Research Article

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Variation in germination, seedling morphology and bio-chemical traits among indigenous arecanut (*Areca catechu* L.) accessions

K.S. Ananda, B. Rajesh and D. Shobha

Central Plantation Crops Research Institute

Regional Station, Vittal- 574 243, Karnataka

Abstract

A nursery experiment was conducted in 17 indigenous arecanut accessions to study the extent of variation for seedling traits and also chlorophyll and phenolic content during the two years 2004-05 and 2005-06 at CPCRI Regional Station, Vittal. Accessions varied significantly for the germination percent, days taken for first emergence, days taken for completion of germination, seedling height, seedling girth, leaf production, total chlorophyll and phenolic content. Among the accessions, Cal-17, Cal-1 and Cal-2 showed early and higher germination while it was delayed in Cal-6 and SCR DTC-92. Superiority for seedling traits was observed in accessions Cal-32, Cal-2, Cal-10, Cal-35 and SCRDTC-18. Highest growth increment between sixth and twelfth month period was noticed in Cal-2 followed by Cal-35 and SCRDTC-18. The highest content of chlorophyll was observed in six month old seedlings of accession Cal-33 followed by Cal-17 and SCRDTC-92. Accession Cal-10 showed maximum total phenolics followed by Cal-4 and Cal-1. The seedling height had significant positive correlation with number of leaves. The seedling girth was positively correlated with leaves/seeddling and negatively correlated with leaf length.

Keywords: Arecanut, chlorophyl, growth increment, polyphenols, seedling traits

Introduction

The breeding system of arecanut crop, its perennial habit and long juvenile phase constitute the chief barriers for crop improvement. In arecanut, mother palm, seed nut and seedling selection procedures are the major factors that influence crop improvement mainly for yield components (Bavappa and Nair, 1982). Considerable increase in yield of the plantation could be achieved by judicious selection of seedlings at the time of planting as well as in subsequent stages (Bavappa, 1970). Variability in respect of nursery traits, vegetative and nut components in indigenous arecanut accessions has been reported (Ananda, 2001). In coconut, leaf polyphenols has been used as one of the biochemical traits for characterization of genotypes (Ratnambal *et al.*, 1995) while in arecanut no such studies have been carried out so far. With this perspective, an attempt was made to study the extent of variation for nursery traits such as germination, seedling characters and also chlorophyll and total phenolic content in arecanut accessions collected from the Andaman and Nicobar group of Islands and also assess the nature and magnitude of association between different nursery traits.

Materials and Methods

The study was undertaken at Central Plantation Crops Research Institute, Regional Station, Vittal Karnataka, during the two consecutive years 2005 and 2006 in 17 indigenous (Andaman and Nicobar collections) arecanut accessions along with check SK local cultivar. Samples of 150 seednuts from each accession was collected and sown in the nursery in three replications of fifty nuts each. Recording of germination was done daily from the first emergence and till its completion. The seedling characters such as seedling height (cm), girth at collar region (cm), number of leaves/seedling, leaf length (cm), breadth of leaf (cm) and split leaves/seedling (%) were recorded in six and twelve month old seedlings. Fresh leaf sample (0.5g) from twenty five seedlings/accession was used for the estimation of total phenols by Folin-

Ciocalteu Reagent (Bray *et al.*, 1954). Similarly 1.0g of fresh leaf sample was taken for estimation of chlorophyll. To establish the relationship between the different nursery and biochemical traits, correlation coefficients were worked out. Statistical analysis was carried out using methods suggested by Panse and Sukhatme (1961).

Results and Discussion

Accessions showed significant variations for nursery characters (Table 1). Among the accessions cent percent germination was noticed in Cal-7 followed by Cal-17 (98.20%), Cal-1 (98.18%) and Cal-32 (98%) while lowest (78.57%) germination was observed in Cal-21. However, the check SK Local recorded 92.35 per cent germination. The days required for first emergence of seednuts start to germinate at 35 days and complete at 104 days after sowing (Bhat, 1956, Murthy and Pillai, 1982). Bavappa (1972) reported germination period of 41 days.

Among the accessions, significant differences were observed for seedling characters at six month of growth (Table 2). The height of seedlings varied from 24.40cm to 69.10cm with a mean of 42.70cm among the accessions. Accession Cal-32 showed maximum seedling height of 54.08cm followed by Cal-2 (47.91), SCRDTC-18 (47.17), Cal-6 (45.25) and Cal-17 (43.53) while accession Cal-5 recorded minimum of 38.50cm. The indigenous accessions showed higher values compared to the local cultivar of South Kanara (38.00cm).

