Research Article *Journal of Plantation Crops, 2004, 32 (2): 39-44*

Secondary selection in Mangala (VTL 3) cultivar of arecanut (*Areca catechu* L.)

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(Manuscript Received 1-9-2003; Revised : 13-10-2003; Accepted : 5-5-2004)

Abstract

An attempt has been made to bring out the varietal purity and improved yield performance if any, through *inter se* /sib-mating of the typical palms of the arecanut variety "Mangala," and secondary selection was exercised for desirable morphological, reproductive and yield components among the *inter se* mated progenies. A set of 13 *inter se* combinations were produced by selecting typical Mangala mother palms growing at CPCRI, Regional Station, Vittal and planted in a randomized block design replicated six times with 9 palms per replication during 1986-87, with a view to undertaking secondary selection at CPCRI, Seed Farm, Kidu. Recording of morphological growth parameters and also recovery of typical palms based on morphological and visual observations were done during 1991. Observations on yield components such as number of nuts produced per palm and chali yield/palm have been recorded for seven consecutive years from 1991-1997. Fruit component traits such as fruit length (cm), fresh fruit breadth (cm), fresh fruit weight (g), husk thickness (cm), dry fruit weight (g), kernel length (cm), kernel breadth (cm), dry kernel weight (g), dry husk weight (g) and recovery (%) were also worked out for the same. Among the progenies of thirteen *inter se* combinations, cent percent typical Mangala palms were recovered from three combinations namely Palm Nos. 56 x 300, 157 x 71 and 35 x214 compared to other combinations and open-pollinated progenies. Analysis of data revealed the significant differences among the *inter se* combinations for characters studied. Among these, 47 x 93, 185 x 42, 35 x 214 and 42 x 300 *inter se* combinations showed higher values for production of nuts (378.08 350.27, 342.68 and 321.64 nuts/palm/year), and chali yield (3.59, 3.45, 3.34 and 2.94 kg per palm/year) with 46.53, 40.82, 36.33, 20.00 percent increase in chali yield over open-pollinated progenies. The highest (24.08%) recovery of chali was noticed in 47 x 93 combination followed by combinations 35 x 214 (23.53%), 154 x 7 (22.64%), 56 x 300 (22.48%), 42 x 300 (21.65%) and 150 x 19 (21.60%), while the *inter se* combination 177 x 95 showed the lowest recovery of 17.28% and the open-pollinated 'Mangala' recovered only 21.04% dry kernel from the fresh nut. Overall, the combinations 47 x 93, 35 x 214 and 154 x 7 exhibited their superiority for most of the nut characters. In this study, it is observed that the superiority of *inter se* progenies of different combinations for recovery of typical Mangala palms as well as for their performance in production of nuts, chali yield and fruit components over the progenies obtained after open pollination, and the alternate bearing nature is also minimum in *inter se* progenies.

Key words: Arecanut, Mangala, secondary selection, *inter se matings*

Introduction

Arecanut (*Areca catechu* L.) is a monoecious palm with male and female flowers occurring on the same inflorescence and it is purely cross-pollinated. Crop improvement in arecanut has been achieved through introduction of exotic and indigenous types and evaluation for economic traits followed by refinements in selection procedures, which have resulted in the release of four high yielding varieties namely, 'Mangala', 'Sumangala', 'Sreemangala' and 'Mohitnagar'. These released varieties possess their own specific desirable characters. Among these, Mangala showed earliness in bearing, more number of female flowers per inflorescence, higher percentage of nut set, initial and cumulative higher yields, quicker stabilization of production and shorter palm height compared to other varieties/cultivars (Bavappa, 1977; Ananda *et al.*, 2000). This semi-tall variety is characterized by partially drooping crown with well spread leaves having more number of leaflets which are dark green in colour with a crinkling at the tip (Murthy and Mohan, 1982).

Although 'Mangala' is a high yielding variety,

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the subsequent progenies of the variety showed greater variation among the individuals of the same population due to the cross-pollinating nature of the crop which resulted in heterozygosity in their genetic constitution. To bring out the varietal purity, an attempt has been made to *inter se* /sib- mate the typical palms of 'Mangala' variety and to exercise secondary selection for desirable morphological, reproductive and yield components and also to study the improvement in yield performance if any, among the *inter se* mated progenies.

