

RESEARCH HIGHLIGHTS

MINI MISSION - I - Increasing Production.

The projects under this mini-mission aim at developing agrotechniques, orchard managements and pest management to increase the production from existing gardens.

Fertiliser requirement.

An experiment with graded doses of NPK on airlayers was initiated in 1978 to assess the response of fertiliser. There was linear response of yield to nitrogen application from 250 to 750 g/tree/year. Response of crop in terms of yield to Phosphorus and Potassium, however, was noticed only upto 150 g/tree/year. Results from an experiment to find out the response of grafts and seedlings of eight varieties to different levels of nitrogen, have indicated that grafts performed better than seedlings. Application of 750 g N/tree significantly increased the yield as compared to lower doses (250 and 500 g N/tree). Among the grafts, M 6/1, A 18/4 and BLA 139-1 yielded more than the other varieties tested. It was found that different levels of nitrogen did not show any significant difference on shelling percentage and nut weight.

Irrigation.

An observation trial on irrigation of cashew revealed that irrigation of 200 litres/tree once in 15 days from November to March (10 irrigations) increased the yield by two fold (7.37 kg/tree) as compared to control (3.54 kg/tree). Irrigating once in 15 days at the rate of 200 litres/tree from January to March was found to be better than irrigating the same quantity of water between November to January. However, 10 irrigations @ 200 litres/tree from November-March resulted in better yield than other treatments (5 irrigations).

Effect of irrigation on cashew.

Treatments	Nut yield (kg/tree)	
	1988	Average yield of 2 years (1987 & 1988.)
a. Fortnightly Irrigation @ 200 litres/tree		
i. November - January (5 irrigations)	4.53	4.83
ii. January - March (5 irrigations)	4.93	5.37
iii. November - March (10 irrigations)	7.37	6.25
b. Control (No irrigation)	3.54	3.22
CD	1.47	1.68

Cropping system.

Attempts have been made to evolve cashew based cropping system with an objective of increasing the returns during the prebearing period of cashew by utilizing interspaces in the orchard. Food and fruit crops, forest trees and cover crops were tried as intercrops. Based on the initial observation on the second year of planting the growth of both acacia and casuarina among tree crops and pineapple among fruit crops are quite promising as intercrops without affecting the main crop (cashew). Among the food crops, tapioca and pigeonpea have not been found suitable as intercrops. Papaya as an intercrop is not found suitable as it requires irrigation.

High density planting.

The experiment on high density planting of cashew was initiated in 1983. Observations revealed that high density plots with 1111 and 2500 trees/ha have already covered the ground area intercepting 82 to 86% light, by sixth year of planting. The plots with 2500, 1111 and 625 trees/ha gave three times more of yield (603, 635 and 601 kg/ha in the plots of 2500, 1111 and 625 trees/ha respectively) than the plots having recommended density of 156 trees/ha (182 kg/ha).

Pruning.

Pruning of leader and lateral shoots has been shown to enhance the yield. It was observed that leader shoot pruning in the months of July and August significantly increased the yield (13 kg/tree) as compared to control (5.2 kg/tree). A large scale trial to demonstrate the beneficial effects of pruning is in progress.

MINI MISSION - II - Increasing Productivity.

The projects under this minimission are aimed at evolving varieties with high yield coupled with better quality and multiple pest resistance. Attempts have been made to achieve this through germplasm collection, varietal improvement through

selection and hybridization, evaluating varieties for nutritional quality, developing an yield index to forecast the yield and identifying / screening varieties for tea mosquito tolerance.

Germplasm collection.

A total of 27 collections from coastal region of Karnataka and 18 clonal collections from coordinating centres have been added to the germplasm collection during the year. Sixty seven clonal accessions have been planted in clonal gene bank. With this addition the total number of accessions in the clonal gene bank has gone up to 153. Based on the earlier performance, accessions with big apple and medium nut (10 Nos.) bushy and compact canopy (11 Nos.), cluster bearing habit (12 Nos.) and early bearing (12 Nos.) have been identified for clonal multiplication. Three dwarf, three CNSL free and two boldnut types identified from Goa and Malabar collections have been clonally multiplied and planted in germplasm conservation block. Scion banks for the three NRC cashew selections namely Selection-1 (VTH 30/4 I), Selection-2 (VTH 40/1 I) and Selection-3 (VTH 107/3 I), proposed for release has been established by planting soft wood grafts (100 grafts for each selection.).

Varietal evaluation.

In the clonal evaluation of 12 recommended varieties, earliness has been observed in 9/8 EPM, M 44/3, M 10/4 and H 2/11. In maximisation plot, both the varieties M 10/4 and M 44/3 exhibited early flowering and similar growth during the second year of planting. A new clonal trial with 14 germplasm selections made on the basis of superior performance in yield and medium nutsize was laid out at Shanthigodu.

Hybridization.

In the hybrid evaluation trial, hybrids such as Bla-139-1 x M 10/4, Bla 139-1 x A 18/4, and 1/3 Ceylon x A 18/4, have been found to be high-yielding. Both A 18/4 and Tree No. 1 have been found to transmit boldnut characters to their progenies. Similarly, earliness in flowering has been observed in progenies which had M 10/4, Bla 139-1 and M 37/3 as one of their parents. Among the newly planted hybrids, 29.5% of the plants flowered after second year of planting. A total of ten selfed progenies were identified for various characters and selfing was carried out to generate second generation of selfed progeny.

Yield index.

Attempts have been made to develop an yield index for cashew to enable forecasting the yield potential of given line/variety. Five characters such as yield, canopy, number of fruits/unit area, height, weight/100 nut has been employed for

this studies. Correlation and path analysis have revealed that canopy area and number of fruits/unit area had significant positive correlations and direct effects on yield. Height of the tree and number of fruits/ unit area had significant positive indirect effect on yield through canopy area.

Quality evaluation.

Variation has been noticed among the varieties (VTH 141, 142, 50, 168, 177, 30 and 59, Ullal-1, Ullal-2 and CNSL free) with respect to in vitro digestibility of kernel proteins by proteolytic enzymes. In vitro digestibility of kernel protein from VTH 30, 50, 59, 141 and Ullal-2 with trypsin was comparable with the standards fixed earlier (> 0.05 A 280 units/15 min). Two NRCC Selections viz. VTH 107/3-1 and VTH 40/1-1, had a low sugar content (< 10.4 mg%). A total of sixteen hybrids and selfs were analysed for their sugars, proteins and lysine contents. Some of the hybrids and selfs had low sugar (8.5-10.65%), and high protein (32.4-41.7%) contents as compared to standards fixed earlier (sugars < 14 g and protein > 35 g). Brazillian collection (VTH 711/1) had a high lysine content of 104.3 μ g/mg protein.

Varietal resistance to tea mosquito bug.

Five tolerant types have been located from hot spot area. Negligible incidence of tea mosquito population was noticed in five tolerant accessions such as Kuntur - 24, VTH 54, 151, 152 and 153. A total of twenty/seven hybrids and ten selfs have been screened for tea mosquito tolerance. Progenies of A 18/4 x Bla 139-1, M 44/3 x 9/8 EPM, 1/6 Mys. kotekar x 13/5 Kodur, T No. 1 x M 10/4 recorded a low score (1 in the scale 0 to 4). Selfs of M 44/3 recorded highest score of 2 to 3.7 (0 to 4 scale).

Biochemical changes due to infestation of tea mosquito bug.

Studies on biochemical changes during infestation of tea mosquito have revealed the reduction of sugars, amino acids, chlorophyll and carotenoids with increased feeding duration. The contents of phenols, ortho-dihydroxy phenols, and proline increased initially followed by a decrease during period of infestation.

SUPPORTIVE PROGRAMMES.

Research programmes under this mainly offers the support to two mini missions and transfer of technology.

Vegetative propagation.

The percentage of success with softwood grafting has been low during January-June (10 to 55%) and was quite high during July-November (66 to 82%). The maximum percentage of success has been recorded in the month of September (82.3%) and the percentage of success in softwood grafting was more than 60% when VTH 174 was used as root stock.

Top working.

Top working of sixty old trees (14-15 years) with M 10/4 was attempted during June, July and August. Although, the initial success was quite good, drying of stumps was noticed at a later stage, which resulted in only 23% survival.

Training.

A total of forty officials and farmers belonging to different State Organisations underwent training on Cashew Production Technology and vegetative propagation of cashew. A one day training programme was organised for cashew demonstration farmers. A Vietnamese trainee underwent training for six months on various aspects of cashew production and cultivation. A seven day training programme on cashew production and processing was organised for five member Vietnamese delegation.

During 1988 planting season, a total of 18,489 grafts have been distributed from the centre of which 12,194 grafts distribution among farmers and 6295 grafts for Government agencies.

Production of parental materials.

Among the 25,000 grafts of different released varieties and germplasm material, 24,000 grafts would be available for distribution among development agencies and farmers during 1989 planting season. A scion bank of nineteen released varieties and three pre-released varieties has been established at Shanthigodu by planting softwood grafts.

Demonstration plot.

Twenty cashew demonstration plots (0.4 to 0.8 ha each) have been established in Puttur (14 Nos.), Buntwal (4 Nos.) and Belthangady (2 Nos.) taluks of Dakshina Kannada by planting softwood grafts of released varieties/elite material supplied by NRC-Cashew. The expenditure for establishing and maintenance of one hectare cashew plot during the first year ranged from a minimum of Rs. 1381 to a maximum of Rs. 8187 depending on the nature of the plot. This programme has been taken up in collaboration with Directorate of Cashewnut Development, Cochin.

Data management.

Data base for (i) Monitoring monthly expenditure, (ii) pay and allowance (iii) grafts allotment and (iv) AICCIP activities, have been made.

**REPORTS ON
ONGOING PROJECTS**

MINIMISSION - I

INCREASING PRODUCTION

There was a linear response of yield to nitrogen application from 250g to 750 g/tree/year. The grafts performed better than seedlings. Among the grafts, M 6/1, A 18/4 and BLA-139-1 yielded more than the other varieties tested. Supplementary Irrigation during November to March (10 irrigations) @ 200 litres/tree once in 15 days doubled the yield of treated plots. Acacia and casuarina among tree crops and pineapple among fruit crops are quite promising as inter-crops without affecting cashew in the second year of planting. High density plots with 2500, 1111 and 625 trees/ha gave 300% more yield than the plots having recommended density of 156 trees/ha. Leader shoot pruning in the month of July and August significantly increased the yield (13 kg/tree) as compared to control (5.2 kg/tree).

Agr. I (a) (176) : Nutritional studies in cashew

**a) Effect of graded doses of NPK fertilizers on the productivity of layers and seedlings
(RC Mandal and N. Yadukumar)**

This experiment was initiated during 1978 with a view to investigate the nutritional requirement of cashew plants raised by seedling and airlayers. Two separate trials both for seedling and air-layers are in progress with nitrogen phosphorus and potassium applied in three doses each using 3³ factorial confounded design. The seedling progeny showed large variation in yield from plant to plant for all these years and as such the trial with seedling progeny has been discontinued.

The observations recorded on yield in the layer plot have shown a linear trend with increased doses of nitrogen from 250g to 750g per tree per year, but application of phosphorus and potassium showed a linear trend upto 150g/ tree/year (Fig. 1.1).

(b) Agr. I (b) : Response of high yielding varieties of cashew to different levels of nitrogen.

This experiment aims at evaluating the eight promising selections identified from the germplasm collection of cashew available at Vittal, for various characters. The experiment was planted at Vittal during 1983 with the varieties viz. WBDC-V, M 6/1, M 10/4, M 44/3, Tree No. 1, A 18/4, 13/5 Kodur and Bla-139-1 as subplot treatments. The two other factors are (1) the levels of nitrogen viz. 250, 500 and 750g per plant/year, keeping P and K constant (125g/tree/year) and (2) two types of planting materials viz. seedlings and grafts. The trial was laid out in a split plot design with two replications.

Observations recorded on yield among the grafts showed maximum in M 6/1 followed by A 18/4 and Bla 139-1 and among seedling population M 6/1, 13/5 Kodur and A 18/4 gave more yield (Table 1.1). It was observed that grafts performed better than the seedling showing more than 165g nut wt./tree/year. Application of different levels of nitrogen did not show any significant difference on individual nut weight and shelling percentage (Tables 1.2 and 1.3). In the case of seedlings nut weight was maximum in Bla-139-1 (7.21g) and minimum in WBDC-V (4.83g), whereas in grafts, it was 6.89g in A 18/4 and 5.3g in M 10/4 (Table 1.2).

Effect of graded doses of NPK on productivity of layers

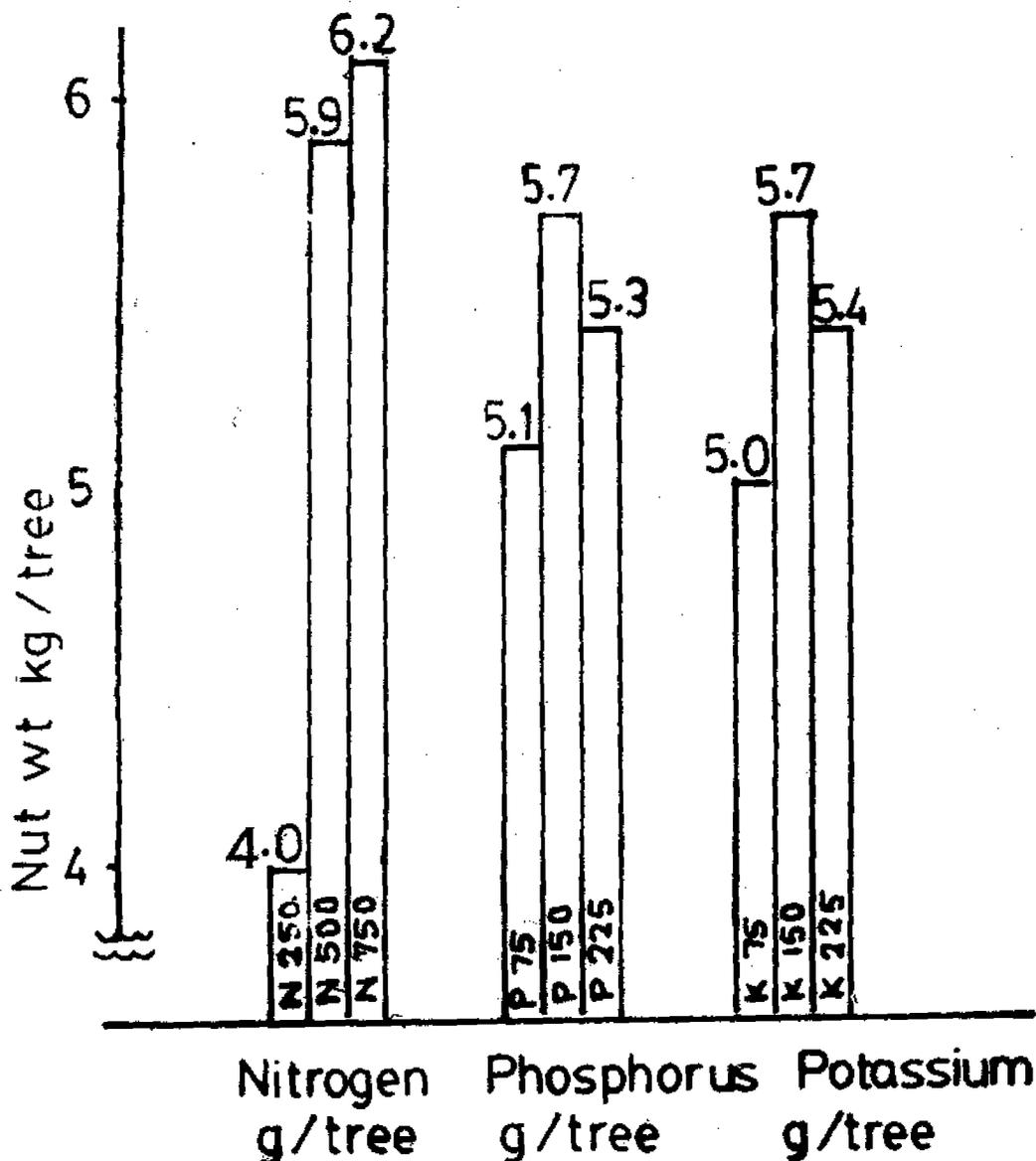


Fig. 1.1

Table 1.1. Response of high yielding varieties of cashew to different doses of Nitrogen. (Nut yield) (Wt. in gram/tree)

