*Journal of Plantation Crops 17: 64-71, April, 1990*

# VARIETY IMPROVEMENT IN ARECANUT

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## INTRODUCTION

Undivided India had about two lakh hectares under arecanut cultivation and the production was about 1.8 lakh tonnes. In post independence period India was forced to import large quantity of arecanut as during partition 50 per cent of the area went to East Pakistan (now Bangladesh). Within two decades selfsufficiency in production was achieved mainly due to concerted efforts in research and development. In research, crop improvement programmes received highest priority. The release of high yielding variety 'Mangala' was a landmark in the research programmes of arecanut in the country. The crop improvement programmes of arecanut included collection, maintenance and evaluation, hybridization and selection. The work carried out mainly at CPCRI, Regional Station, Vittal and also other arecanut research centres in the country is summarized in this article.

### *Collection and maintenance of Germplasm*

Arecanut is adopted to the warm humid tropics. The maximum crop diversity is observed in the Near-East countries like Indonesia, Malaysia, Philippines and particularly on the chains of Archipelagos strewn across the Pacific ocean. Besides the cultivated species, *Areca catechu*, a number of other uncultivated species exist. Due to this diversity, South-East Asia can be considered as the centre of origin. In India, arecanut cultivation and its industry have been rooted in tradition and culture. The Central Arecanut Research Station, Vittal (Presently the Central Plantation Crops Research Institute, Regional Station, Vittal) has embarked on the collection and maintenance of world arecanut germplasm since its inception in 1957. This germplasm bank consists of twentythree exotic types belonging to six species of *Areca* and fortyfive indigenous types of *A. catechu* obtained from different parts of India as well as from important arecanut growing countries such as Sri Lanka, the Philippines, Indonesia, Singapore, Malaysia, Thailand, Solomon Islands, Fiji, South China and Mauritius (Table 1). The variability in this collection includes genes for dwarfness, early bearing, suckering habit and high fruit set. In evaluation trials, superior varieties with high yield potential over the local cultivar (Dakshina Kannada) were identified.

An accession among exotic types that was striking in several respects and in conformity with the accepted selection criteria was 'VTL-3' (Fig.1). While the local varieties required about five years to flower, this exotic introduction from Peking (China) flowered in three years. This has

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**Fig 1. Mangala (VTL 3)**

a larger number of female flowers per bunch and more number of bunches. Apart from being precocious in flowering it was a heavy bearing tree. About 70 per cent more of yield has been recorded by VTL-3 in comparison to Local (Dakshina Kannada). This has been released under the name 'Mangala' for general cultivation (Bavappa, 1977). An unique feature of this type is the short stature (semi-dwarf) and the shorter (5.5 mm) internodal distance as compared to 16 cm in Local types. Mangala has got a highly extended male phase that overlaps with the female phase leading to natural selfing. It is characterised by partially drooping up of crown with well spread leaves and having more number of leaflets crinkled at the tip portion. Fruits when ripe are dark orange coloured, with a mean volume of 59.23 $cm^3$ and weighing 48 g (average) The