Materials and Methods

The present study was carried out at the CPCRI Elite Seed Garden at Kidu, Karnataka. A set of 13 *inter se* combinations was produced by selecting typical 'Mangala'(VTL-3) mother palms at CPCRI, Regional Station Vittal and planting along with open pollinated Mangala (as check) in a randomized block design replicated six times with 9 palms per replication, during 1985-86 with a view to undertaking secondary selection at CPCRI Elite Seed Garden, Kidu. Recording of morphological growth parameters such as plant height (m), stem height (m), girth (cm), number of nodes/palm, Number of leaves/palm, crown length (m) and internodal length (cm) and also recovery of typical palms based on morphological and visual observations were done during 1991. Observations on yield components such as number of nuts produced per palm and chali yield/palm have been recorded for seven consecutive years from 1991-1997. Fruit component traits like, fresh fruit weight (g), fruit length (cm), fruit breadth (cm), husk thickness (cm), dry fruit weight (g), kernel length (cm), kernel breadth (cm), dry kernel weight (g), dry husk weight (g) and recovery (%) of dried kernel from fresh fruit, were also studied by random sampling of 20 nuts from each replication. The data were analyzed statistically and interpreted suitably.

Results and Discussion

Growth parameters of different *inter se* combinations of 'Mangala' are presented in Table 1.

Table 1. Growth performance of *inter se* progenies of Mangala

Characters /*inter se* combinations	Plant height (m)		Stem height (m)		Girth (cm)		No. of nodes/palm		No. of leaves	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
185 x 42	5.25	4.96-5.50	2.50	2.29-2.65	37.00	33.4-38.2	30.00	26.0-32.0	10.0	9-11
47 x 93	5.70	5.40-5.90	2.68	2.18-2.85	40.00	38.6-43.0	28.00	25.6-34.8	9.5	8.5-11
19 x 300	6.15	5.85-6.64	3.60	2.90-3.95	46.00	39.5-51.1	19.00	16.7-26.9	10.0	9-11
42 x 300	5.65	5.46-5.85	2.85	2.70-3.10	41.00	38.8-43.4	26.00	24.5-33.4	9.0	7.66-10.7
154 x 7	5.80	5.31-5.95	2.96	2.52-3.22	41.50	35.10-46.2	27.00	23.0-32.0	10.0	9.5-11
124 x 56	5.85	5.70-6.32	3.10	2.80-3.80	44.00	40.76-48.9	27.50	23.8-32.6	9.0	8.7-10.4
177 x 95	5.78	5.41-6.25	3.34	3.01-4.18	32.00	29.35-44.6	25.50	20.1-32.0	10.0	9.5-11
56 x 300	5.40	5.30-5.65	2.87	2.75-2.99	38.00	37.10-39.9	31.00	29.1-33.2	11.0	10-12
157 x 71	5.32	5.22-5.58	2.91	2.80-3.06	37.50	36.20-39.2	30.50	28.9-34.0	10.0	9.7-11
35 x 214	5.55	5.46-5.68	2.68	2.51-2.88	36.15	34.90-38.7	32.00	27.6-33.8	11.0	10.3-12
95 x 154	5.82	4.50-6.10	3.90	3.25-4.30	33.80	28.70-43.2	24.00	21.8-32.0	9.0	8-11
150 x 19	4.90	4.51-5.80	2.80	2.45-3.68	44.00	37.70-51.2	22.50	19.6-28.5	8.0	7.7-9.5
93x114	5.69	5.40-6.15	3.75	3.16-4.34	42.90	35.90-44.7	26.00	22.0-31.5	10.0	9.8-11
Mangala(OP)	6.26	4.86-7.25	3.82	2.76-4.15	47.00	33.50-52.5	21.00	18.1-30.5	9.0	7-9.6
Mean	**5.65***	-	**3.13***	-	**40.10***	-	**26.43***	-	**9.70**	-
CD (+/-0.05)	**1.18**	-	**0.93**	-	**7.86**	-	**4.98**	-	**NS**	-