Variety	N. levels			Mean	Seedling	Graft
	N-250	N-500	N-750			
WBDC-V	851	589	1069	836.3	801	872
M 6/1	947	825	1238	1003.3	853	1153
M 10/4	690	558	1202	816.6	744	889
M 44/3	551	858	786	731.6	609	855
A 18/4	616	875	1235	908.6	816	1000
Tr. No. 1	250	343	275	289.6	290	288
Kodur 13/5	703	472	1167	780.6	816	745
BLA-139-1	699	913	668	760.0	535	985
Mean	663.4	679.13	955.13		683	848.3

CD for N = 114.05

Table 1.2. Response of high yielding varieties of cashew to different levels of Nitrogen. (Individual nut weight in gram)

Variety	N levels			Mean	Seedling	Graft
	N-250	N-500	N-750			
WBDC-V	5.20	5.66	4.98	5.28	4.83	5.76
M 6/1	5.21	6.65	5.26	5.70	5.47	5.94
M 10/4	6.53	5.75	5.94	6.08	6.88	5.30
M 44/3	5.41	5.62	5.24	5.42	5.37	5.69
A 18/4	6.90	6.45	6.53	6.62	6.43	6.82
T. No. 1	6.06	5.42	6.29	5.92	5.33	6.51
Kodur 13/5	7.52	6.18	6.69	6.79	7.01	6.58
BLA-139-1	6.64	6.97	6.20	6.60	7.21	5.99
Mean	6.18	6.08	5.89		6.06	6.07

Table 1.3. Response of high yielding varieties of cashew to different levels of Nitrogen. (Shelling percentage)

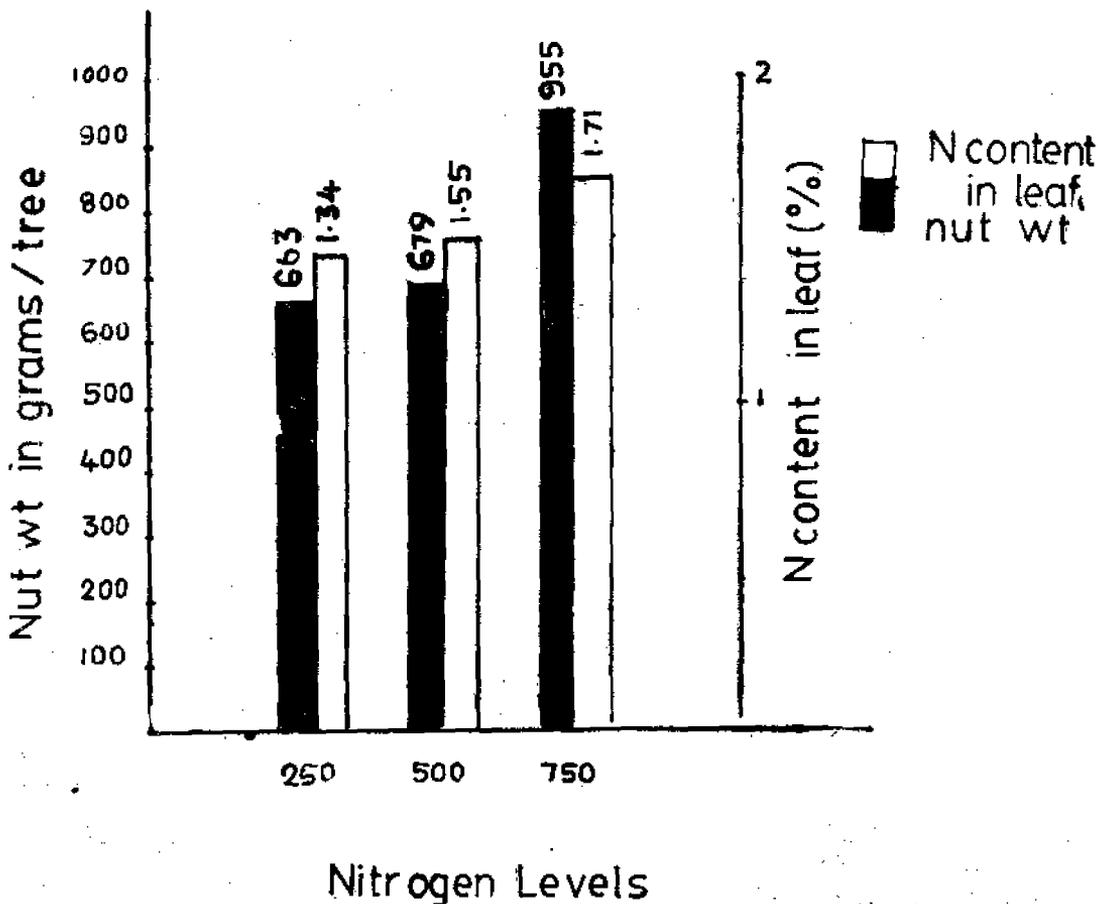
Variety	N levels			Mean	Seedlings	Graft
	N-250	N-500	N-750			
WBDC-V	26.18	28.39	27.24	27.27	27.78	26.76
M 6/1	28.23	27.63	25.87	27.24	27.74	26.75
M 10/4	27.82	27.72	26.74	27.40	27.64	27.22
M 44/3	27.77	28.23	28.87	29.29	27.87	28.81
A 18/4	26.93	28.26	27.30	27.49	26.57	28.27
Tr. No. 1	27.53	30.60	28.83	28.98	30.00	28.36
Kodur 13/5	28.01	27.92	27.31	27.74	28.79	29.76
BLA-139-1	26.87	27.89	28.93	27.89	26.00	28.55
Mean	27.4	28.8	27.3		27.94	27.54

The soil samples taken at the top 0.25 cm depth during February were analysed for organic carbon, P_2O_5 and K_2O content and it was found that the organic carbon was 1.26% and P_2O_5 and K_2O content 18.25 and 132 ppm respectively.

The analysis of leaf tissues revealed that the nitrogen content increased from 1.32% in case of plants applied with 250g nitrogen/tree to 1.71% in case of plants applied with 750g nitrogen per tree. Similar trend was not observed in case of P and K content in the leaf tissues (Fig. 1.2).

Fig. 1.2

Response of high yielding varieties of cashew to different levels of Nitrogen (Nut yield and leaf N content)



Agr. III. Effect of irrigation on Cashew.
(N. Yadukumar, RC Mandal).

This project envisages to study the response of cashew to supplementary irrigation during two flowering phases, to work out the critical stages of irrigation. Considering these aspects, an observational trial was laid out in 1986 at NRCC Experimental Station, Shanthigodu with the following treatments imposed on 13 year old cashew trees.

(a) Fortnightly irrigation @ 200 litres water/tree during

- (1) November - January (First flowering phase)
- (2) January - March (Second flowering phase)
- (3) November - March (covering both phases)

(b) Control (No irrigation)

The observations recorded during February to April has revealed that the irrigation has direct effect on fruit retention. There was an increase in fruit retention in all the treatments as compared to control (Table 1.4). Maximum fruit retention was noticed (44%) in the third treatment where irrigation was given from November - March.

Table 1.4. Effect of irrigation on fruit retention

Treatment	Fruit set	No. of nuts harvested	% fruit retention
Irrigation once in 15 days			
Nov - Jan	27	9	33.0
Jan - Mar	16	6	37.5
Nov - Mar	25	11	44.0
Control	13	4	30.7

The soil moisture studies were conducted to find out soil moisture percent at two depths viz. 0-50 cm and 50-100 cm in each treatment monthwise, one day prior to next irrigation from November - March. The details of the observations recorded are given in Table 1.5 and Fig. 1.3. The soil moisture was determined by gravimetric method (oven dry basis). The data revealed that the soil moisture at field capacity (2 days after irrigation) was 24% and one day prior to next irrigation was 19.15%. In irrigated plot, the moisture content one day prior to next irrigation, was 21.66% in November and it decreased in the progressive month and finally in March it was 17.60% (Table 1.5). In the control plot, it varied from 15.06% (in November) to 9.02% (in March). The comparative higher moisture content during November can be attributed to the precipitation received (173 mm) during the period.

Table 1.5. Moisture content of soil (%) month-wise at two depths

Months	Control		Mean	One day prior to next irrigation		
	0-50 cm	50-100 cm		Depth		Mean
				0 - 50 cm	50 - 100 cm	
Nov	14.00	16.12	15.06	22.51	20.81	21.66
Dec	10.35	9.65	10.00	20.25	20.10	20.17
Jan	9.20	9.40	9.30	18.77	19.29	19.03
Feb	8.61	9.43	9.02	17.82	16.80	17.31
Mar	9.21	8.82	9.02	18.00	17.20	17.60
Mean			10.48			19.15

The moisture content of the treatment plot November - January after discontinuation of irrigation from January to March reduced gradually and it was 12% in March which was 3% more than the control plot. There is no marked difference in moisture content at two different depths.

Irrigation @ 200 lit. of water/tree once in 15 days from November-March (10 irrigation) resulted in significant two fold increase in yield (7.3 kg/tree) as compared to control (3.54 kg/tree) indicating a definite response for irrigation (Fig 1.4). It is also confirmed that irrigation from November - March is significantly superior to other treatments of irrigations i.e. November - January and January - March (5 irrigations each).

Agr. IV : Cashew based Cropping systems - Inter and mixed cropping. RC Mandal, N Yadukumar and E Mohan).

This project was initiated at NRC - Cashew, Puttur with a view to find out suitable intercrops that can be grown in the cashew plantations in the initial years of orchard establishment which will enhance the economic returns. The project also aims at the identification of the appropriate food crops, fruit crops, forest-tree crops and cover crop through cashew based farming system under rainfed conditions. The details of the crop combinations are as follows.

1. Annual food crops Cashew + Tapioca
 Cashew + Pigeonpea (Redgram)
2. Fruit crops Cashew + Pineapple
 Cashew + Papaya
 Cashew + Guava
3. Forest tree species Cashew + Casuarina
 Cashew + Subabul
 Cashew + Acacia
4. Cover crops Cashew + Mucuna
5. Cashew only (control)

Fig. 1.3.