Table 1. *List of arecanut germplasm available at Vittal*

| Sl. No. | Accession No. | Country/Place of collection | Name of the species |
|---|---|---|---|
| 1. | VTL-1 | Fiji | *Areca catechu* |
| 2. | VTL-2 | Mauritius | *Areca triandra* |
| 3. | VTL-3 | China | *Areca species* |
| 4. | VTL-5 | Ceylon-1 | *Areca species* |
| 5. | VTL-6 | Indonesia-1 | *Areca triandra* |
| 6. | VTL-7 | Indonesia-2 | *Areca triandra* |
| 7. | VTL-9 | Indonesia-4 | *Areca* species |
| 8. | VTL-11 | Indonesia-6 | *Areca catechu* |
| 9. | VTL-12 | Saigon-1 | *Areca* species |
| 10. | VTL-13 | Saigon-2 | *Areca* species |
| 11. | VTL-14 | Saigon-3 | *Areca* species |
| 12. | VTL-15 | Ceylon-2 | *Areca* species |
| 13. | VTL-17 | Singapore | *Areca* sepcies |
| 14. | VTL-18a | Br. Sol. Island-1 | *Areca* species |
| 15. | VTL-18b | Br. Sol. Island-2 | *Areca* species |
| 16. | VTL-18c | Br. Sol. Island-3 | *Areca* species |
| 17. | VTL-21 | Ceylon-3 | *Areca concinna* |
| 18. | VTL-23 | Australia | *Areca normanbyii* |
| 19. | VTL-26 | Fiji | *Areca catechu* |
| 20. | VTL-27 | Saigon | *Actinoryhtis callapai* |
| 21. | VTL-28a | Saigon-1 | *Areca* species |
| 22. | VTL-28b | Saigon-2 | *Areca* species |
| 23. | VTL-28c | Saigon-3 | *Areca* species |
| 24. | VTL-29a | Andamans | |
| 25. | VTL—29b | Andamans | |
| 26. | VTL—29c | Andamans | |
| 27. | VTL—29d | Andamans | |
| 28. | VTL—29e | Andamans | |
| 29. | VTL—29f | Andamans | |
| 30. | CAL-1 | Andamans | *Areca catechu* |
| 31. | CAL-2 | | |
| 32. | CAL-4 | | |
| 33. | CAL-5 | | |
| 34. | CAL-6 | | |
| 35. | CAL-7 | | |
| 36. | CAL-10 | | |
| 37. | CAL-17 | | |
| 38. | CAL-21 | | |
| 39. | CAL-27 | | |
| 40. | CAL-29 | | |
| 41. | CAL-32 | | |
| 42. | CAL-33 | | |
| 43. | CAL-35 | | |
| 44. | SCRDTC-43 | | |
| 45. | SCRDTC-92 | | |
| 46. | Tirthahalli | Karnataka | |
| 47. | Sagar | Karnataka | |
| 48. | Kumta | Karnataka | |

*Cont'd*

Table 1. *cont'd*

| Sl. No. | Accession No. | Country/Place of collection | Name of the species |
|---|---|---|---|
| 49. | Dapoli | Maharashtra | |
| 50. | Chare | Karnataka | |
| 51. | Mahuva B | Gujarat | |
| 52. | Sirsi | Karnataka | |
| 53. | Tirthahalli (overlapping) | Karnataka | |
| 54. | Tirthahalli (oblong) | Karnataka | |
| 55. | Hirehalli (dwarf) | Karnataka | |
| 56. | Sweet areca | Karnataka | |
| 57. | Kahikuchi | Assam | |
| 58. | Kamrup | Assam | |
| 59. | Mettupalayam | Tamil Nadu | |
| 60. | Mohitnagar | West Bengal | |
| 61. | Sreevardhan-I | Maharashtra | |
| 62. | Sreevardhan-II | Maharashtra | |
| 63. | South Kanara (Local) | Karnataka | |
| 64. | MN-1 (Secondary nursery) | Mohitnagar | |
| 65. | MN-2(Secondary nursery) | Mohitnagar | |
| 66. | MN-3 (Secondary nursery) | Mohitnagar | |
| 67. | MN-4 (Secondary nursery) | Mohitnagar | |
| 68. | SCRDTC-18 | Andamans | |

kernels weigh about 11.55 g.

The yield data of 6 years (1981-87) in Mangala garden (planted in 1967) showed the mean yield of 12.67 kg/palm/year as compared to South Kanara local which yielded 8.59 kg/palm/year. Mangala cultivar also showed alternate bearing habit. 1.56 per cent yielded more than 1000 nuts/palm. In case of South Kanara local 0.2 per cent palms yielded more than 900 nuts/palm (Rekha, *et al.*, 1988). Among the collection, the performance of exotic types Indonesia-6 (VTL-11), Singapore (VTL-17), Saigon-1 (VTL-12), Ceylon-1 (VTL-5) have been observed in multilocation trials. A comparative yield trial of 16 types for a period of 9 years (1964-65 to 1972-73) showed that five introductions viz., VTL-3 of China (10.3 kg wet weight per tree), VTL-11 of Indonesia (14.5 kg of wet weight per tree), VTL-12 of Thailand (12.9 kg wet weight per tree), VTL-13 of Saigon (11.7 kg wet weight per tree) and VTL-17 of Singapore (14.6 kg wet weight per tree) have high yield potential and the increase in yield (weight of nuts) was 6 to 50 per cent more than the local cultivar of Dakshina Kannada (9.7 kg wet weight per tree) (CPCRI, 1974).