Characters / *inter se* combinations	Crown length(m)		Internodal distance (cm)		Colour intensity of the leaf		Presence of crinkling at the tip leaf	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
185 x 42	2.75	2.67-2.85	8.33	8.81-8.28	DG	DG-DG	P	P-P
47 x 93	3.02	3.22-3.05	9.57	8.52-8.19	DG	LG- DG	P	M-P
19 x 300	2.55	2.95-2.69	18.95	17.37-[illegible]80	G	LG-LG	P	M-P
42 x 300	2.80	2.76-2.75	10.96	9.28-11.02	DG	LG-DG	P	P-P
154 x 7	2.84	2.79-2.76	10.96	10.06-10.96	LG	LG- G	LP	LP-LP
124 x 56	2.75	2.90-2.52	11.27	11.66-11.76	MG	LG-DG	LP	LP-LP
177 x 95	2.44	2.40-2.07	13.10	13.06-15.0	LG	LG- MG	LP	LP-MP
56 x 300	2.53	2.55-2.66	9.26	9.01-9.50	DG	DG-DG	P	P-P
157 x 71	2.41	2.42-2.52	9.54	9.0-9.70	DG	DG-DG	P	P-P
35 x 214	2.87	2.95-2.80	8.38	8.52-9.09	DG	DG-DG	P	P-P
95 x 154	1.92	1.25-4.60	16.25	13.44-1[illegible].91	LG	LG-MLG	MP	LP-MP
150 x 19	2.10	2.06-2.12	12.44	12.50-12.91	LG	LG-LG	MP	LP-MP
93x114	1.94	2.24-1.81	14.42	13.78-14.36	DG	LG-DG	P	MP-P
Mangala (OP)	2.44	2.10-3.10	18.19	15.3-18.20	LG	LG- DG	MP	LP-P
Mean	**2.53***	-	**12.30***	-	-	-	-	-
CD (+/-0.05)	**1.42**	-	**5.80**	-	-	-	-	-

DG- dark green, G- green, LG- light green; P- prominent, MP- medium prominent, LP- less prominent

* Significant at 5% level

Significant variations among the *inter se* progenies were observed with respect to plant height, stem height, crown length, number of nodes and internodal length, while the progenies did not differ in the production of leaves. In general, wide range of variability was noticed in open - pollinated Mangala compared to *inter se* progenies for most of the growth characters. Intensity of colour of leaf varied between green to dark green colour in case of *inter se* progenies and light green to dark green colour was observed in open- pollinated progenies. Crinkling at the tip of the leaf is the characteristic morphological marker of the variety Mangala (Bavappa, 1977; Murthy and Mohan,1982). All the *inter se* combinations showed prominent crinkling of the leaf whereas it varied from less prominent to prominent in case of open-pollinated progenies. Thus, open - pollination in arecanut leads to heterozygosity resulting in greater amount of variability within the population.

Among the progenies of thirteen *inter se* combinations, hundred percent typical Mangala palms were recovered from three combinations namely 56 x 300, 157 x 71 and 35 x214 (Table 2). All *inter se* combinations have recovered greater number of typical Mangala palms in their progenies except 177 x 95, 95 x 154 and 150 x 19 combinations. The average recovery of typical palms is 82.14 per cent and six *inter se* combinations have thrown more than average typical Mangala palms while the open-pollinated Mangala showed 62.96 per cent recovery of typical Mangala palms which is less than the average recovery. It is clear from the results that the *inter se*/sib-mating of the typical palms have contributed towards attaining homozygosity in the subsequent progenies compared to progenies obtained from the open- pollinated Mangala palms.

Table 2. Recovery of typical Mangala types in *inter se* combinations

Inter se combinations (Palm No.)	Total palms	No. of typical palms	Typical palms to adult palms (%)
185 x 42	54	53	98.15
47 x 93	54	46	85.19
19 x 300	54	42	77.78
42 x 300	54	51	94.44
154 x 7	54	38	70.37
124 x 56	54	44	81.48
177 x 95	54	35	64.81
56 x 300	54	54	100.0
157 x 71	54	54	100.0
35 x 214	54	54	100.0
95 x 154	54	37	68.52
150 x 19	54	36	66.7
93x114	54	43	79.63
Mangala (Open-pollinated)	54	34	62.96
	Mean	**44.36**	**82.14**

A significant variation observed among the *inter se* combinations for their performance for production of number of nuts per palm per year (Table 3) and chali yield (kg) per palm per year (Table 4). Among these, 47 x 93 *inter se* combination showed higher values for mean (378.08 nuts/palm/year) and cumulative (2646.6) nuts produced per palm followed by the combinations185 x 42, 35 x 214 and 42 x 300, which have produced mean of 350.27, 342.68 and 321.64 nuts/palm/year, respectively. An average of 267.61 nuts/ palm/ year were produced while check Mangala recorded 291.60 nuts/ palm/year with cumulative of 2041.18 nuts. Out of