Monthly Moisture Status Of Soil as Affected by Treatments

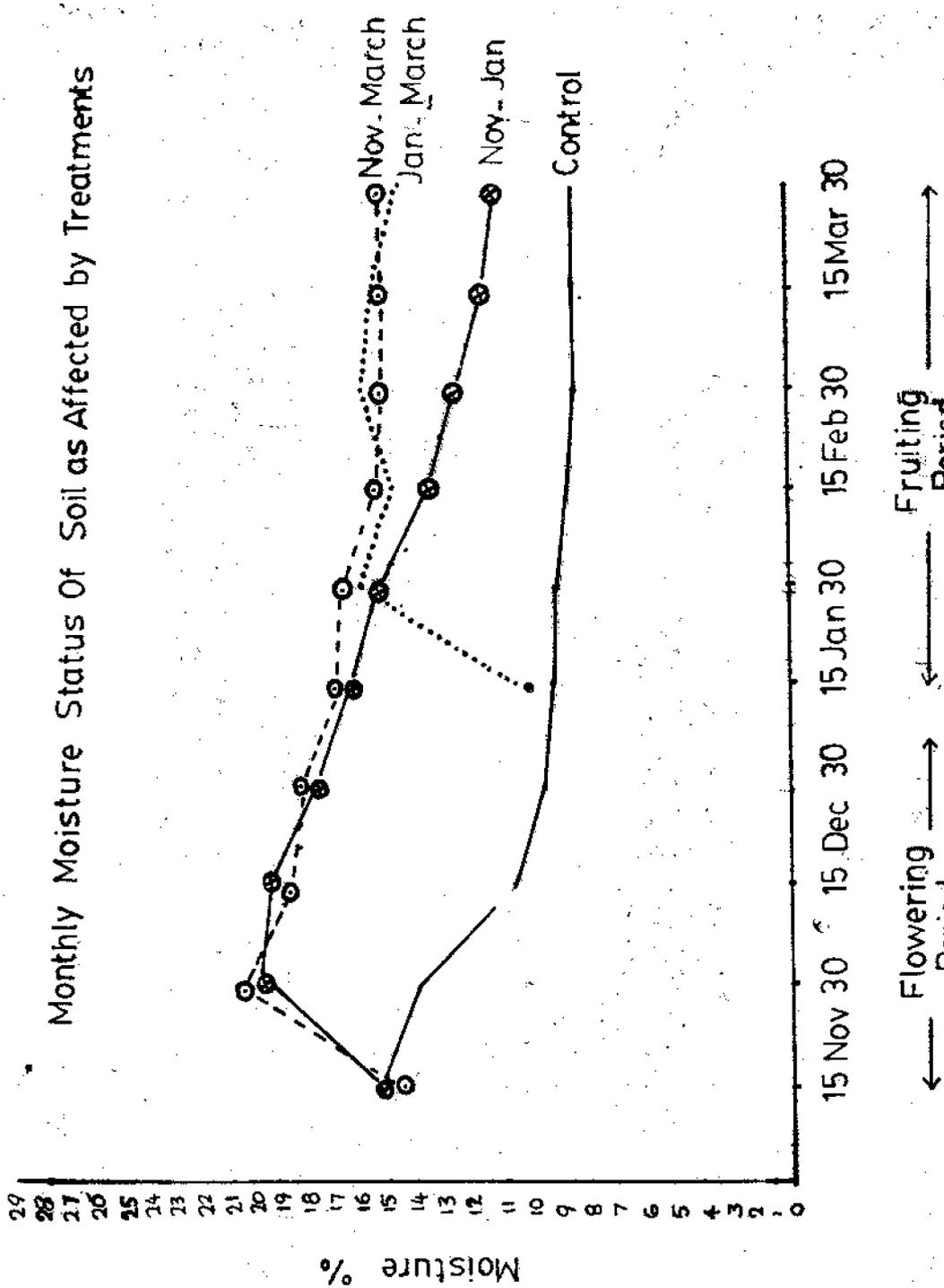
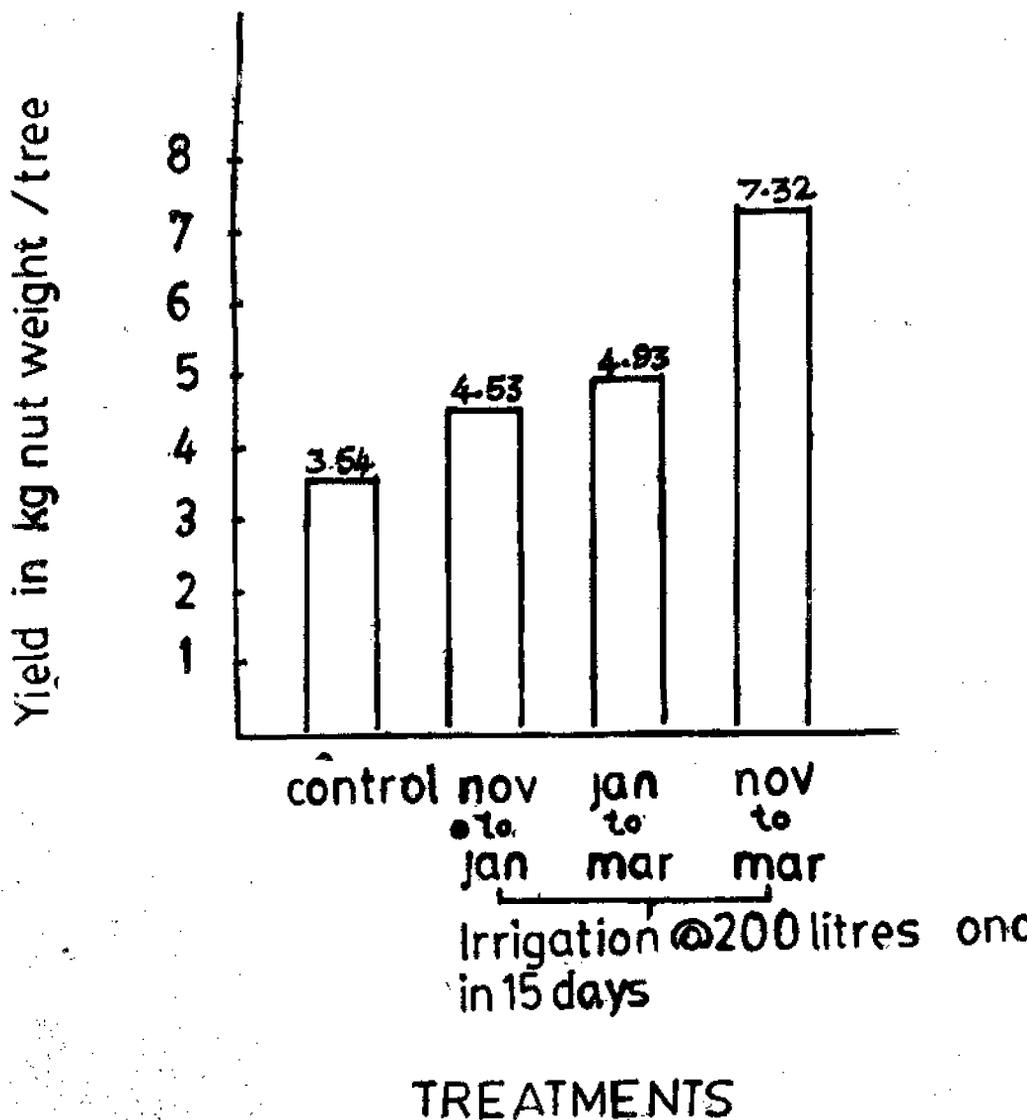


Fig. 1.4.

Effect of irrigation on cashew



The preliminary observations on the main and inter/mixed crops were recorded after one year of their orchard life except for red gram and tapioca which was done at the time of harvest. Observations such as growth characters (Table 1.6) light interception (Table 1.7), ground coverage by different crops (Table 1.8) and cost of cultivation and returns of intercrops (Table 1.9) were made.

Cashew

Maximum height, girth and spread of the main crop (Cashew) were recorded in the plots inter/mixed cropped with redgram, pineapple, *Mucuna* sp., casuarina and acacia as compared to the cashew planted with Tapioca as intercrop. This indicates the competition by tapioca in the initial growth stage of cashew plant (Table 1.6). The canopy coverage of cashew varied from 1.3 to 3.2% of the given area and the light interception from 1 to 2.4% within one year of its growth period (Table 1.7).

Food Crops :

a. **Tapioca: (*Manihot esculenta*)** The tapioca harvesting was done at the 10th month of planting. The average height of the stem of tapioca was 2.28m which was double the height of cashew plant (1.0m) in the same plot. The root length of tapioca was found to be 30.4 cm. Tapioca plants utilized maximum light, intercepting 65% of light (Table 1.7) the root and shoot ratio was found to be 1.25 : 1.97 showing a high harvest index. The fresh tubers harvested from the plot has worked out to 5 tonnes/ha and the cost of production to Rs. 2244/ha. The amount realised from the sale of fresh tubers @ Rs. 1/kg. was Rs.5000/ha. (Table 1.9).

b. **Redgram: (*Cajanus cajan*)** The variety Vaishaki was harvested during December after 6 months of planting. The total biomass production was 46 quintals/ha out of which, the grain yield turned out to be only 1.5 g/ha because of the frequent attack by pod borer. The cost of cultivation was calculated to Rs. 2202/ha in the first year of cultivation in a virgin land and the amount realised from red gram seeds was Rs. 2400/ha (@ Rs. 16.00/kg) giving a net profit of Rs. 378/ha (Table 1.9).

Fruit crops

a) **Pineapple (*Ananas comosus*):** Pineapple is a biennial fruit crop which is commonly grown in the laterite tracts of this region. The crop has established well and the growth observations recorded so far showed an encouraging trend. The average height of the plant recorded was 86 cm bearing 53 - 56 leaves and the interception of light by this crop was 61.5% (Table 1.7). The cost of cultivation was worked out to Rs. 10,250/ha (Table 1.9) in the first year which include Rs. 3000/- being the cost of pineapple suckers also.

b) *Papaya (Carica papaya)* : Papaya was planted in the interspace after the establishment of the main crop. Observations recorded after five months of planting revealed that the canopy of the papaya has covered 13.9% of the given area. The interception of light by the crop at the flowering stage was 11%.

c) *Guava (Psidium guajava)*: Guava was also planted in the field after the establishment of cashew. The observations recorded after five months of planting showed the canopy of the crop covering 5.2% (Table 1.8) of the area and the light intercepting upto 4.9% (Table 1.7). The cost of cultivation worked out to Rs. 2800/ha (Table 1.9).

Cover crops :

Mucuna bracteata was planted in the interspace using unrooted cuttings. The cover crop has established well but it covered only 30% of the given area (Table 1.8).

Tree spices

a) *Casuarina (Casuarina equisetifolia)*. It showed a steady growth and attained just double the height of cashew in the same plot (casuarina - 240 cm. and cashew - 118 cm). The canopy coverage of casuarina was more (16.75%) than that of cashew (2.7%) in the given area (Table 1.8). The casuarina plants intercepted light upto 14.3% (Table 1.7). The crop was allowed to grow straight by cutting side branches upto 50 cm height and the biomass of the same was worked out to 1.5 tonnes dry weight/ha and has been recycled by incorporating in the soil around the base of the plant. The cost of cultivation/ha in the initial years was Rs. 3000/ha (Table 1.9).

b. *Leucaena (Subabul) (Leucaena leucocephala)* : Subabul plant in the interspace of cashew was also shown better growth than the main crop (Subabul 141 cm and cashew 107 cm) as in the case of casuarina (Table 1.6). But the ground coverage by the canopy of the subabul was only 5.75% (Table 1.8) which is minimum among the tree species planted along with cashew. The coverage by cashew in this plot was only 2.1%, and the canopy coverage of both the crops was 7.8% (Table 1.8). As a result of poor canopy, the light interception was only 2.9% during first year of growth (Table 1.7). In the initial years, the subabul plants were protected against the attack of rabbit with thorny bamboo fence and hence the cost of cultivation has increased to Rs. 3500/ha (Table 1.9).

c. *Acacia* (*Acacia auriculiformis*) : *Acacia* growth was better than that of cashew planted in the same plot (*Acacia* 200 cm and cashew 115.9 cm) (Table 1.6). The area covered by *acacia* was 38% of the given area which is more than double that of *casuarina* (Table 1.6). *Acacia* intercepted 23.4% of the fallen light in the plot (Table 1.7).

Table 1.6 Growth Characters of Cashew and Intercrops (1 year after planting)

Treatment	Height (cm)		Girth (cm)		Av. Canopy spread EW&NS	
	Main Crop	Inter Crop	Main Crop	Inter Crop	Main Crop	Inter Crop
Cashew + Tapioca	99	244	10.4	—	103.0	—
Cashew + Redgram	125	120	13.2	—	156.3	—
Cashew + Pineapple	125	80	13.0	—	160.7	—
Cashew + Papaya	110	112	11.0	9.18	117.3	124.4
Cashew + Guava	115	75	11.5	3.12	115.2	72.0
Cashew + Mucuna	112	—	12.2	—	131.0	—
Cashew + Casuarina	118	240	12.6	7.20	131.9	122.0
Cashew + Subabul	107	141	11.0	2.30	118.2	70.0
Cashew + Acacia	116	200	10.9	7.70	118.5	185.0
Cashew alone	109	—	12.5	—	132.0	—

Table 1.7 Light Interception

Treatment	Cashew		Intercrops	
	mmol/plot/sec	%	mmol/plot sec	%
Cashew + Tapioca	8.00	1.0	498.0	65.0
Cashew + Redgram	17.0	2.2	398.8	51.8
Cashew + Pineapple	18.4	2.4	471.8	61.5
Cashew + Papaya	9.4	1.2	84.9	11.0
Cashew + Guava	10.1	1.4	38.3	4.9
Cashew + Casuarina	14.8	1.9	109.9	14.3
Cashew + Acacia	9.7	1.3	179.6	23.4
Cashew + Subabul	11.7	1.5	22.2	2.9
Cashew + Mucuna	11.6	1.5	—	—
Cashew alone	12.1	1.6	—	—

Light intensity in the open = 767 mmol/plot/sec

Plot size = 384 sq.m.

Table 1.8. Ground Coverage by Cashew (main crop) and inter / mixed crops (%)

	Ground Coverage / plot (%)		
	Cashew	Intercrops	Total
Cashew + Tapioca	1.3	75.0	76.3
Cashew + Redgram	3.0	75.0	78.0
Cashew + Pineapple	3.2	63.0	66.2
Cashew + Papaya	1.7	13.9	15.6
Cashew + Guava	2.1	5.2	7.3
Cashew + Casuarina	2.7	16.7	19.5
Cashew + Acacia	1.7	38.0	39.7
Cashew + Subabul	2.1	5.7	7.8
Cashew + Mucuna	2.1	30.0	32.1
Cashew alone	2.1	—	2.1

Table 1.9 Cost of cultivation and returns

Treatment	Cost of cultivation of intercrops/ha Rs	Total income per ha.	Net profit from intercrops Rs/ha.
Cashew + Tapioca	2244	5000	3756
Cashew + Redgram	2022	2400	378
Cashew + Pineapple	10250	—	—
Cashew + Papaya	2800	—	—
Cashew + Guava	2000	—	—
Cashew + Casuarina	3000	—	—
Cashew + Subabul	3500	—	—
Cashew + Acacia	3000	—	—

Thus out of the tree species tested, acacia has grown very fast and covered 38% of the given area in the very first year itself. This indicates that the main crop is likely to suffer from lack of light from second year onwards. To overcome this, lopping of lower branches at least upto 2 m height of the acacia plants have to be taken up during the subsequent years.

Phy. III. High density planting of cashew

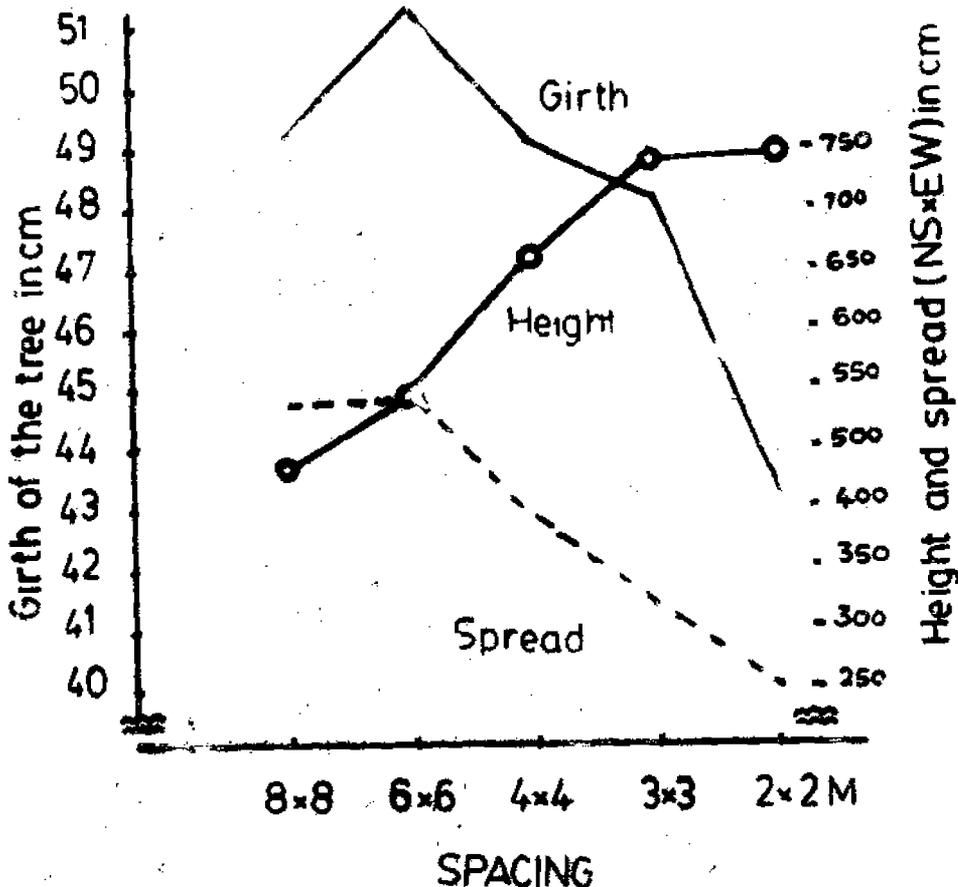
(N Yadukumar and E Mohan).

The experiment was laid out at NRCC Experimental station, Shanthigodu during 1982 in order to study the growth behaviour and production potential of cashew under high density planting system. This also aims at the evaluation and recommendation of the most suitable density of planting cashew trees that may increase the crop production per unit area. The experiment was planted with five treatments such as spacing of planting at a distance of 8x8m, 6x6m, 4x4m, 3x3m, and 2x2m in five replications. This will accommodate 156, 278, 625, 1111 and 2500 trees per ha with respect to the spacing mentioned above.