Among the indigenous types, Tirthahalli (Karnataka) with greater number of nuts per bunch, Mohitnagar (West Bengal) with heavy nuts and Shrivardhana (Ratnagiri district of Maharashtra) with quality nuts were identified to be promising. An extreme case of dwarfness (spontaneous mutant) is located at Hirehalli (Karnataka). A seven year old tree has about 20 cm long trunk with almost overlapping nodes. However, the yield potential of this dwarf genotype was very low. It is considered to be a valuable breeding material with a scope for combining high yield and dwarfing character through hybridisation.

With a view to generating elite planting

material in arecanut, large scale planting of VTL-3 (Mangala), VTL-11 and VTL-17 was taken up at CPCRI Seed Farm, Kidu (Karnataka). Both VTL-11 and 17 gave 53.3 and 38.9 per cent more yield than released variety Mangala These were released by name 'Sumangala' and 'Sreemangala' respectively (Table 2).

*Selection*

Selection of mother palms for seed nut collection based on high yield alone proved to be ineffective in the progeny as heritability for yield in arecanut was only 0.2. The selection based on characters with high heritability and which are also correlated with yield was stressed by Bavappa and Ramachander (1967a) (Table 3).

The performance of different set of palms having diverse pre–bearing periods has been empirically worked out by Bavappa and Ramachander (1967b). The age at the first bearing alone has high heritability and correlation with yield. Progenies of such early bearing palms gave a higher proportion of early bearers in the progeny. By confining selection of seednuts to 62 per cent of palms yielding in the fifth year after transplanting, a yield increase of about 8 to 15 per cent was obtained in the progeny.

Another method of selection tried has been based on the most superior combination of all the characters (selection index) so as to get the maximum benefit. A selection index based on 29 characters was found to be five times superior to the usual method of selection of mother palms based on high yield alone. Since this sort of selection cannot be practiced with ease, a simpler method of locating superior palms was worked out (Ramachander and Bavappa, 1972). Selection of seedlings having maximum number of leaves, girth at collar and minimum height at the time of transplanting was found to be practicable solution. This selection method based on seedling characters was 332 per cent more efficient than

Table 2. *Performance of exotic and indigenous cultivars at Vittal*

| Cultivar | No.of nuts/ palm/year | Wt. of nuts/ palm/year (kg) | % over Mangala | % over Local |
|---|---|---|---|---|
| Mangala | 299.6 | 11.25 | - | 6.23 |
| VTL-11 | 606.2 | 17.25 | 53.33 | 62.89 |
| VTL-17 | 418.8 | 15.63 | 38.93 | 47.59 |
| Local | 298.7 | 10.59 | - | - |

Table 3. *Correlation of different characters with yield (No. of nuts) and their heritability*

| | Characters | Genotypic correlation | Heritability % |
|---|---|---|---|
| 1. | Age at first bearing | −0.55 | 72 |
| 2. | Number of leaves shed | 0.53 | 32 |
| 3. | Number of inflorescences produced | 0.02 | 46 |
| 4. | Number of female flowers produced | −0.44 | 8 |
| 5. | Percentage of nut set | 0.88 | 33 |
| 6. | Number of nuts sper bunch | 0.86 | 22 |

Table 4. *Behaviour of plants in different categories with reference to girth at collar and no.of nodes.*

| Characters correlated with yield | Levels | Percentage of occurrence | Mean yield of nuts/ tree/year (four years) |
|---|---|---|---|
| Girth at collar (cm) | Less than 20 | 6 | 67 |
| | 20-25 | 10 | 121 |
| | 26 and above | 84 | 194 |
| Number of nodes | Less than 3 | 7 | 87 |
| | 4 | 9 | 151 |
| | 5 and above | 84 | 191 |

selection based on high yield alone (Bavappa, 1970).