Table3. Yield performance of *inter se* combinations of Mangala (No. of nuts/palm/year)

Inter se combinations	90-91	91-92	92-93	93-94	94-95	95-96	96-97	Cumulative yield	Mean
185 x 42	140.81	312.23	359.66	339.39	437.80	468.85	393.13	2451.87	350.27
47 x 93	185.00	351.98	315.00	387.67	421.37	512.35	473.18	2646.55	378.08
19 x 300	158.60	250.33	271.73	262.39	387.18	375.90	313.35	2019.48	288.50
42 x 300	176.20	340.23	296.05	333.09	317.79	387.76	400.37	2251.49	321.64
154 x 7	101.16	128.45	221.06	214.21	312.67	301.53	366.17	1645.25	235.04
124 x 56	66.72	169.17	173.25	214.31	329.35	290.77	181.77	1425.34	203.62
177 x 95	56.20	119.48	87.37	131.51	194.47	236.63	248.28	1073.94	153.42
56 x 300	142.05	201.43	244.03	288.27	319.85	396.77	279.16	1871.56	267.37
157 x 71	63.56	153.10	159.80	131.82	265.49	170.13	172.41	1116.31	159.47
35 x 214	180.90	223.28	249.23	422.25	384.83	462.25	475.99	2398.73	342.68
95 x 154	84.95	263.27	256.45	345.42	231.44	248.13	339.07	1768.73	252.68
150 x 19	116.30	319.82	288.42	270.76	291.08	407.37	255.77	1949.52	278.50
93x114	73.284	130.86	188.72	232.16	333.66	261.06	346.18	1565.42	223.70
Mangala (check)	160.00	283.60	270.00	386.36	280.16	345.10	315.96	2041.18	291.6
GM	**121.84**	**231.95**	**241.48**	**282.83**	**321.94**	**347.47**	**325.77**	**1873.24**	**267.61**
CD(+\- 0.05)	**70.77**	**136.14**	**145.61**	**139.34**	**147.00**	**166.15**	**157.38**	-	**52.08**

Table 4. Performance of *inter se* progenies of Mangala (chali yield/palm/ year (kg)

Inter se combinations	Year							Cumulative Yield	Mean	% increase or decrease over O.P. Mangala
	90-91	91-92	92-93	93-94	94-95	95-96	96-97			
185 x 42	1.34	2.98	3.43	3.23	4.17	4.47	3.75	23.37	3.34	36.33
47 x 93	1.78	3.34	2.99	3.68	4.00	4.87	4.50	25.14	3.59	46.53
19 x 300	1.22	1.93	2.09	2.02	2.98	2.89	2.41	15.54	2.22	-9.39
42 x 300	1.61	3.11	2.71	3.05	2.91	3.55	3.66	20.6	2.94	20.00
154 x 7	1.02	1.30	2.23	2.16	3.16	3.05	3.70	16.62	2.37	-3.27
124 x 56	0.47	1.19	1.21	1.50	2.31	2.04	1.28	10.00	1.43	-41.63
177 x 95	0.40	0.86	0.63	0.94	1.39	1.69	1.78	07.63	1.09	-55.51
56 x 300	1.29	1.82	2.21	2.61	2.89	3.59	2.53	16.94	2.42	-1.22
157 x 71	0.49	1.18	1.23	1.01	2.04	1.31	1.33	08.61	1.23	-49.80
35 x 214	1.80	2.25	2.51	4.26	3.88	4.66	4.80	24.16	3.45	40.82
95 x 154	0.69	2.13	2.07	2.79	1.87	2.01	2.74	14.28	2.04	-16.73
150 x 19	1.01	2.77	2.50	2.35	2.52	3.53	2.22	16.94	2.42	-1.22
93x114	0.62	1.11	1.60	1.97	2.83	2.22	2.94	13.30	2.26	-7.76
Mangala (Check)	1.34	2.38	2.27	3.25	2.35	2.90	2.65	16.46	2.45	-
GM	**1.08**	**2.03**	**2.12**	**2.48**	**2.81**	**3.06**	**2.88**	**16.40**	**2.35**	**-**
CD (±0.05)	**0.06**	**0.71**	**0.62**	**0.09**	**0.83**	**0.23**	**0.55**	**-**	**0.49**	**-**