In the 6th year of planting, the observations recorded on growth characters like girth, height and spread revealed the significant differences. The details of the data analysed are given in Fig. 1.5. Owing to the closer spacing, the trees attained minimum girth (43.2cm) in 2x2m spacing as compared to widely spaced trees, 51.4cm in 6x6m and 49.2cm in 8x8m. Maximum height (7.49m) was observed in 2x2m spacing and minimum (4.79m) in 8x8m spacing. With regard to spread, minimum spread was observed (2.50m) in 2x2m spacing and maximum in 8x8m spacing and 6x6m spacing (5.4m).

Fig. 1.5

Growth characters as affected by different spacing (6th year of planting)



b) *Papaya (Carica papaya)* : Papaya was planted in the interspace after the establishment of the main crop. Observations recorded after five months of planting revealed that the canopy of the papaya has covered 13.9% of the given area. The interception of light by the crop at the flowering stage was 11%.

c) *Guava (Psidium guajava)*: Guava was also planted in the field after the establishment of cashew. The observations recorded after five months of planting showed the canopy of the crop covering 5.2% (Table 1.8) of the area and the light intercepting upto 4.9% (Table 1.7). The cost of cultivation worked out to Rs. 2800/ha (Table 1.9).

Cover crops :

Mucuna bracteata was planted in the interspace using unrooted cuttings. The cover crop has established well but it covered only 30% of the given area (Table 1.8).

Tree spices

a) Casuarina : (*Casuarina equisetifolia*). It showed a steady growth and attained just double the height of cashew in the same plot (casuarina - 240 cm. and cashew - 118 cm). The canopy coverage of casuarina was more (16.75%) than that of cashew (2.7%) in the given area (Table 1.8). The casuarina plants intercepted light upto 14.3% (Table 1.7). The crop was allowed to grow straight by cutting side branches upto 50 cm height and the biomass of the same was worked out to 1.5 tonnes dry weight/ha and has been recycled by incorporating in the soil around the base of the plant. The cost of cultivation/ha in the initial years was Rs. 3000/ha (Table 1.9).

b. *Leucaena (Subabul) (Leucaena leucocephala)* : Subabul plant in the interspace of cashew was also shown better growth than the main crop (Subabul 141 cm and cashew 107 cm) as in the case of casuarina (Table 1.6). But the ground coverage by the canopy of the subabul was only 5.75% (Table 1.8) which is minimum among the tree species planted along with cashew. The coverage by cashew in this plot was only 2.1%, and the canopy coverage of both the crops was 7.8% (Table 1.8). As a result of poor canopy, the light interception was only 2.9% during first year of growth (Table 1.7). In the initial years, the subabul plants were protected against the attack of rabbit with thorny bamboo fence and hence the cost of cultivation has increased to Rs. 3500/ha (Table 1.9).

c. *Acacia* (*Acacia auriculiformis*) : *Acacia* growth was better than that of cashew planted in the same plot (*Acacia* 200 cm and cashew 115.9 cm) (Table 1.6). The area covered by *acacia* was 38% of the given area which is more than double that of *casuarina* (Table 1.8). *Acacia* intercepted 23.4% of the fallen light in the plot (Table 1.7).

Table 1.6 Growth Characters of Cashew and Intercrops (1 year after planting)

Treatment	Height (cm)		Girth (cm)		Av. Canopy spread EW&NS	
	Main Crop	Inter Crop	Main Crop	Inter Crop	Main Crop	Inter Crop
Cashew + Tapioca	99	244	10.4	—	103.0	—
Cashew + Redgram	125	120	13.2	—	156.3	—
Cashew + Pineapple	125	80	13.0	—	160.7	—
Cashew + Papaya	110	112	11.0	9.18	117.3	124.4
Cashew + Guava	115	75	11.5	3.12	115.2	72.0
Cashew + Mucuna	112	—	12.2	—	131.0	—
Cashew + Casuarina	118	240	12.6	7.20	131.9	122.0
Cashew + Subabul	107	141	11.0	2.30	118.2	70.0
Cashew + Acacia	116	200	10.9	7.70	118.5	185.0
Cashew alone	109	—	12.5	—	132.0	—

Table 1.7 Light Interception

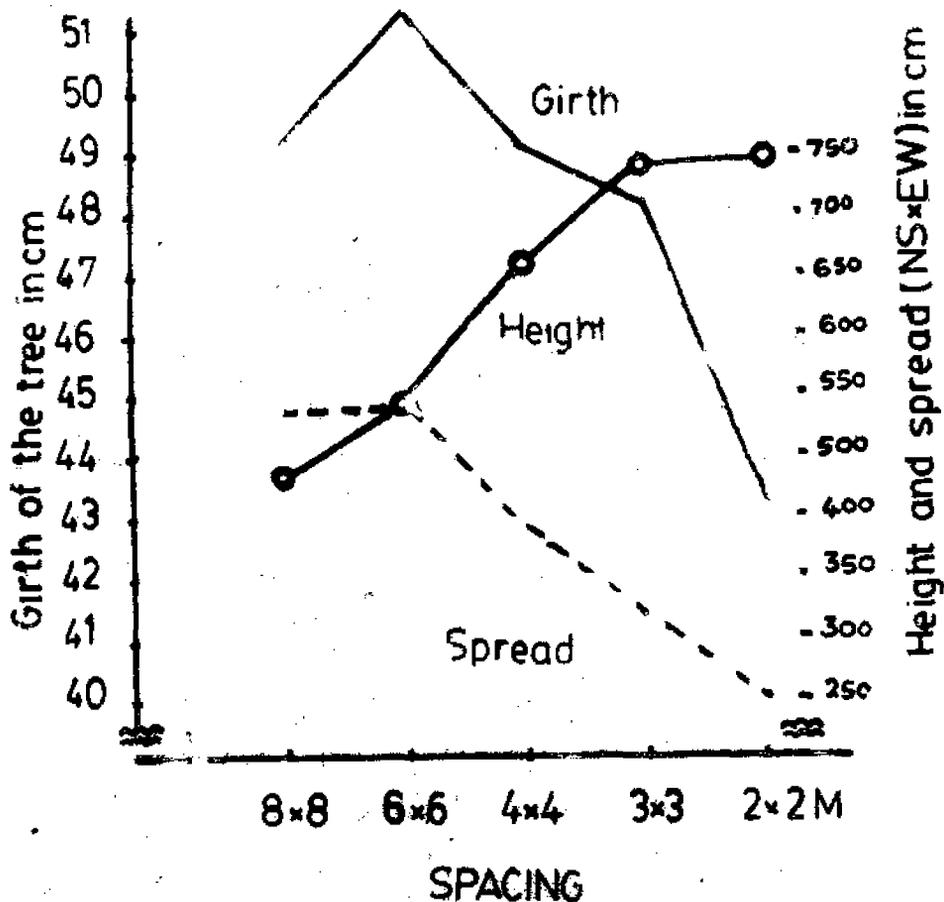
Treatment	Cashew mmol/plot/sec	%	Intercrops mmol/plot sec	%
Cashew + Tapioca	8.00	1.0	498.0	65.0
Cashew + Redgram	17.0	2.2	398.8	51.8
Cashew + Pineapple	18.4	2.4	471.8	61.5
Cashew + Papaya	9.4	1.2	84.9	11.0
Cashew + Guava	10.1	1.4	38.3	4.9
Cashew + Casuarina	14.8	1.9	109.9	14.3
Cashew + Acacia	9.7	1.3	179.6	23.4
Cashew + Subabul	11.7	1.5	22.2	2.9
Cashew + Mucuna	11.6	1.5	—	—
Cashew alone	12.1	1.6	—	—

Light intensity in the open = 787 mmol/plot sec
Plot size = 384 sq.m.

In the 6th year of planting, the observations recorded on growth characters like girth, height and spread revealed the significant differences. The details of the data analysed are given in Fig. 1.5. Owing to the closer spacing, the trees attained minimum girth (43.2cm) in 2x2m spacing as compared to widely spaced trees, 51.4cm in 6x6m and 49.2cm in 8x8m. Maximum height (7.49m) was observed in 2x2m spacing and minimum (4.79m) in 8x8m spacing. With regard to spread, minimum spread was observed (2.50m) in 2x2m spacing and maximum in 8x8m spacing and 6x6m spacing (5.4m).

Fig. 1.5

Growth characters as affected by different spacing (6th year of planting)



When the values were computed to see the ground coverage in the given area, it was found that the canopy coverage was more than 100% in case of 2x2m spaced plot which indicates the need for thinning out the population. In the case of normal spacing (8x8m) the canopy coverage was only 35.7% (Fig. 1.6). With respect to light interception, maximum (86%) was observed in 2x2m spacing plot and minimum (52%) in the normal spacing (Fig. 1.7).

Fig. 1.6 Ground coverage by the crop canopy
6th year of planting

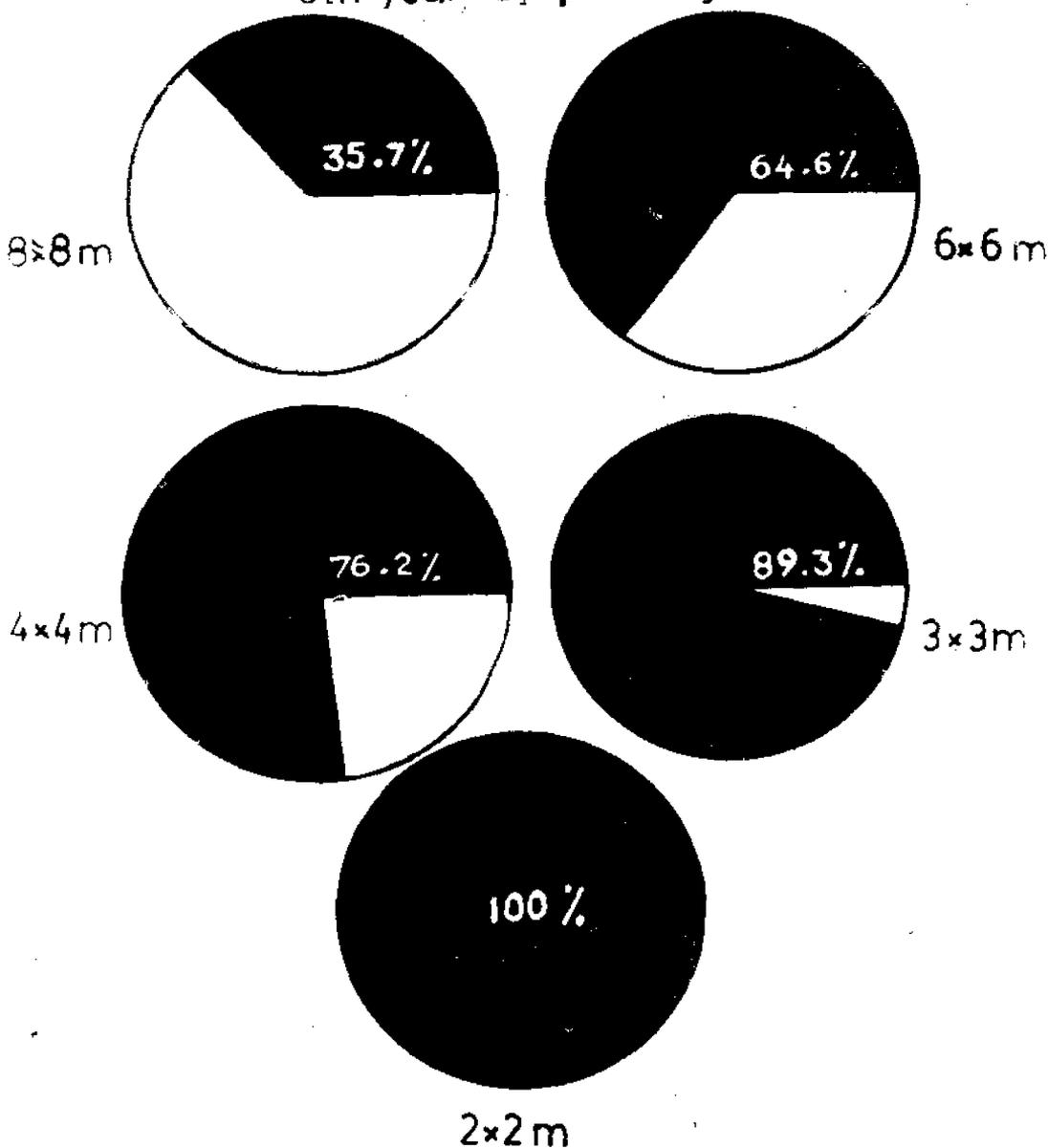
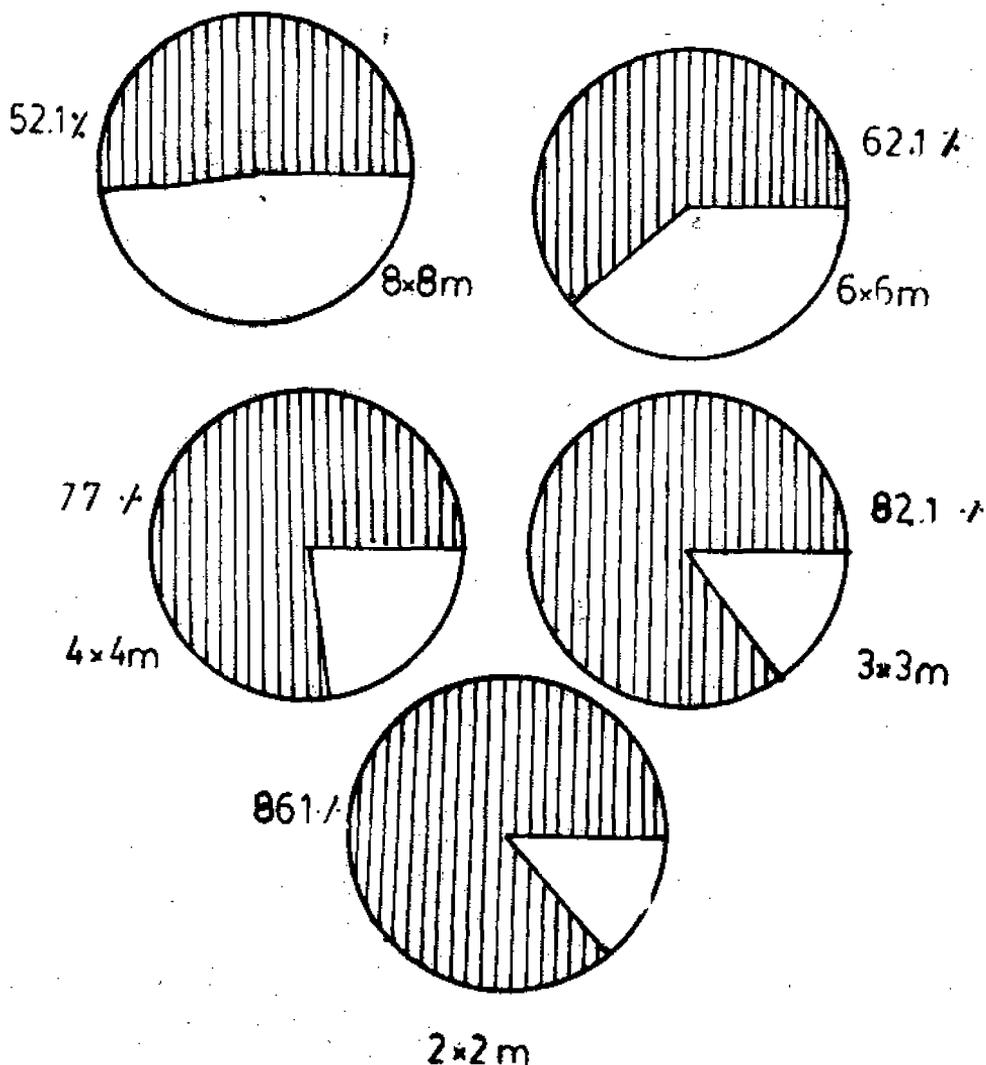