Table 1. Mean germination in indigenous arecanut accessions

Accession	Weight of seed nut (g)	% germination	No. of days taken for emergence	No. of days taken for completion of germination
Cal-1	37.15	98.18	35	81
Cal-2	41.50	94.54	35	89
Cal-4	37.14	88.00	45	83
Cal-5	35.10	90.00	48	89
Cal-6	32.60	95.23	52	104
Cal-7	33.80	100.00	40	84
Cal-10	35.65	70.90	52	97
Cal-17	38.54	98.20	36	81
Cal-21	31.96	81.57	43	97
Cal-27	19.08	83.60	41	98
Cal-29	35.20	96.00	43	97
Cal-32	33.80	78.00	46	91
Cal-33	40.06	96.36	36	95
Cal-35	36.87	90.00	39	87
SCRDTC-18	37.30	88.50	37	97
SCRDTC-43	32.59	90.00	44	98
SCRDTC-92	32.60	90.67	52	103
S.K. Local (check)	35.40	92.35	41	97
Grand Mean	34.79	90.10	42.39	93.06
CD (P = 0.05)	3.96	7.62	4.16	7.08

plumule ranged from 35 (Cal-35) to 52 (Cal-10) days with a mean of 42.39 days. Among the accessions Cal-1, Cal-17, Cal-33 and SCRDTC-18 showed early germination compared to other accessions. The number of days required for completion of germination ranged from 81 to 104 days with a mean of 93.06 days. Among the accessions, Cal-1, Cal-17 and Cal-4 showed early germination. Earlier workers have reported that arecanut

Girth at collar region of the seedling ranged between 0.51cm to 0.89cm with a mean of 0.63cm. Accession Cal-32 recorded maximum and Cal-5 minimum collar girth among the accessions studied. However, accessions Cal-2 (0.82), Cal-7 (0.74), Cal-27 (0.65) and Cal-1 and Cal-10 (0.64) had desirable girth at the six month. The SK Local also showed desirable girth of 0.70cm when compared to the other indigenous accessions.

Table 2. Morphological traits in six month old arecanut seedlings (sprouts)

Accession	Height (cm)		Girth (cm)		No. of leaves		Leaf length (cm)		Leaf breadth (cm)		% of seedlings showed splitting	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Cal-1	41.47	31.2-52.0	0.64	0.35-0.70	2.68	2-3	22.23	13.0-30.5	3.90	2.4-3.9	12.56	04.5-16.6
Cal-2	47.91	34.1-57.7	0.82	0.41-0.76	3.74	2-3	22.80	12.1-31.2	4.13	3.0-5.6	09.80	02.3-11.5
Cal-4	42.03	30.1-59.3	0.61	0.51-0.94	3.00	2-4	21.62	12.5-28.4	4.17	2.5-5.3	04.50	02.6-09.8
Cal-5	38.50	24.4-56.9	0.51	0.37-0.68	2.48	1-3	22.40	12.2-29.7	3.71	2.7-4.7	09.14	04.7-12.5
Cal-6	45.25	31.2-57.5	0.61	0.57-1.11	2.69	3-5	21.72	15.3-34.1	4.21	2.8-5.7	10.11	04.5-13.6
Cal-7	39.29	27.1-49.8	0.74	0.51-0.97	3.36	3-4	20.86	16.1-27.2	3.92	3.0-4.8	12.22	08.6-14.5
Cal-10	39.96	28.3-47.1	0.64	0.45-0.75	2.78	2-3	20.70	09.1-27.1	3.48	1.8-4.8	07.14	03.6-09.8
Cal-17	43.53	31.4-53.8	0.54	0.27-0.66	2.66	1-3	23.14	16.6-32.1	3.13	2.2-4.1	16.33	09.9-18.7
Cal-21	38.56	30.0-52.0	0.56	0.30-0.70	2.70	2-4	23.00	14.0-30.1	3.23	2.0-5.0	10.56	05.8-13.8
Cal-27	39.56	29.5-52.5	0.65	0.32-0.78	2.65	2-3	22.56	15.5-31.1	3.56	2.2-5.7	05.90	02.4-07.0
Cal-29	42.56	31.6-52.1	0.60	0.41-0.71	2.69	2-3	21.85	15.1-29.4	3.65	2.0-5.3	11.28	06.0-13.7
Cal-32	54.08	34.1-69.1	0.89	0.58-1.40	3.70	3-4	19.98	12.3-25.4	3.92	2.8-5.6	13.80	10.0-15.0
Cal-33	42.95	30.4-53.1	0.63	0.41-0.74	2.74	2-3	22.01	12.1-26.1	4.20	2.5-5.6	15.90	11.4-17.0
Cal-35	43.22	34.1-53.3	0.59	0.41-0.71	2.80	2-3	24.12	16.7-29.8	3.79	2.3-5.2	09.80	04.9-10.9
SCRDTC-18	47.17	31.5-59.2	0.57	0.41-0.74	2.47	1-3	26.94	15.4-39.1	4.36	3.1-5.8	04.26	01.6-07.8
SCRDTC-43	42.35	22.0-53.0	0.53	0.39-0.65	2.40	2-4	24.56	16.0-33.0	3.86	2.0-5.1	05.30	02.0-06.0
SCRDTC-92	41.57	26.7-54.6	0.52	0.41-0.67	2.39	1-3	22.05	15.1-30.6	3.79	2.8-4.8	06.23	04.5-07.5
S.K. Local	38.00	25.6-48.0	0.70	0.55-0.78	2.25	2-3	20.70	16.8-32.0	4.11	2.5-5.0	06.12	04.0-07.0
GM	42.70**	24.4-69.1	0.63**	0.30-1.40	2.78*	1-5	22.41**	09.1-39.1	3.84**	1.8-5.7	09.50	01.5-18.7
CD (P = 0.05)	3.04	-	0.08	-	0.30	-	1.97	-	0.51	-	03.01	-