thirteen *inter se* combinations, seven combinations yielded more than the average where as four combinations (185 x 42, 47 x 93, 42 x 300 and 35 x 214) showed more than the check Mangala. The linear increase for production of nuts was noticed in all the combinations from 1990 to 1997 (Fig. 1) and the entire *inter se* combinations have yielded maximum during the years 94-95, 95-96 and 96-97 when the palms attained stabilization in yield and the same trend was also observed earlier in local cultivars (Patel, 1957; Ananda, 1999; Anuradha Sane *et al.*, 2002). The *inter se* combination 47 x 93 produced a maximum of 512.35 nuts per palm per year followed by the combination 35 x 214 (462.25 nuts/palm/year) while a minimum of 170.13 nuts/palm/year was obtained in 157 x 71 during the peak period of 1995-96. From this it can be presumed that during the initial period of bearing, all the palms of different combinations exhibited lesser yield compared to subsequent years. During early-bearing stage, all the *inter se* combinations showed variation but later the variation was minimized due to linear increase in the production of nuts among the combinations.

A significant variation among the *inter se* and open - pollinated Mangala palms in respect of chali yield (kg/palm/ year) was observed. The yield of chali/dried kernel ranged between 1.0 kg/palm/year in *inter se* combination 177 x 95 and 3.59 kg/palm/year in 47 x 93 combination with an average of 2.35 kg chali/palm/ year. Higher cumulative chali yield of 25.14, 24.16, 23.37 and 20.60 per palm with a mean of 3.59, 3.45, 3.34 and 2.94 kg per palm/year were also observed in the combinations 47 x 93, 35 x 214, 185 x 42 and 42 x 300 respectively, whereas Mangala (check) recorded a cumulative yield of 16.46 kg/palm with a mean of 2.65 kg chali/palm/year. Interestingly 46.53, 40.82, 36.33 and 20.00 percentage increases in chali yield were observed in combinations 47 x 93, 35 x 214, 185 x 42 and 42 x 300 over open - pollinated 'Mangala' populations.

Consistency of *inter se* combinations with respect to both the characters *i.e*, number of nuts produced /palm/ year and also chali yield (kg/palm/year) has been recorded (Figs. 1 and 3). The combination 47 x 93 has shown linear trend over the years in respect of chali yield. Consistency in chali yield per palm/year was also noticed in 42 x 300 although it is a comparatively low yielder, whereas open-pollinated Mangala population showed alternate bearing habit which is undesirable (Rekha *et al.*, 1991) The linear trend with moderate yield tendency of total population continued upto sixth year of bearing and in the seventh year a marginal decline in yield was observed. Similar trend was noticed in earlier studies (Ananda, 2001; Bavappa, 1980; Bhat, 1968).

Among the combinations studied for recovery of typical 'Mangala' palms and their yield performance, *inter se* combinations 47 x 93 and 35 x 214 (Fig.5), 185 x 42 and 42 x 300 exhibited their higher potentialities over the progenies of the open-pollinated Mangala (Fig.6). Significant differences were observed among the *inter se* population for all the nut characters studied (Table 5). About five *inter se* combinations have recorded higher values for nut traits compared to the open-pollinated Mangala (check). Among the *inter se* combinations, maximum fruit length of 6.26 cm and breadth of 4.5 cm was observed in 154 x 7 followed by 185 x 42