Fig. 1.7

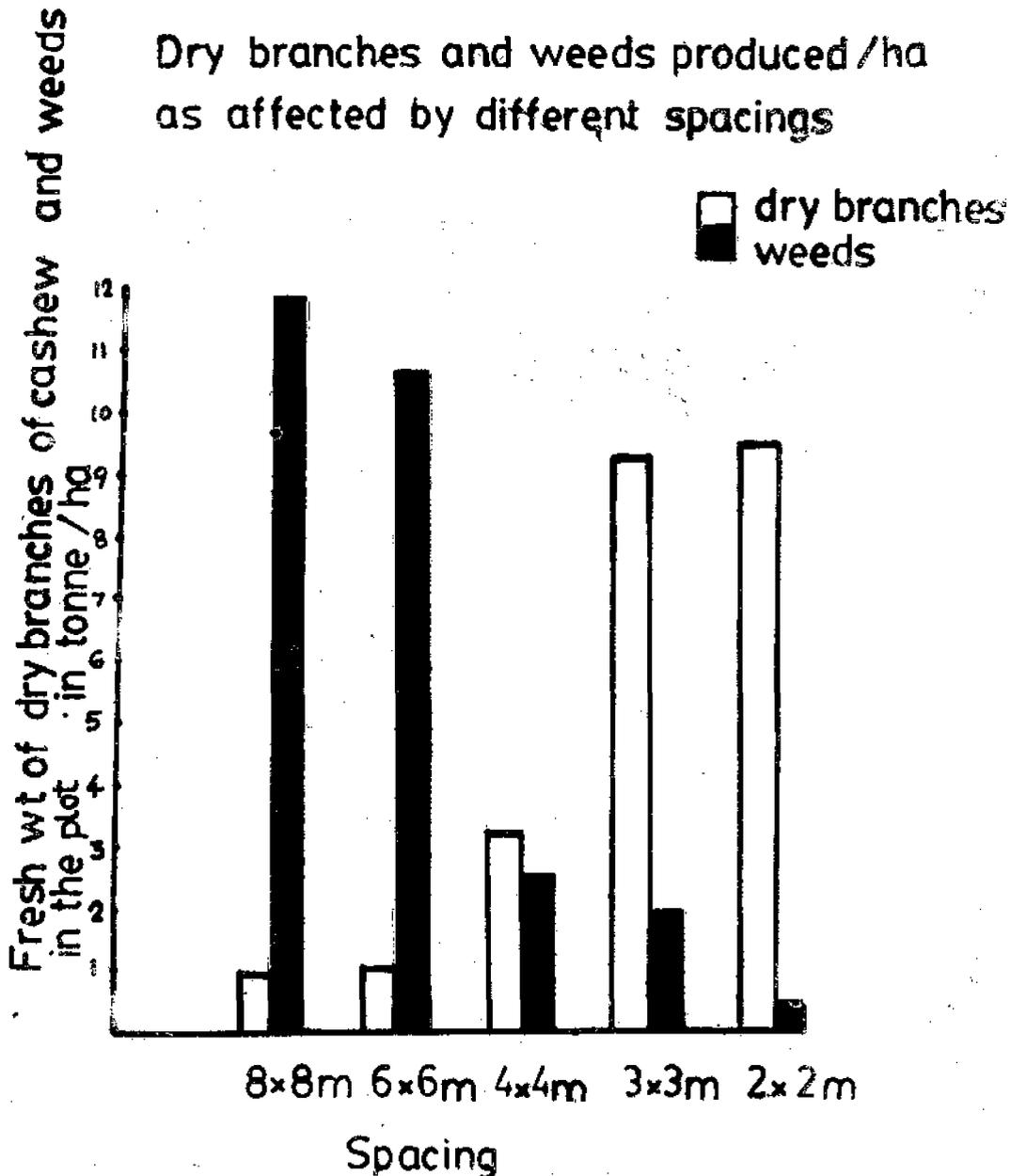
Light interception by the crop (6th year of planting)



The dry branches produced in different spacing treatments ranged from 9.50 tonnes/ha in 2x2m spacing plot to 0.90 tonnes/ha in normal spacing plot. The occurrence of weeds in the interspace in 8x8m spacing was more (22.80 tonnes/ha) than 2x2m spacing (0.43 tonnes/ha) (Fig. 1.8).

Fig. 1.8

Dry branches and weeds produced/ha as affected by different spacings



The data on yield revealed that maintaining high population density of 2500, 1111 and 625 trees/ha yielded significantly more nut weight than the rest of the treatments (Table 1.10).

Table 1.10. Yield as affected by density

Density/ha	Yield Nut Wt:kg/ha 1988	Previous yield Nut Wt: kg/ha 1987
156	186.6	181.5
278	208.8	226.5
625	601.2	592.5
1111	635.2	757.8
2500	603.4	780.0
C D	325.9	318.3

Ent. III (176). Pest management in Cashew. (D Sundararaju)

This project was initiated at CPCRI, Vittal during 1972-'73 in order to evolve suitable chemical control schedules for combating the major pests of cashew effectively and economically with special reference to serious pests like tea mosquito (*Helopeltis antonii*) and cashew stem and root borer (*Plocaederus ferrugineus*).

a. Biological control of cashew stem and root borer

During the period under report, as biological control three trials with grubs and two trials with adults were undertaken for testing the baculovirus of rhinoceros beetle on cashew stem borer grubs and adults. The details of the treatments and the results obtained are presented in the tables 1.11 and 1.12.

Maximum mortality of grubs due to baculovirus treatments was noticed in the trial I and same trend could not be seen in the subsequent two trials (Table 1.11). In the baculovirus treated group, the mortality of the grubs ranged from 80 to 100%, whereas, in the control group also considerable mortality was noticed (50-75%). In general mortality was noticed in the baculovirus treated groups after prolonged period (2-3 months) indicating the lower infection due to baculovirus.

The adult beetles of stem borer (*Plocaederus ferrugineus*) was also treated with baculovirus inoculum. The adult beetles were allowed to swim in the baculovirus inoculum containing 4% sugar for 30 minutes and control beetles were allowed to swim in 4% sugar solution for 30 minutes. Two trials were carried out on these aspects and in the second trial two species of beetle (*P. ferrugineus* and *P. obsus*) were tried and the result are given in Table 1.12.

Table 1. 11. Effect of baculovirus of Rhinoceros beetle on cashew stem and root borer grubs.

Treatment	Percentage of mortality on 1st month	Percentage of mortality on 2nd month	Percentage of mortality on 3rd month	Total percentage of mortality
Trial I (treated on 12.7.1988)				
oral feeding (0.2 ml grub)	70.0	20.0	10.0	100.0
Oval feeding + Bark feeding (12 hr)	20.0	60.0	10.0	90.0
Bark feeding (12 hr)	40.0	10.0	30.0+20.0p*	80.0+20.0p
Control + Buffer feeding (0.2ml/grub)	25.0	0.0	50.0	75.0
Control	0.0	25.0	25.0	50.0
Trial II (treated on 13.10.88)				
Oral feeding				
(0.2 ml/grub)	30.0+20.0p	0.0	—	30.0+20.0p
Control	0.0	33.3p	—	33.3p
Trial III (Treated on 6.1.89)				
oral feeding 0.2 ml/grub)	30.8	15.4	7.7p	46.2+
Baculovirus contaminated cowdung feeding (12 hr)	16.7	+23.1p	16.7p	30.8p
Control + buffer feeding	75.0	33.3p	0.0	16.7+
		0.0	0.0	50.0p
				75.0

P* - Mortality as pre pupa & pupa

Table 1.12. Effect of Baculovirus of Rhinoceros beetle on adults of cashew stem and root borer.

Details	Trial I (treated on 10.10.1988)		Trial II (treated on 30.12.1988)			
	Baculovirus treated	Control	Baculovirus treated		Control	
			p.f.	p.o.	p.f.	p.o.
Mortality on 1st month (%)	62.5	33.3	25.0	16.7	0.0	0.0
Mortality on 2nd month (%)	25.0	66.6	50.0	66.7	75.0	50.0
Mortality on 3rd month & after	0.0	0.0	25.0	0.0	0.0	0.0
Total mortality (%)	87.5	100.0	100.0	83.4	75.0	50.0

p.f. = *Plocaederus ferrugineus*, P.O. = *p. obesus*

In this trial maximum mortality due to baculovirus treatment could be noticed in the first trial during first month. But in the second trial, extent of mortality was same both in treated as well as in control. Since above studies were taken up in a small group of beetles (6-8), the trial will be repeated including sufficient number of beetles in each group for further confirmation.

b. Survey of natural enemies of cashew stem and root borer.

A total of one hundred and sixty grubs were collected in order to identify the natural enemy complex of this species. No natural enemy/pathogen could be noticed. The survey will be continued.

c. Chemical control of tea mosquito bug.

A large plot trial (@ 100 trees/treatment) with three treatments viz. (i) Decamethrin 0.002% (ii) Endosulfan 0.05% (iii) control was taken up at Elenthilla KCDC plantation. Three sprayings were given during flushing (November) flowering (December), and fruitsetting (February) stages. The data recorded for the control of tea mosquito bug (Table 1.13) revealed that both chemical treatments recorded minimum damage of shoot and panicle ranging from 1.1 to 12.2% of shoot damage and 20.4 to 28.4% of panicle damage, whereas, the untreated control recorded highest shoot damage of 27.0% and panicle damage of 65.2%.

Table 1.13 Chemical control of tea mosquito bug.

Treatment	% pretreatment damage		% damage after 1st spray		% damage after 2nd spray		% damage after 3rd spray	
	Shoot	Panicle	Shoot	Panicle	Shoot	Panicle	Shoot	Panicle
Decamethrin 0.002 %	9.5	0.0	12.2	28.4	3.7	23.1	1.1	25.2
Endosulfan 0.05%	7.3	0.0	7.3	21.2	1.5	21.6	1.9	20.4
Control	10.5	66.7	18.3	42.5	32.0	60.2	27.0	65.2

However, considering the harmfulness against natural enemies complex particularly spiders, use of decamethrin is discouraged and only endosulfan may be recommended against the control of tea mosquito bug and other foliage pests.

d. Biological control of *Chromolaena odorata*, perennial weed in cashew plantation.

The larval cultures of *pareuchaetus pseudoinsulata* (Arctiidae : Lepidoptera) received from the Biological Control Laboratory, IHR, Bangalore were multiplied in the laboratory and a total of 4724 larvae (5-7 days old) were released in four locations at Shanthigodu farm and it was found that the larval cultures failed to establish. Hence further multiplication was discontinued.

MINISSION II

INCREASING PRODUCTIVITY

A total of 153 accessions are being maintained in the cashew clonal gene bank. Based on the earlier performance, 45 accessions were identified for promising characters viz. apple size, compact canopy, cluster bearing and early bearing for clonal multiplication. The scion banks for the three NRCC selections namely VTH 30/4-1, VTH 40/1-1 and VTH 107/3-1 have been established by planting softwood grafts. Among the 27 hybrids and 10 selfs tested Bla 139-1 x M 10/4, Bla 139-1 x A 18/4 and 1/3 Ceylon x A 18/4 were found to be high yielding. Both A 18/4 and T. No. 1 were found to transmit boldnut characters to hybrid progeny. In a survey to locate tolerant types to TMB, five promising trees were identified in the hot spot areas. Progenies of crosses A 18/4 x Bla 139-1, M 44/3 x 9/8 EPM, 1/6 Mys. Kotakar x 13/5 Kodur, T. No. 1 x M 10/4 recorded a low score against tea mosquito attack (a score of 1 in the scale of 0-4). During the period of tea mosquito infestation, phenols ortho-dihydroxy phenols, and proline contents in infested tissue increased initially followed by a decrease.

Gen. I (176) : Collection, conservation, cataloguing and evaluation of cashew germplasm (KRM Swamy and Thimmappaiah)

The main objective of this project is to collect the indigenous as well as exotic germplasm accessions and evaluate and maintain them for crop improvement programme and also to support the cashew research workers in the country by supplying the required materials. This project was initiated at Central Plantation Crops Research Institute, Regional Station, Vittal during 1972 and at present after the establishment of National Research Centre for Cashew (1986) a total of 292 accessions are being maintained of which 161 are maintained at Vittal and the rest at NRC-Cashew Experimental Station, Shanthigodu. The collection also includes a few related species such as *Anacardium microcarpum*, *A. pumilum* and *A. orthonianum*.

During the period under report, Udipi, Kundapur, Belthangady, Puttur and Karkala taluks of Dakshina Kannada district were surveyed and 22 collections were added. These collections include genotypes of bold nut size, cluster bearing types, bold kernel and big apple types (Table 2.1). In addition to this, 26 collections were received from coordinating centres of which 18 collections are available for field planting. Among these collections five are reported to be resistant/tolerant to tea mosquito bug which has to be confirmed by the Centres.

Table 2.1. Germplasm collected from Dakshina Kannada during 1988

Character	No. of collections	Collection Number
Bold nut size (11g-15g)	9	KU-6,7,9; BE-1; KA-5; PU-1,2,6,8
Medium nut size (7-10g)	13	U-2, 3, 8; KU-3,4,10; BE-2,7,8; KA-2,4; PU - 4,7.
Cluster bearing (>5 fruits/panicle)	4	KU-4, 10; BE-8; KA-4.
Bold kernel size (2.5-3.0g)	6	KU-6,7; BE-1; PU-6,7,8.
Big apple size (> 80g)	7	U-1; KU - 6,7; PU-1,2,7,8.
Medium shelling % (25-30%)	6	KU-6,7,10; BE-1; KA-4; PU-7.

A National Cashew Gene Bank (NCGB) has been established by planting the clonal progenies of the germplasm available at Vittal and Shanthigodu after evaluation and diverse genotypes collected from different Research Centres and locations. During June 1988, 67 clonal progenies were planted @ 6 plants/ accession providing a closer spacing of 6m x 6m at Kemminje resulting a total of

153 clones. The newly planted clonal accessions also included the related species of *Anacardium* viz. *A. microcarpum*, *A. pumilum* and *A. orthoianum*. These three related species could be successfully grafted on *A. occidentale* root stock (VTH-174) indicating that they are graft compatible. The field establishment is around 97% and have shown satisfactory growth.