Correlations worked out between plant characters recorded one and two years of growth after transplanting showed that girth at collar one year after transplanting and the number of nodes two years after transplanting have significant phenotypic and genotypic correlations with yield. The yield behaviour of the plants under different groups for the above two characters is given in Table 4 (Bavappa and Ramachander, 1967a, 1967c).

Plants which have less than 20 cm girth after one year of planting and plants which have produced less than four nodes after two years show a very low yield. This group which account for nearly 13 per cent in the initial population will have to be replanted during the first two years of establishment of the plantation. This can increase the overall yield of the plantation by nine per cent. This will not only improve the productive potential of the plantation but also reduce its maintenance cost.

Despite the uniform standards adopted for selection of mother palms, certain palms have been found to give consistently high yielding progenies. This ability to transmit high yield irrespective of male parent in an open pollinating system is presumed to be due to 'prepotency'. While comparing the progeny performance of such prepotent palms and non-prepotent mother palms, the actual yield differences between the two population was found to be due to differences in percentage seed set. Since percentage of set was also found to have a higher heritability than yield, this has to be reckoned as an important criterion for selection of mother palms.

A modified mass-pedigree selection was initiated in arecanut with a view to achieve higher yields than those realised through seedling and mother palm selection (Bavappa and Ramachander, 1967c, 1968a, 1968b). Bulk norm and individual norm tests were applied to screen the families and individuals within the selected families. However, the results of replicated field trial indicated that mass pedigree selection was ineffective in arecanut.

### *Floral Biology and Hybridization*

Dr. Shama Bhat was the first to study the floral biology in detail in his post-graduate programme (Shama Bhat 1961). In arecanut, the inflorescence (spadix) are produced in the leaf axils. The upper limit of spadices that transform into fruit bearing bunches in a palm could be as high as seven. The male flowers are borne on the ribbon like rechillae in two rows while the female flowers are confined to the basal portion. A

spadix accommodates up to about 600 female flowers and 15000-48000 male flowers. Some varieties that typically bear small nuts are found to produce as many as 1500 female flowers per spadix (Murthy and Bavappa, 1960; Murthy, 1977). Each male flower has got six fertile stamens. The inflorescence is protandrous and male phase continues for eleven days. The female phase does not commence by that time. Primarily it is a cross pollinated species, however, in some cases, interspadix and intraspadix pollination was also recorded.

Intense bee activity is also found in the areca garden. Bees are, however, not found to visit the female flowers and there is doubt about the role played by the bees in the pollination. The female flowers remain receptive up to six days. In spite of a good pollen dispersal system, yield in arecanut is often retarded due to low fruit set. Only about 12.0 to 42.2 per cent of the female flowers are set in different cultivars. The percentage fruit set can be improved to some extent by assisted pollination like spraying with pollen sucrose solution (26.4 per centage of set) and also with hormones (Shama Bhat, 1963).

The main objectives of hybridization programme undertaken at CPCRI, Vittal was to (1) evolving high yielding regular bearing varieties; (2) to improve nut size and number of nuts/bunch; (3) to evolve a hybrid showing desirable characters of Mangala and quality of 'Sreevardhan' variety; (4) to incorporate dwarfness of 'natural mutant' to high yielding varieties; and (5) to develop varieties tolerant to yellow leaf disease. In addition, interspecific hybridization was taken up to transfer desirable characters of *A. triandra* such as suckering habit, high female flowers production and high nut set to *A. catechu*.

Attempts made to exploit hybrid vigour were encouraging (Murthy and Pillai, 1982). Some of the hybrids from crosses involving 'Local' × 'Indonesia' (VTL 47), 'Local' × 'Andamans' (VTL 45), 'Local' × 'Indonesia' (VTL-48) and 'Nicobar' (VTL 46) × 'Local' showed earliness in bearing, larger inflorescences, higher number of female flowers and heavier crown. Some of these hybrids are being screened for their tolerance to yellow leaf disease and those having dwarf mutant as one of the parents showed some tolerance. *A. catechu* and *A. triandra* interspecific hybrids exhibited maximum hybrid vigour for number of female flowers, length of spadix and girth of stem at fixed mark. These hybrids also showed high sterility. Their sterility was attributed to incompatible interactions of cytoplasm of these two species and to ovecome this problem by repeated backcrossing with *A. catechu* was suggested.

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