Table 5. **Fruit components of *inter se* progenies of Mangala**

inter se combinations	Characters									
	Fresh fruit wt. (g)	Fresh fruit length (cm)	Fresh fruit breadth (cm)	Husk thickness (cm)	Dry fruit wt. (g)	Kernel wt.(g)	Kernel length (cm)	Kernel breadth (cm)	Husk wt.(g)	Recovery %
185 x 42	48.20	5.89	4.40	0.70	16.38	9.53	2.19	2.59	6.85	19.77
47 x 93	39.46	5.81	4.03	0.68	13.91	9.50	1.99	2.52	4.41	24.08
19 x 300	41.29	5.86	4.11	0.78	12.96	7.69	1.88	2.29	5.27	18.62
42 x 300	42.26	5.47	4.11	0.72	13.06	9.15	1.83	2.44	4.56	21.65
154 x 7	44.62	6.26	4.52	0.70	17.65	10.10	2.02	2.83	7.55	22.64
124 x 56	38.99	5.70	3.95	0.68	11.57	7.00	1.86	2.24	4.57	17.95
177 x 95	41.26	5.65	4.09	0.77	12.51	7.13	1.85	2.31	5.38	17.28
56 x 300	40.26	5.52	4.06	0.60	13.09	9.05	2.06	2.44	4.04	22.48
157 x 71	38.57	5.77	4.19	0.70	12.77	7.69	1.94	2.37	5.08	19.94
35 x 214	42.83	5.75	4.37	0.60	15.00	10.08	1.95	2.66	4.92	23.53
95 x 154	43.17	5.78	4.15	0.65	13.62	8.09	1.77	2.48	5.53	18.74
150 x 19	40.13	5.70	4.05	0.60	13.23	8.67	1.91	2.58	4.56	21.60
93x114	45.15	5.73	4.27	0.72	12.99	8.49	2.03	2.59	4.50	18.80
Mangala(check)	***40.17***	***5.85***	***4.49***	***0.65***	***17.45***	***8.40***	***2.00***	***2.88***	***9.05***	***21.04***
GM	*41.88*	*5.77*	*4.20*	*0.68*	*14.01*	*8.61*	*1.95*	*2.52*	*5.44*	*20.58*
CD (±0.05)	**9.66**	**0.55**	**0.40**	**0.17**	**3.20**	**2.22**	**0.27**	**0.34**	**0.45**	-

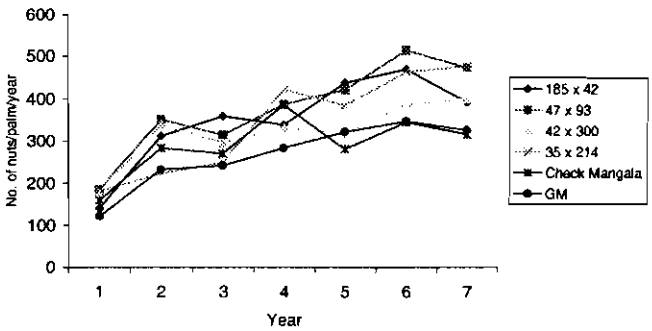

Fig. 1. Yield performance of selected *inter se* combinations over the years

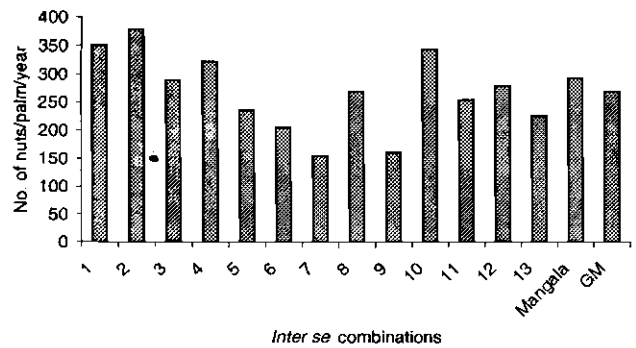

Fig. 2. Mean yield performance of *inter se* combinations

combinations (5.89 cm and 4.40 cm). Combinations 154 x 7 and 35 x 214 have yielded 10.10 and 10.08 g of kernel weight per nut while open - pollinated 'Mangala' gave only 8.46 g dry kernel weight/nut which is less than the average kernel weight (8.61g/nut). The highest (24.08%) recovery of chali was noticed in 47 x 93 combination

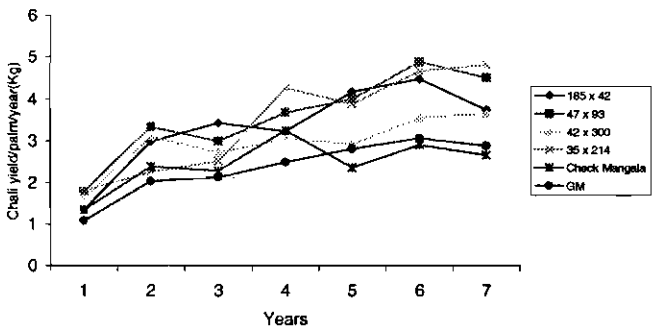

Fig. 3. Chali yield of selected *inter se* progenies over the years (kg)

followed by combinations 35 x 214 (23.53%), 154 x 7 (22.64%), 56 x 300 (22.48%), 42 x 300 (21.65%) and 150 x 19 (21.60%), whereas the *inter se* combination 177 x 95 showed lowest recovery of 17.28 per cent and the open - pollinated 'Mangala' recovered only 21.04