The observations on growth parameters recorded in the progenies planted during 1986 and 1987 are given in Table 2. 2.

Table 2. 2. Variation for growth characters in the clonal germplasm accessions

Character	Class	% Accessions
1987 Planted (30 accessions)		
Plant height (cm)	51-100	20.0
	101-150	63.3
	151-200	16.7
Plant girth (cm) (15 cm from ground level)	6-10	73.3
	11-15	26.7
Canopy spread-NS (cm)	51-100	43.3
	101-150	43.3
	151-200	13.3
Canopy spread-EW (cm)	51-100	50.0
	101-150	40.0
	151-200	10.0
1986 planted (56 accessions)		
Plant height (cm)	151-200	8.9
	201-250	41.0
	251-300	44.6
	301-350	5.3
Plant girth (cm) (15 cm from ground level)	16-20	51.8
	21-25	46.4
	26-30	1.8
Canopy spread (NS) (cm)	151-200	14.3
	201-250	60.7
	251-300	23.2
	301-350	1.8
Canopy spread (EW) (cm)	151-200	17.9
	201-250	53.6
	251-300	23.2
	301-350	5.4

The yield analysis of the germplasm at Vittal revealed that 12 individual trees gave more than 15kg nut/year (Table 2. 3.) The highest yield was recorded in VTH-136/1-I (21. 60 kg) followed by 144/4-I (21.00 kg).

Table 2. 3. Best yielders in cashew germplasm available at Vittal (1988)

VTH No.	Parentage	Yield (kg)	Nut wt. (g)	Shelling %	Kernel count/lb.
13/2I	M 78/1	20.68	7.0	25.0	261
19/2I	M 33/3	16.95	6.7	27.0	250
27/2I	A 5/2	17.00	4.5	28.9	349
50/4I	EPM 9/8	19.22	7.6	26.3	227
71/1I	6/1 Divancheruvu	15.55	5.7	28.4	239
80/2II	8/4 Ramanakapeta	17.30	6.0	28.0	233
81/3I	8/5 Chendiputuka	15.45	4.5	29.0	349
120/1 II	1/3 Ceylon	15.90	5.0	25.7	349
136/1I	T. No 100	21.60	6.0	28.8	267
134/1I	T No. 110	20.30	6.8	26.5	252
144/4I	H-6/22	21.00	5.0	29.0	313
147/3I	H 1/3	15.30	5.0	28.4	313

Evaluation

The evaluation of the germplasm was continued to identify superior genotype for various characters such as (1) trees producing big apple and medium sized nut (2) trees with high yield and high shelling percentage (3) trees with bushy habit and compact canopy (4) trees with early flowering (5) cluster bearing and high yield (6) trees with high yield and medium sized nut (7) dwarf, CNSL-free and bold nut size.

A total of ten trees which showed big apple and medium sized nut were identified from the 16 year old seedling population (Table 2. 4). The variation in apple size was more than 70 g and nut size varied from 6. 4 g - 8. 7 g. Clonal material prepared from these ten types have been supplied to ICAR Research Complex, Goa for field evaluation.

A total of 10 trees were marked for the promising characters like high yield and high shelling percentage but the size of the nut was small (4-6g). The shelling percent varied from 30-35% and ten years mean yield from 6- 9 kg/tree/year (Table 2. 5).

Trees with bushy/medium plant habit and medium/compact canopy were also identified (11 Nos.) from the germplasm for clonal multiplication. In this group, yield varied from 5-8 kg and having medium sized nut (5. 4 - 8. 0 g). Their shelling percent varied from 25-30 (Table 2. 6).

Table 2.4. Trees producing big apple and medium sized nuts identified for clonal multiplication

VTH No.	parentage	Yield (kg)		Apple wt.(g)	Nut wt.(g)	Shelling %	Kernel Count/lb
		1977-88 (12 yr mean)	1988				
22/2I	M 64/4	7.53	7.25	85	8.0	19.6	239
33/4I	A 18/4	7.49	6.89	69	7.5	25.0	239
92/2I	13/8 C. putuka	6.00	6.98	70	8.0	27.9	197
105/2I	3/3 Simh.	8.01	11.93	85	7.2	30.0	216
107/3I	3/8 Simh.	8.43	10.83	74	7.6	28.8	217
133/4I	T. No. 109	4.30	2.10	104	6.4	26.7	284
139/4I	T. No. 121	8.26	8.45	110	5.0	25.0	363
146/1I	H 3/1	6.58	11.90	80	6.8	26.1	267
146/4I	H 3/1	6.65	10.55	95	6.8	24.5	267
155 L	T. No. 44 VTL	4.20*	3.64	83	8.7	26.2	206

Except 139/4I and 155L others are supplied to I CAR Research Complex for Goa, for trial.

*Mean yield of 2 years

Table 2.5. High yielding trees with high shelling percent identified for clonal multiplication

VTH No.	parentage	Yield (kg)		Nut wt. (g)	Shelling %
		1977-88 (Mean of 12 yrs)	1988		
27/4I	A 5/2	8.89	12.00	4.9	32.3
57/1II	12/2 Kaviti	9.04	11.75	5.2	33.0
69/1I	5/10 S. punu.	8.30	13.80	6.0	30.0
79/1I	8/1 Kodur	9.84	13.60	7.0	30.0
97/2I	1/8 Baruva	6.69	12.20	4.5	33.3
99/3I	2/1 Baruva	4.98	7.85	4.6	32.6
100/4I	2/1 Baruva	8.09	11.80	4.5	32.0
101/2I	2/6 Neelavathi	5.38	8.35	5.0	32.3
108/4I	4/2 Simh.	5.37	6.20	4.8	32.6
135/4I	T. No. 111	5.96	4.89	3.85	35.1

Table 2.6. Trees with bushy / medium plant habit and medium compact canopy identified for clonal multiplication

VTH No.	Parentage	Yield (kg)		Nut wt. (g)	Shelling %	Kernel count/lb.
		1977-88 (12 yr. mean)	1988			
12/3II	M 44/3	4.98	10.70	7.6	29.7	206
19/2II	M 33/3	5.33	9.35	6.6	30.0	216
20/3II	M 37/3	5.30	9.10	6.2	26.4	284
26/4II	M 104/3	6.27	12.93	7.0	29.2	239
30/2I	A 18/4	8.25	8.15	6.0	28.3	267
30/3I	A 18/4	6.34	6.40	6.0	25.0	302
47/1II	8/5 EPM	5.52	10.53	6.6	28.6	324
52/1II	102 St. puram	8.13	14.05	6.4	26.1	267
68/2II	5/1 RB puram	3.41	6.50	8.0	25.0	227
90/1II	13/1 C. putuka	5.28	6.25	5.4	28.0	303
141/3II	H-2/11	3.85	4.25	6.0	23.3	349

Twelve trees were identified as early flowering and maturing types (Table 2.7). These trees flowered early (November) and gave 50-75% nut during February. These plants gave an average yield of 6-9 kg with medium sized nut (4.2 - 8.7 g). The shelling percent was medium (26-29%).

Table 2.7. Early maturing trees identified for clonal multiplication

VTH No.	Parentage	Yield (kg)		Nut wt. (g)	Shelling %	Kernel count/lb.
		1977-88 (12 year mean)	1988			
27/2I	A 5/2	7.79	17.00	4.2	28.9	349
50/2I	9/8 EPM	9.23	14.70	7.8	27.0	215
50/4I	9/8 EPM	6.49	19.20	7.6	26.3	227
52/4II	10/2 St. puram	9.33	15.70	5.5	29.1	284
128/2II	T. No. 274	7.78	10.00	4.8	26.0	363
130/3I	T. No. 119	7.80	14.10	5.2	32.7	245
134/1I	T. No. 110	8.93	20.50	6.8	26.5	252
137/1I	T. No. 100	8.44	21.60	6.1	28.8	267
141/3I	H-2/11	6.03	9.90	4.7	28.9	349
141/4I	H-2/11	6.59	13.20	5.3	27.9	313
145/4I	H-3/6	3.53	10.00	5.0	28.5	335
155/L	T. No. 44 VTL	4.20	3.84	8.7	26.2	235

Cluster bearing habit is one of the important characters for selection of high yielding lines and this was observed in 12 trees (Table 2.8). These trees gave more than 5 nuts/panicle with a minimum yield of 8 kg/tree/year. The nut size varied from 4.7 - 7.8 g with a medium shelling percent (26-30%).

Table 2. 8. Cluster bearing trees with a minimum yield of 8 kg identified for clonal multiplication

VTH No.	Parentage	Yield (kg)		Nut wt. (g)	Shelling %	Kernel Count/lb.
		1977-88 (Mean of 12 yrs)	1988			
30/21	A 18/4	8.25	8.15	6.0	28.3	267
39/31	2/6 Dicherla	7.85	7.35	6.4	27.1	239
50/21	9/8 EPM	9.22	14.80	7.8	27.0	215
51/11	9/10 Dv. ur.	8.40	11.95	7.4	21.7	303
52/11	10/2 St. puram	8.13	14.05	6.4	25.5	325
57/11	12/2 Kaviti	8.57	10.30	5.3	29.7	302
59/21	13/5 Kodur	9.15	12.45	7.1	24.2	254
105/21	3/3 Simh.	8.01	11.93	7.2	30.3	216
107/31	3/8 Simh.	8.43	10.93	7.2	30.3	216
119/41	1/1 Ceylon	9.35	14.40	4.7	27.1	349
141/31	H 2/11	6.00	9.90	4.7	28.9	349
144/41	H 6/22	8.10	21.00	5.0	26.7	378

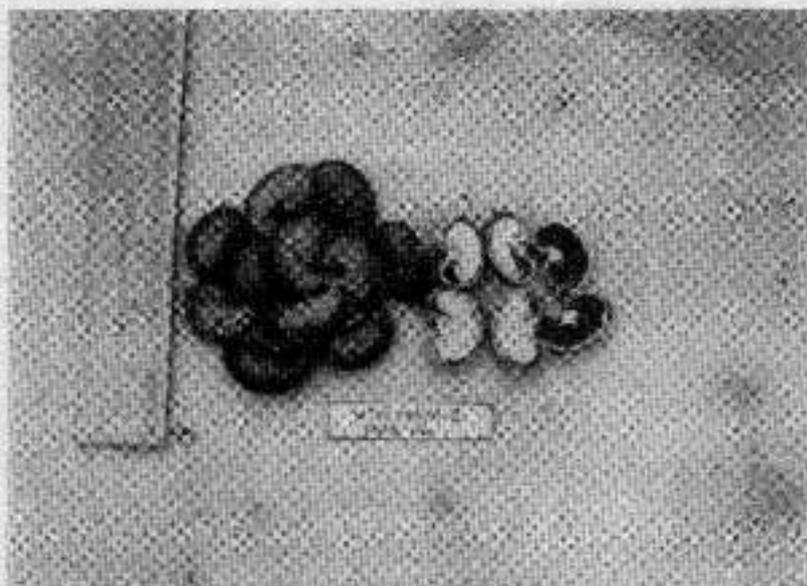
High yield and medium nut size are the important characters as far as the economic yield is concerned and this was noticed in 14 trees (Table 2-9). In these plants, yield varied from 5-11 kg (average of 10 years) and nut size from 7.0-9.0 g. These trees were clonally multiplied for laying out an experiment at Shanthigodu. These elite trees have a low kernel count of 210-240/lb.

Table 2. 9. Salient features of NRC - Cashew selections

Characters	Sel. - 1 (VTH - 30/41)	Sel. - 2 (VTH-40/11)	Sel. - 3 (VTH-107/31)
Plant height (m)	5.0	9.0	8.0
Plant habit	Bushy	Erect	Erect
Canopy shape	Medium	Medium	Medium
Flowering season	Nov-Dec	Nov-Dec	Dec-Jan
Harvesting season	Feb-Mar	Feb-Mar	Mar-Apr
Apple colour	Red	Pink	Yellow
Apple size	Big (70 g)	Medium (50 g)	Big (70 g)
Nut size	Medium (7.5 g)	Medium (9.2g)	Medium (7.6g)
No. of nuts/kg	133	108	131
Shelling %	25.0	28.6	28.8
Kernel count/lb.	240	210	210
Mean yield/year (kg) (10 yrs mean)	8.3	8.8	9.0
Highest yield recorded (kg)	16.3	13.40	25.30
Age of the tree (years)	16	16	16
Original source	A 18/4	2/9 Dich.	3/85 Simh.

Dwarf (3 Nos.) and CNSL-free (3 Nos.) plants have been identified for clonal propagation. The dwarf plants had medium/compact canopy and the CNSL-free types had medium nut size (Fig. 2.1).

Fig. 2.1. CNSL Free Types



Based on the evaluation of germplasm for 15 vegetative growth and reproductive characters, three selections proposed for release are Selection - 1 (VTH - 30/4-I), Selection - 2 (VTH 40/1-I) and Selection - 3 (VTH 107/3-I). Clonal material from these three NRCC selections were prepared for establishing a scion bank and planting was done at Experimental Station, Shanthigodu. The salient features of these selections are given in Table 2.9.

Cataloguing

The tree-wise data collected in the germplasm descriptors list in the germplasm available at Vittal and Shanthigodu has been computerised. A total of 1418 trees from 292 accessions were grouped for some of the important characters (Table 2.10). Short flowering phase (< 60 days) was recorded in 148 trees and the cluster bearing habit (> 5 fruits/panicle) in 58 trees. A total of 187 trees were having big sized apple (> 70 g) and 3 trees having big sized nut (> 10 g). High shelling percentage ($> 31\%$) and low kernel count/lb (< 210 /lb) were recorded in 82 trees.

**Table 2. 10. Characteristics of germplasm accessions
(seedling progenies)**

Character	Category	No. of trees
Flowering duration	Short (< 60 days)	148
	Medium (61-80 days)	381
	Long (> 80 days)	889
No. of fruits/panicle	Low (1-2)	695
	Medium (3-5)	665
	High (> 5)	58
Apple size	Small (< 40 g)	355
	Medium (41-70 g)	876
	Big (> 70 g)	187
Nut size	Small (2-5 g)	785
	Medium (6-9 g)	614
	Big (> 10 g)	3
Shelling %	Low (< 25%)	258
	Medium (25-30%)	889
	High (> 31%)	171
Kernel count/lb.	Low (< 210)	82
	Medium (210-320)	798
	High (> 320)	436

Gen. II (176) : Varietal improvement of Cashew

(Thimmappaiah, PM Kumaran and KRM Swamy)

This project envisages the crop improvement in terms of high yield potential with other desirable characters like high shelling percentage, resistance/tolerance to tea mosquito bug and quality parameters like high protein, high lysine and low sugar. These targets are proposed to be achieved by hybridization and selection and also by varietal evaluation, conducting comparative yield trial. The experiment was initiated at CPCRI, Vittal during 1972.