** Significant at 1 % level, * Significant at 5 % level

Wide variations were noticed for number leaves per seedling during six months of growth which ranged from 2.25 to 3.74 leaves per seedlings with a mean of 2.78. Accession Cal-2 produced maximum of 3.74 leaves followed by Cal-32 (3.70), Cal-7 (3.36) and Cal-4 (3.00) while accession SCRDTC-92 showed minimum leaves (2.39) per seedling. Among the accessions, the leaf length ranged between 19.98cm and 26.94cm with a mean of 22.41cm. The accession SCRDTC-18 had the maximum leaf length of 26.94cm while minimum of 19.98cm was noticed in accession Cal-32. Accession SCRDTC-18 showed maximum leaf breadth (4.36cm) while Cal-21 recorded the minimum (3.23cm). Among the accessions, maximum of 16.33 per cent split leaves in seedlings was observed in Cal-17 followed by Cal-33 (15.90%), Cal-32 (13.80%) and Cal-1 (12.56%) while 6.12% seedlings showed leaf splitting in the check SK local.

Significant differences were observed for morphological characters except for number of split leaves per seedling in twelve month old seedlings (Table 3). Among the 17 indigenous accessions, Cal-2 showed superiority for most of the characters by recording 109.28cm seedling height, 1.62cm girth at collar region, 4.50 leaves/seedling, 47.79cm leaf length and 3.92 % split leaves per seedling. All indigenous accessions showed greater values for characters studied when compared to the check SK local. The early germinated seedlings of accessions Cal-35, SCRDTC-18, Cal-32 and Cal-33 were significantly more vigourous than the seedling from late germinated nuts. Simillar trend was observed in an earlier study by Bavappa *et al.*(1957).In the present study, heavier nuts exhibited comparatively better germination and produced seedlings with greater vigour which confirms the findings of the earlier workers (Bavappa and Abraham,1961).

Growth increment in seedlings between 6th and 12th month period showed significant differences among the accessions (Table 4). Higher growth increment in terms of height was observed in accession Cal-2 (61.37cm) followed by Cal-35 (51.21cm) and SCRDTC-18 (45.33cm) while higher increment in seedling girth was noticed in SCRDTC-18 (1.02cm) and Cal-35 (0.97cm). Increment in leaf production was higher in accessions SCRDTC-43 and SCRDTC-18. Accessions Cal-10 and Cal-2 showed maximum increment in length of leaf while more increment in leaf breadth was recorded in Cal-29 and Cal 33 accessions.