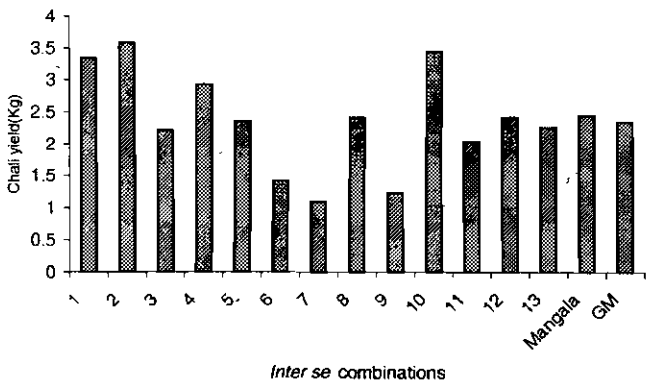

Fig. 4. Mean chali yield (kg) of *inter se* combinations

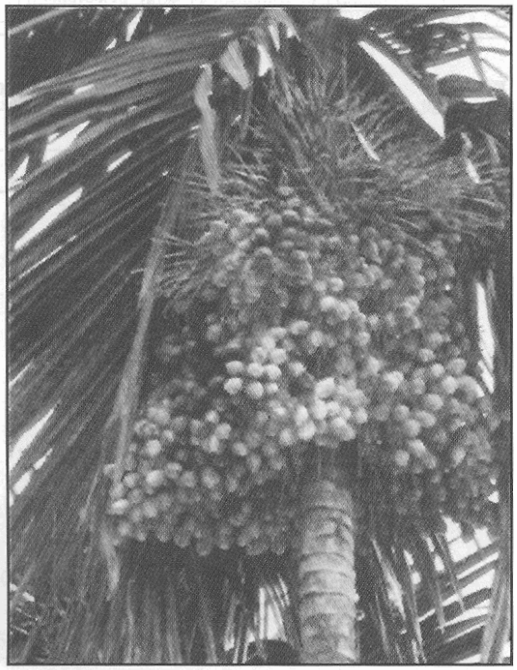

Fig. 5. *Inter se* (35x214) Mangala

per cent dry kernel from the fresh nut. Overall the combinations 47 x 93, 35 x 214 and 154 x 7 exhibited their superiority for most of the nut characters.

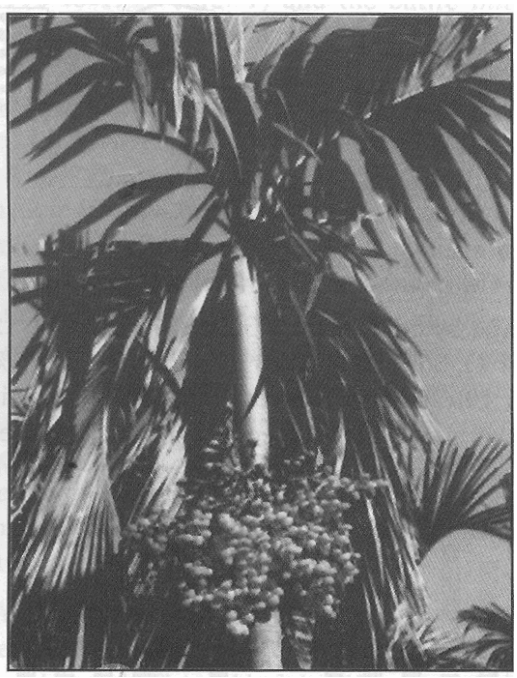

Fig. 6. Mangala (Open-pollinated)

Conclusions

In this study, it is observed that superiority of *inter se* progenies of different combinations for recovery of typical 'Mangala' palms as well as for their performance in terms of production of nuts, chali yield and fruit components over the progenies obtained from open pollination, and the alternate bearing nature is also minimized in *inter se* progenies. Among the *inter se* combinations of 'Mangala' studied, the combinations 47 x 93, 35 x 214, 185 x 42 and 42 x 300 were found to be consistent for yield and its components over the years as compared to open-pollinated 'Mangala' progenies. Therefore, in arecanut the varietal purity and improvement in their yield and its components can be achieved through *inter se*/sib-mating of typical high yielding mother palms of the cultivar and by exercising selection in second generation.

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