1. Hybridization and Selection

The three progeny trials (Trial - I, II and III) planted with 27 hybrids and 10 selfs at Vittal during 1984 have been evaluated for morphological, flowering and yield characters.

a) Progeny Trial - I :

This trial has been planted with 18 cross combinations and a control (M 44/3) @ 6 plants/combination in three replications (RBD). The morphological growth characters and yield recorded in these plants revealed the following

aspects. There was no significant difference in yield in the fourth year of planting between the combinations. The maximum yield was recorded (674 g / plant) in 1/3 Ceylon x A 18/4 followed by selfed progeny of 1/3 Ceylon (662 g/plant) and M 44/3 (563 g/plant). Thus, once again 1/3 Ceylon and M 44/3 proved their potency for transmitting high yielding ability in their progenies. Similarly combinations with M 37/3, M 10/4 and Bla - 139 - 1 as parents exhibited early flowering (October - November) and combinations with A 18/4 parentage showed bold nut characters in the F₁ populations.

b) Progeny Trial - II :

A total of seven selfed progenies @ 6 plants / accession in two replications have been planted in this trial as an observation plot. The progenies have shown early flowering in M 10/4, high yield in T. No. 270, bold nut in T. No. 1 and high shelling percentage in M 44/3 (31.6%). The selfed progeny of M 10/4 continues to show dwarfing tendency in the first generation of selfing.

c) Progeny Trial - III :

A total of 15 cross combinations and a control (M 44/3) have been planted in this experiment @ 4 plants/combination in two replications (RBD). The observations recorded in these plants revealed significant differences with regard to height, girth, morphological characters and also yield per plant. The highest yield was recorded in Bla -139-1 x M 10/4 (1.3 kg / plant) followed by the progeny of Bla-139-1 x A 18/4 (581.5 g / plant) and A 18/4 x M 10/4 (461.3 g / plant). Thus Bla-139-1 and M 10/4 proved their potency not only for high yielding but also for imparting early flowering character in other combinations too. Based on the observations recorded, two parents A 18/4 and T. No.1 (as female only) were found to be as donar parents transmitting bold nut trait in F₁ progenies.

Reaction to Tea mosquito bug (TMB) :

All the hybrid and selfed progenies planted under these three experiments were evaluated for tea mosquito tolerance under natural level of infestation, which was considered as moderate to severe. The damage was scored on 0-4 scale based on lesion count on young shoot, panicle and tender nut. The hybrids and selfs were found to vary in their reaction to TMB. The details of combinations showing less lesions are given in Table 2.11. In the progeny trial-I, the progenies of seven combinations had a score ranging from 1.13-1.97 which was considered as moderate and five combinations in the progeny trial-III had less than 1.0 score showing less damage. But all the selfed progeny (Trial-II) were highly susceptible.

Table 2. 11. Details of reaction of hybrid/selfed progeny against tea mosquito

Combination	Score	Experiment
13/2 San. x M 44/3 Bla-139-1 x 13/5 Kodur A 18/4 x 13/5 Kodur 1/3 Ceylon (Self) M 10/4 x WBDC-V M 44/3 Self A 18/4 x 7/10 Tetagunta	1.13-1.97	Trial-I
A 18/4 x Bla- 139-1 M 44/3 x 9/8 EPM 1/6 Mys. Kotekar x 13/5 Kodur T. No. 1 x M 10/4 M 44/3 (OP) Control	1.0	Trial-III

Quality Evaluation

A total of 12 selected hybrid plants and two Brazilian collections (VTH 711/1 and 711/10) were evaluated for biochemical quality parameters like sugars, phenols, protein and lysine content in their kernel. Significant difference in these parameters were observed in these hybrids. The percentage of protein among the hybrids evaluated varied from 32.4 - 41.7%. The sugar content (<10.5%) and phenol contents were low. Hybrid combination with M 10/4 as one of the parents recorded a higher lysine content. Similarly high protein content was recorded in progenies which had A 18/4, Bla - 139 - 1, and Vetore - 56 as one of their parents.

New Hybrid progeny :

Out of 145 hybrids planted at Kemminje during 1987, from 33 cross combinations, 29.5 percent of the plants from 19 combinations flowered during the year. Maximum flowering was recorded in the progenies of the combinations viz., 13/2 Sanyasiputka x 13/5 Kodur, 13/5 Kodur x M 37-3 and M 44/3 x A 18/4. The progenies of the combinations 13/5 Kodur x 13/2 San., A 18/4 x 13/5 Kodur and M 44/3 x T. No. 56 flowered very early (October-November).

Hybridization

(a) **Selfing** : During the period, 11 trees from the first generation of selfs were selected for various characters for taking up selfing programme in cashew with a view to generate inbred lines. Among the selected trees, selfing was initiated in nine trees as and when the panicles were emerged and ready for pollination.

The details of the tree selected, number of flowers pollinated and the number of initial set recorded after 15 days of pollination are given in Table 2.12. Out of 2425 flowers pollinated, a total of 866 initial set was recorded giving 35.8% set after 15 days of pollination.

Table 2. 12. Details of selfing programme in Cashew

Tree No. / Acc. No.	No. of flowers pollinated	Initial set after 15 days	% Set
11/7 (VTH-3)	232	128	55.2
15/7 (VTH-120)	342	173	50.5
11/1 (VTH-11)	564	111	19.7
16/5 (VTH-16)	202	68	33.7
12/4 (VTH-30)	278	119	42.8
4/13 (VTH-93)	165	39	23.6
1/8 (VTH-12)	156	27	17.3
127/2 (VTH-127)	200	110	55.0
34/7 (VTH-34)	286	93	32.5
Total	2425	866	35.8

(b) *Interspecific Hybridization : Anacardium occidentale* L. (V-5) was crossed with the related species like *A. pumilum* and *A. orthonianum* and reciprocal crosses were also effected. The crosses were found to be successful.

Table 2. 13. Mean growth performance of 12 recommended varieties (1988)

Treatment No.	Variety	Height (m)	Girth (m)	Canopy spread (m ²)	Spread	
					N-S (m)	E-W (m)
1	EPM 9/8	2.27	20.87	5.22	2.23	2.33
2	Tr. No. 56	2.58	22.83	6.27	2.41	2.58
3	Tr. No. 1	2.31	21.79	5.57	2.29	2.43
4	H 2/12	1.99	20.47	5.46	2.41	2.25
5	M 44/3	2.18	17.30	5.42	2.43	2.23
6	H 2/11	2.06	17.93	5.00	2.20	2.28
7	H-3-13	2.39	20.87	5.28	2.32	2.27
8	Ullal-1	2.25	19.93	5.98	2.45	2.44
9	M 10/4	2.08	18.90	5.90	2.38	2.43
10	H-3-17	2.28	18.47	4.15	2.06	2.02
11	Bia-139-1	2.19	20.97	5.06	2.26	2.22
12	Bia-39-4	2.61	23.47	5.59	2.54	2.48
	CD	0.30	2.54	NS	NS	NS

Evaluation of Pre - released and Released varieties :

The vegetative growth characters were recorded in all the 12 recommended varieties planted during 1986 for the clonal evaluation. The details are given in Table 2.13. The mean height varied from 1.99m (H 2/12) to 2.61m (Bla-39-4) and girth 17.30m (M 44/3) to 23.47m (Bla-39-4). The canopy spread was found to be maximum (6.27m) in T.No. 56 and minimum in H-3-17 (4.15m).

The maximisation plot planted during 1986 with two released varieties viz. M 10/4 and M 44/3 (50 grafts each), have established well and started flowering. The initial yield is recorded and the cost of cultivation is being worked out.

Based on the evaluation of the germplasm, a new clonal evaluation trial with 14 germplasm selections has been planted in the field with M 44/3 as control at Shanthigodu. The experiment was planted in CRD with 14 replications/treatment (single plant). The details of the germplasm selections planted in new clonal trial are given in Table 2.14. The selections have been made based on their yield, nut weight, shelling percentage and kernel count/lb. This also includes the three NRCC selections, viz., 30/4, 40/1 and 107/3.

Ent. I (176) : Varietal resistance to tea mosquito bug (D. Sundararaju)

The project envisages the screening of available germplasm collection of cashew and hybrids, evaluation against the tea mosquito attack and to identify the tolerant/resistant types for future line of work. This also includes the survey and collection of tolerant/resistant types from the hot spot area and screening them in the laboratory for confirmation.

1. Survey of cashew plantations for tolerant/resistant types

The hot spot areas of tea mosquito bug was surveyed at two locations, viz., Kunthur and Elanthila in Puttur taluk. During the period, five tolerant types towards tea mosquito bug were located at Kunthur during April, 1988. These trees along with the one identified earlier (T. No. 24 Kunthur) were monitored for incidence of tea mosquito bug during the fruiting season.

The tolerant types such as VTH-153, 152 and 151 identified from the germplasm were monitored along with susceptible type VTH-54 for tea mosquito incidence. In these accessions, the pest population was negligible up to December, and during February 1989 low to moderate incidence was noticed on the panicles of the tolerant types VTH-153, 152, 151 with a damage score of 1.5, 2.0 and 3.0 under 0-4 scale respectively. These accessions will be screened in laboratory for confirmatory result in the ensuing season.

Three progeny evaluation trials planted at Vittal with 32 cross combinations and seven selfs were evaluated for the tea mosquito infestation. The details of observations recorded are given in Tables 2. 15, 2. 16 and 2. 17.

Table 2.1.4. Features of germplasm selections in new clonal trial planted at Shanthagodu during 1988

Acc/trees No.	Original percentage	Yield (kg/tree)		Average wt./ Nut (g)	Shelling %	Kernel count/lb.	Flowering* season	Flowering* duration
		1987	Av. of 9/11 yrs					
13/2 (R-I)	M 78/1	29.0	11.7	7.0	28.0	261	M	L
30/4 (R-I)	A 18/4	10.6	8.3	7.5	25.0	239	M	L
40/1 (R-I)	2/9 Dicherla	7.1	8.8	9.2	28.6	162	M	M
155 Layer	Vittal Col.	4.0	—	8.7	26.2	206	M	S
92/2 (R-I)	13/8 Chendiputka	11.3	6.5	8.0	27.9	197	M	S
107/3 (R-I)	3/8 Sch	25.3	9.0	7.6	28.8	217	M	M
574/2524	4/5 Bapatla	12.3	7.2	8.2	28.9	191	E	M
174/49	H-47-7	14.7	7.6	7.5	28.4	214	M	L
539 2	M 76/2	23.9	6.7	6.7	28.3	240	L	L
652/15	871/0-6 Belthangady	5.9	6.0	8.8	27.4	241	L	L
196/18	8/8 Alivelu							
	Venkatapuram.	3.6	5.2	9.4	27.2	183	M	L
118/4 (R-II)	11/14 Karur	11.3	4.9	8.0	27.6	202	L	L
69/2 (R-I)	13/5 Kodur	17.6	9.7	7.1	24.2	254	M	L
194/12	5/11 56 Sc	4.0	5.6	8.9	30.7	156	L	L
VTM-12	M 44/3 (Control)							

*Flowering season :

E = Early

M = Mid

L = Late

*Flowering duration :

M = Medium

(61-80 days)

L = Long (80 days)

Table 2.15. Reaction of progenies of Progeny Trial-I for tea mosquito bug

Names of cross combinations	Shoot/panicle damage score (0-4 scale)
M 44/3 x M 44/3	1.8
13/2 Sanyasiputka x M 44/3	1.1
13/2 Sanyasiputka x 13/2 Sanyasiputka	2.0
Bla-139-1 x T. No. 1	3.0
Bla-139-1 x 13/5 Kodur	1.2
M 10/4 x WBDC-V	1.8
M 37/3 x M 37/3	2.2
M 37/3 x A 18/4	3.6
WBDC-V x WBDC-V	2.0
M 37/3 x T. No. 1	2.6
A 18/4 x 13/5 Kodur	1.4
A 18/4 x A 18/4	2.0
1/3 Ceylon x 13/5 Kodur	4.0
1/3 Ceylon x 1/3 Ceylon	1.5
1/3 Ceylon x A 18/4	2.5
M 37/3 x 13/5 Kodur	2.5
1/3 Ceylon x 1/3 Mys. Kotekar	2.5

Table 2.16. Reaction of progenies of Progeny Trial-III to tea mosquito bug

Names of cross combinations	score (0-4 scale)
A 18/4 x M 10/4	
Bla-139-1 x M 10/4	2.2
A 18/4 x M 10/4	2.6
A 18/4 x Vetora-56	1.7
7/10 Tetagunta x A 18/4	2.4
Bla-139-1 x A 18/4	
7/10 Tetagunta x Bla-139-1	2.4
M 37/3 x 7/10 Tetagunta	0.8
M 44/3 x 9/8 Eparupalayam	1.8
M 16/1 x 13/5 Kodur	1.3
T. No. 1 x 7/10 Tetagunta	1.0
WBDC-V x M 10/4	0.7
1/6 Mys. Kotekar x 13/5 Kodur	0.9
T. No. 1 x M 10/4	1.7
WBDC-V x 13/5 Kodur	

In the case of progeny trial - I, among eighteen cross combinations, 5 combinations gave a scoring of less than 2. The ranking in these population varied from 1.1 to 4.0 under 0-4 scale. Progenies of 13/2 San. Putka x M 44/3 had least infestation. The progenies identified (<2) will be screened in the laboratory for confirmation of the result.

In the second progeny trial, among 15 cross combinations, the infestation showed a variation in ranking from 0.5 to 2.6. Here, progenies of 4 combinations showed <1 score which are identified as potential tolerant ones. These need to be confirmed by laboratory screening.

In the third trial, all the seven selfed progenies showed the infestation ranking >2.0. These are also to be confirmed by laboratory screening.

Table 2.17. Reaction of selfed progenies to tea mosquito bug

Names of selfs	Shoot and panicle damage score (0-4 scale)
M 10/4 x M 10/4	2.7
M 16/1 x M 16/1	3.2
M 37/3 x M 37/3	2.5
M 44/3 x M 44/3	2.3
T. No.1 x T. No. 1	3.4
1/3 Ceylon x 1/3 Ceylon	3.7
T. No. 270 x T. No. 270	2.4

**Phy. V(176): Quality evaluation in Cashew
(KV Nagaraja)**

This project was initiated at CPCRI, Vittal during 1984 for the characterization of the cashewnut and apple of the released and pre-released varieties with respect to protein, sugars, starch and aminoacid in kernel and ascorbic acid, sugars, aminoacid, phenols and tannin in cashew apple.

During the period, cashew kernel protein from eight selected accessions was extracted at pH 10.0 and precipitated with 90% ammonium sulphate saturation. The precipitated protein after dialysis was used for *in vitro* digestibility by trypsin, α -chymotrypsin and pepsin. The details of the accession selected and results obtained are given in Table 2.18. The results indicate a wide range of variability with respect of digestibility.

Cashew kernels from two pre-released varieties 107/3-1 and 40/1-1, were analysed for their sugar and phenol content and the results are given in Table 2.19. Both the varieties had low sugar content.

