexual flowers noticed in Mangala and Sreemangala but not in dwarf hybrids. Overlapping of male and female phase observed in hybrids allows certain amount of selfing and all hybrids and tall parents showed inter-spadix overlapping except Mohitnagar. The more number of female flowers, longer female phase and gap between male and female phases were found to be advantageous and could be favourably utilized in arecanut breeding. It is clear from the study that floral traits in arecanut are vital for choice of parents/hybrids and

adoption of breeding methods as well as working out techniques of artificial pollination and seed production.

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