Total chlorophyll and polyphenol content were estimated in six month old seedlings (Table 5). Among the accessions, maximum chlorophyll content was recorded in accession Cal-33 (2.86mg/g) followed by accession Cal-17 (2.74mg/g) and SCRDTC-92 (2.69mg/g) while, accession, Cal-21 (2.01mg/g) showed minimum chlorophyll content. The present results corroborates with earlier studies (Rajesh and Ananda, 2005). Among the accessions, the polyphenol content ranged from 1.14mg/g

Table 3. Morphological traits in twelve month old arecanut seedlings

Accession	Height (cm)		Girth (cm)		No. of leaves		Leaf length (cm)		Leaf breadth/(cm)		Split leaves/seeding (%)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Cal-1	65.56	55.0-75.0	1.27	1.0-1.6	3.43	3-4	35.66	29.0-43.0	5.32	4.0-7.0	2.77	2.0-3.0
Cal-2	109.28	66.5-159.5	1.62	1.2-2.0	4.50	3-5	47.79	32.0-65.0	5.23	2.3-9.4	3.65	2.0-3.8
Cal-4	64.79	53.4-76.0	1.41	1.0-1.6	3.87	3-5	29.26	23.0-37.5	4.56	3.0-6.5	3.92	2.1-4.0
Cal-5	74.48	53.0-93.0	1.45	1.1-1.9	3.96	3-5	33.32	24.0-44.0	4.74	3.0-7.0	2.97	1.9-3.6
Cal-6	72.43	52.5-89.4	1.46	1.1-1.9	3.79	3-5	38.82	29.0-44.0	4.46	2.3-7.5	3.64	2.5-4.0
Cal-7	72.30	52.0-91.5	1.35	1.0-1.9	4.04	2-5	35.39	29.0-44.0	4.88	3.0-7.5	3.25	2.0-4.0
Cal-10	70.58	48-79.0	1.53	1.2-1.8	3.65	3-5	45.75	28.0-47.0	4.57	3.0-6.5	2.69	2.0-3.6
Cal-17	66.37	55.0-81.0	1.32	1.1-1.6	4.07	2-5	35.92	26.0-48.5	4.75	2.3-6.7	3.55	2.6-4.2
Cal-21	71.56	56.50-86.0	1.36	1.0-1.5	4.00	2-5	34.56	20.0-41.0	4.50	2.0-6.0	3.23	2.7-4.1
Cal-27	73.56	61.66-97.0	1.42	1.3-1.7	4.10	2-5	36.00	28.0-49.5	4.80	2.1-5.9	3.25	3.0-4.0
Cal-29	67.68	55.0-77.5	1.22	1.0-1.4	3.42	3-5	40.46	30.5-50.0	5.43	3.8-7.0	2.90	2.0-3.6
Cal-32	79.98	75.0-95.0	1.52	1.2-1.8	4.19	3-5	38.31	31.5-47.5	5.53	4.1-8.2	3.45	2.8-4.0
Cal-33	76.86	67.1-93.5	1.48	1.2-1.9	3.34	3-5	42.73	32.0-55.5	5.85	3.0-9.1	3.02	2.0-4.0
Cal-35	94.43	69-124.0	1.56	1.2-2.0	3.85	3-5	46.07	31.0-58.0	4.85	2.4-9.0	2.61	2.0-3.5
SCRDTC-18	92.50	36.0-123	1.59	0.7-2.1	3.95	3-5	46.63	20.5-72.0	4.73	2.9-6.5	3.24	2.5-4.5
SCRDTC-43	86.50	38.0-112.0	1.36	0.5-2.0	4.00	3-5	36.56	20.0-68.5	4.50	3.0-7.0	3.00	2.1-4.0
SCRDTC-92	56.74	43.0-69.0	1.18	1.0-1.4	3.66	3-5	33.26	23.5-47.0	3.96	3.0-5.4	3.55	2.5-4.5
S.K. Local	55.00	46.0-89.0	1.20	0.6-2.1	4.05	2-5	33.08	30.0-69.8	4.26	2.0-8.4	3.55	3.0-4.7
GM	75.03**	36.0-159.0	1.41**	0.7-2.1	3.88*	2-5	38.31**	20.0-72.0	4.83**	2.0-9.4	3.23	1.9-4.7
CD(P=0.05)	6.99	-	0.18	-	0.60	-	5.79	-	0.94	-	NS	-

** Significant at 1 % level, * Significant at 5 % level

Table 4. Mean growth increment in arecanut seedlings between 6th and 12th month period

Accession	Seedling height (cm)	Girth (cm)	Number of leaves	Leaf length (cm)	Leaf breadth (cm)
Cal-1	24.09	0.63	0.75	13.43	1.42
Cal-2	61.37	0.80	0.76	24.99	1.10
Cal-4	22.76	0.80	0.87	7.64	0.39
Cal-5	35.98	0.94	1.48	10.92	1.03
Cal-6	27.18	0.85	1.10	17.10	0.25
Cal-7	33.01	0.61	0.68	14.53	0.96
Cal-10	30.62	0.89	0.87	25.05	1.09
Cal-17	22.84	0.78	1.41	12.78	1.62
Cal-21	33.00	0.80	1.30	11.56	1.27
Cal-27	34.00	0.77	1.45	13.44	1.24
Cal-29	25.12	0.62	0.73	18.61	1.78
Cal-32	25.90	0.63	0.49	18.33	1.61
Cal-33	33.91	0.85	0.60	20.72	1.65
Cal-35	51.21	0.97	1.05	21.95	1.06
SCRDTC-18	45.33	1.02	1.48	19.69	0.37
SCRDTC-43	44.15	0.83	1.60	12.00	0.64
SCRDTC-92	15.17	0.66	1.27	11.21	0.17
S.K. Local	17.00	0.50	1.80	12.38	0.15
GM	32.37**	0.78**	1.09*	15.91 **	0.99 **
CD (P=0.05)	05.61	0.06	0.29	02.86	0.38

***Significant at 1% level, *Significant at 5% level*

to 2.08mg/g with a mean of 1.54mg/g in six month old seedlings. Accession Cal-10 recorded maximum total phenolics while Cal-7 showed minimum content among the indigenous accessions. However, accessions Cal-10, Cal-4 and Cal-1 showed higher content of total phenolics in six month old seedlings. Significant variations in seedling leaf polyphenol content was reported earlier in exotic arecanut accessions (Ananda and Rajesh, 2005).

Table 5. Biochemical parameters in indigenous arecanut accessions

Accession	Total chlorophyll (mg/g)	Total phenolics (mg/g)
Cal-1	2.50	1.97
Cal-2	2.52	1.24
Cal-4	2.13	2.04
Cal-5	2.16	1.14
Cal-6	2.32	1.24
Cal-7	2.23	1.14
Cal-10	2.52	2.08
Cal-17	2.74	1.56
Cal-21	2.01	1.63
Cal-27	2.32	1.60
Cal-29	2.37	1.59
Cal-32	2.44	1.41
Cal-33	2.86	1.52
Cal-35	2.57	1.50
SCRDTC-18	2.46	1.52
SCRDTC-43	2.68	1.47
SCRDTC-92	2.69	1.45
S.K. Local	2.52	1.60
GM	2.45**	1.54**
CD (P = 0.05)	0.23	0.27

** Significant at 1 % level

Accessions with higher content of polyphenols can be used in quality improvement along with high yield and such varieties will have more pharmaceutical/industrial value.

In order to establish the relationship between the traits, correlation coefficients were worked out among the different parameters. Only leaves per seedling showed significant positive correlation with seedling height and seedling girth and leaf length had significant negative correlation with seedling girth. The total seedling height was positively correlated with girth (0.450), number of leaves (0.504) and leaf breadth (0.360). Seedling girth also showed positive correlation with leaf breadth and percentage of split leaves but the correlation was non-significant. It has been reported that seedling traits at the time of planting significantly correlated with yield during first year of bearing (Bavappa and Ramachander, 1967) and similarly, positive correlation of seednut weight and seedling girth with yield has also been established (Bhagavan *et al.,* 1981).

The present study indicated significant variation for germination (%), days to first emergence, days to completion of germination, seedling traits and biochemical parameters. Among the accessions, Cal-17 and Cal-1 showed early and higher germination while accessions Cal-32, Cal-2, Cal-10, Cal-35 and SCRDTC-18 exhibited superiority for seedling traits. It was observed that seedlings from early and high initial germination were significantly more vigorous than the seedlings from late/ delayed germination. Germination and vigour of seedlings was also influenced by quality of seed in arecanut. These findings can be utilized in selection of desirable parents and future breeding of the crop.

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