Table 2.18. In vitro digestibility of cashew kernel protein

Variety	In vitro digestibility A 280/15 min		
	Trypsin	α -Chymotrypsin	Pepsin
VTH-30	0.055	0.048	0.06
VTH-50	0.056	0.041	0.02
VTH-59	0.063	0.056	0.023
VTH-141	0.056	0.038	0.018
VTH-142	0.033	0.033	0.018
Ullal-1	0.045	0.04	0.022
Ullal-2	0.053	0.211	0.02
Oil less	0.048	0.058	0.016

Values are mean of three individual estimations. In Vitro digestibility expressed as increase in absorbance at 280 nm/15 min.

Table 2.19. Kernel sugar and phenol content of varieties proposed for release

Variety	Sugar (mg/100 mg flour)	Phenols (μ g/100 mg flour)
107/3-1	8.93	43.87
40/1-1	10.38	59.10

Values are mean of three individual estimations and based on defatted cashew kernel

A total of 15 selected cashew hybrid samples were analysed for their kernel protein, sugars, lysine and phenol contents and the results are given in Table 2.20. All the samples had very low phenol content. The sugar content among the hybrids varied from 7.5 g% (H-22/2) to 10.6 g% (S-11/8). Similarly, protein content also varied from 32.5% (S-11/7) to 41.7% (H-12/4). Lysine content was found to vary from 59.68 μ g/mg protein (H-24/1) to 104.39 (B1/1) Phenols among the hybrids varied from 0.52 - 4.4 μ g/100mg flour.

The selected eight pre-released and released varieties were also studied for their kernel sugars, phenols and lysine content and the results are given in Table 2.21. Among the varieties the sugar content varied from 7.64 to 13.71 and phenols from 49.89 to 118.68. Maximum lysine content (105.33) was observed in VTH-142 and minimum (64.29) in VTH-30 and Ullal-1 varieties.

Table 2.20. Analysis of hybrid cashew kernel samples.

Hybrids/ Exotic	Sugars (mg/ 100 mg flour)	Protein (g/ 100 g)	Lysine (ug/mg protein)	Phenols (ug/ 100 mg flour)
H 5/8	8.495	38.02	63.65	1.734
H 22/2	7.532	41.1	69.27	1.704
H 15/7	8.866	34.35	74.39	0.52
H 1/1	8.991	32.85	104.39	0.834
H 1/10	9.158	37.19	72.5	0.662
H 28/2	8.568	35.62	74.39	0.989
H 20/3	8.153	38.1	75.62	1.054
H 7/8	9.839	36.85	75.69	0.584
H 20/8	9.638	41.62	65.37	3.56
H 12/4	9.103	41.74	60.45	4.376
H 32/3	9.283	34.42	92.27	2.588
H 1/10	10.325	36.37	62.21	1.696
S 11/8	10.651	32.41	93.29	3.47
H 24/1	7.769	38.44	59.68	4.036
H 16-12	8.646	34.9	72.39	3.068

Values are based on defatted kernel flour and mean of three individual estimations

Table 2.21. Sugars, phenols and lysine contents of kernel of some released and pre-released varieties.

Variety	Sugars (mg/100 mg flour)	Phenols (ug/100 mg flour)	Lysine (ug/100 mg protein)
VTH-50	10.06	65.73	72.14
VTH-59	10.86	59.33	95.77
VTH-30	13.71	118.68	64.29
VTH-141	9.64	93.61	94.75
VTH-142	8.65	91.31	105.33
Ullal-1	7.64	90.71	84.29
Ullal-2	8.89	166.59	64.56
Oilless	8.26	49.89	66.23

Values are based on defatted flour and mean of three individual estimations

**Stat. III (176) : Developing a yield index for Cashew
(S.Bhagavan and TV Sathyanandan)**

Yield in cashew is a complex character and is governed by many characters viz. canopy structure, height, girth and other reproductive characters.

The objective of this project is to develop an yield index in cashew which give weightage to some of the inter-related characters.

The data collected on various characters during 1987 was subjected to path co-efficient analysis and the result is presented in Table 2.22. For the analysis, characters like height of the tree (x_1), canopy growth (x_2), average number of fruits/unit area (x_3), hundred nut weight (x_4) and yield (x_5) were considered.

Table 2.22. Direct (diagonal elements) and indirect effects of various characters on yield for the year 1987 data.

	x_1	x_2	x_3	x_4	r
x_1	-0.09	0.13	0.00	-0.16	-0.12
x_2	-0.03	0.40	0.05	-0.17	0.25
x_3	-0.00	0.09	0.23	-0.06	0.26
x_4	-0.02	0.10	0.02	-0.69	-0.59

From the table it is clear that the height of the tree and hundred nut weight have both negative correlations and negative direct effect, thereby suggesting negative weights of appropriate magnitude for these characters towards yield index.

The canopy area and average fruit per unit area correlate positively with positive direct effects and hence it suggests positive weights of appropriate magnitude for these characters. Further when the yield related characters were regressed on yield the multiple correlation coefficient was to the tune of 57.38% indicating that these variables explain only 57 percent of the total variation in yield.

Data collected during 1988 from 71 trees such as height of the trees, spread of the trees (both East-West and North-South direction) number of fruits/unit area (in four random spot of the tree) hundred nut weight and actual yield were subjected to statistical analysis. The five characters selected during the previous years was considered this year also and the correlation coefficient between the five characters were worked out (Table 2.23). Further attempts were made to study the direct and indirect effects of these characters and the result is presented in Table 2.24.

Table 2.23. Correlation coefficient between the five characters for the 1988 data.

	x_2	x_3	x_4	x_5
x_1	0.58	0.38	0.04	0.35
x_2		0.52	0.05	0.50
x_3			-0.08	0.40
x_4				0.00

Table 2.24. Direct (diagonal elements) and indirect effects of various characters on yield for the year 1988 data

	x_1	x_2	x_3	x_4	r
x_1	0.07	0.21	0.07	0.00	0.35
x_2	0.04	0.36	0.10	0.00	0.50
x_3	0.03	0.19	0.18	0.00	0.40
x_4	0.00	0.02	-0.01	-0.01	0.00

The above analysis reveals that the characters like canopy area and average number of fruits/unit area have both higher positive correlation with the yield and higher positive direct effect on yield. Height of the tree and number of fruits/unit area showed higher positive indirect effects on yield through the character canopy area. When the yield-related characters were regressed on yield the multiple correlation coefficient was to the tune of 27.5% which indicates that these variables explain only 28% of the total variation in yield.

From the analysis of 1987 and 1988 data, it is clear that correlation worked out for 1987 observation on yield and yield related characters are not well confirmed with observations recorded in 1988. Moreover, the total variation in yield is not fully accounted by these characters since the multiple regression coefficient was hardly 57.38% during 1987 and 27.5% during 1988. Therefore, further attempts will be made by considering more variables of importance in the study which will account for a good variation in yield.

Ad-hoc Scheme : Screening and Biochemical Evaluation of Cashew germplasm in relation to Tea mosquito infestation (KV Nagaraja, D Sundararaju and Joy John)

The ad-hoc scheme on screening and biochemical evaluation of cashew germplasm in relation to tea mosquito infestation sanctioned by ICAR was started in June 1988. The main objective of the project is to identify varieties with tolerance to tea mosquito and to investigate biochemical changes during infestation. Work done has been reported under two heads namely, biochemical studies and entomological studies.

Biochemical studies

In an attempt to understand the biochemical changes taking place during infestation, forty day old seedlings (VTH-174) were infested with 5 day old nymphs of tea mosquito (3 nymphs/seedling) and allowed to feed for different periods. After the feeding, the damaged tissue was extracted with ethanol and ethanol extract after concentration was fractionated into sugars, amino acids and phenols. The fractions were analysed and the results are given in Table 2.25.

Table 2.25. Biochemical changes due to tea mosquito infestation

Tissue	Period of infestation	Sugars (mg/g fr. wt.)	Phenols (mg/g fr.wt.)	Ortho dihydroxy phenols (mg g fr. wt.)	Amino acids (mg/g fr. wt.)	Proline (μ g/g fr. wt)
Shoot	0	5.24	0.141	0.079	0.358	44.32
	1	4.81	0.304	0.208	0.302	122.77
	3	2.22	0.119	0.074	0.107	24.39
	5	1.22	0.105	0.040	0.108	35.70
Leaf	0	7.65	0.363	0.153	0.307	125.8
	1	5.81	0.716	0.289	0.251	134.6
	3	3.19	0.500	0.203	0.182	57.4
	5	2.4	0.588	0.210	0.164	38.2

Values are mean of 4 individual estimations. 40 days old seedlings (VTH - 174) were employed for infestation studies.

Sugar and amino acid contents both in shoot and leaves decreased with increased period of infestation, whereas, phenols, ortho dihydroxy phenols and proline increased initially followed by a decrease.

In an another experiment changes in chlorophyll and carotenoid pigments during infestation were looked into and the results are given in table 2.26. Chlorophyll a tended to decrease while Chlorophyll b tended to increase with period of infestation but total chlorophyll did not show any significant variations. Carotenoids showed a decrease with increase in period of infestation.

Table 2.26. Changes in chlorophyll and carotenoids in leaves due to infestation

Period of infestation	Chl.a	Chl.b	Total Chl.	Carotenoids
	(ug/mg fr. wt)			
0	0.333	0.155	0.487	0.0817
1	0.283	0.198	0.43	0.051
3	0.408	0.101	0.513	0.142
5	0.267	0.222	0.468	0.058

40 days old seedlings (VTH-174) were employed for infestation studies. Values are mean of four individual estimations.

Entomological studies

(a) Mass culturing of tea mosquito bug :

(i) Rearing : Three methods of mass rearing were tried in order to establish ideal rearing conditions for tea mosquito bug. The three methods are : (i) the newly hatched nymphs (5 nymphs/cage) were reared in glass chimney cage (20x7cm). Two tender shoots/cage kept in glass vial with water were provided as feed and shoots were changed on every alternate days: (ii) The newly hatched nymphs (15-20 nymphs/cage) were reared in aluminium cage (15x15x20cm). Four tender shoots kept in four glass vials fixed on an aluminium plate (15x2.5cm) with a handle. The shoots were replaced every day: (iii) The shoots with eggs (10-20; eggs) were kept with seedling covered with cylindrical polythene film cage (30x75cm). The newly hatched nymphs are being fed for two days on potted cashew seedling, supplemented with two tender cashew shoots. On third day, the nymphs were transferred to aluminium cage (15-20 nymphs/cage) and reared as in method (ii).

The results of the above studies indicate that method (iii) is found to be ideal and will be followed for mass rearing of tea mosquito bug (Table 2.27).

Table 2.27. Mass rearing of tea mosquito bug

Method of rearing	No. of nymphs reared	% mortality of nymphs	% nymphs reached adult stage	Female:Male ratio of adults
(i)	128	92.2	7.8	1:2.3
(ii)	693	88.5	31.5	1:1.1
(iii)	898	39.5	60.5	1:0.9

(b) Fecundity studies

The laboratory reared females were observed for fecundity and the period of oviposition by caging them on potted cashew seedling as well as on tender cashew shoots on the tree itself. The details of the data collected in this regard is given in

Table 2.29. Extent of damage caused by different instars of nymphs of tea mosquito bug on VTH-174 grafts (@ one nymph/graft)

Nymphal instars	Shoot* damage on days						Midrib damage on days**						Lamina damage on days**						Mean Nymphal mortality on 5th day (%)
	1st	2nd	3rd	4th	5th	Mean	1st	2nd	3rd	4th	5th	Mean	1st	2nd	3rd	4th	5th	Mean	
I	0.7 (0.77)	1.0 (0.91)	1.0 (1.00)	1.3 (1.14)	1.7 (1.28)	1.1 (1.02)	0.6 (0.77)	1.0 (0.95)	1.0 (1.01)	2.7 (1.65)	3.5 (1.86)	1.8 (1.25)	0.1 (0.36)	0.9 (0.96)	1.0 (0.99)	2.6 (1.60)	4.7 (2.15)	1.9 (1.21)	0.0
II	0.3 (0.54)	0.7 (0.68)	2.3 (1.49)	3.0 (1.73)	4.0 (2.00)	2.1 (1.09)	1.6 (1.26)	2.3 (1.50)	2.0 (1.38)	4.1 (1.99)	7.1 (2.67)	3.4 (1.76)	0.7 (1.04)	2.0 (1.40)	1.0 (1.01)	1.8 (1.33)	5.0 (2.33)	2.1 (1.40)	0.0
III	2.0 (1.41)	2.3 (1.52)	4.0 (2.00)	4.0 (2.00)	4.0 (2.00)	3.3 (1.79)	2.8 (1.67)	5.6 (2.36)	6.3 (2.42)	6.1 (2.45)	8.8 (2.97)	5.9 (2.37)	0.9 (0.83)	2.8 (1.49)	5.3 (2.23)	3.8 (1.95)	8.3 (2.88)	4.2 (1.87)	0.0
IV	2.3 (1.52)	3.3 (1.82)	4.0 (2.00)	4.0 (2.00)	4.0 (2.00)	3.5 (1.87)	2.0 (1.33)	3.1 (1.75)	5.7 (2.38)	5.3 (2.31)	8.9 (2.99)	5.0 (2.15)	1.3 (1.28)	2.5 (1.58)	2.9 (1.71)	3.0 (1.72)	7.5 (2.74)	3.4 (1.80)	100.0
V	3.0 (1.73)	3.3 (1.82)	4.0 (2.00)	4.0 (2.00)	4.0 (2.00)	3.7 (1.91)	2.0 (1.37)	3.4 (1.83)	5.2 (2.25)	6.0 (2.41)	6.0 (2.43)	4.5 (2.06)	1.0 (0.98)	1.1 (1.02)	2.7 (1.58)	4.8 (2.10)	3.1 (1.73)	2.5 (1.49)	0.0
Mean	1.7 (1.20)	2.1 (1.35)	3.1 (1.70)	3.3 (1.77)	3.5 (1.86)	2.7 (1.57)	1.8 (1.28)	3.1 (1.68)	4.0 (1.88)	4.8 (2.16)	6.9 (2.58)	4.1 (1.92)	0.8 (0.90)	1.9 (1.29)	2.6 (1.51)	3.2 (1.74)	5.7 (2.35)	2.6 (1.56)	
CD at 5%																			
Between nymphal instars						(0.16)						(0.26)							(0.13)
Between days of damage						(0.16)						(0.26)							(0.13)
Interactions						(0.38)						NS							(0.28)

* Based on 0-4 scale

** Based on 0-9 scale

*** Mean of three replications

NS = Non-significant (Figures in parantheses are square root transformed values)

The data collected were analysed after substituting zero values with 0.1 and square root transformation by employing techniques for the factorial design and presented in Table 2.29.

From the table it is clear that the nymphs can cause highest damage on shoot, moderate to higher damage on midribs and comparatively less damage on lamina of tender leaf. Maximum damage on shoot and lamina was caused by third, fourth and fifth instar nymphs whereas on midribs, maximum damage was caused by third and fourth instar nymphs.

The interactions between the age of nymphs and duration of feeding was significant with respect to damage on shoot indicating that to get higher shoot damage required for susceptibility feeding was required more than five days for first instar, four days for second instar, three days for third instar and two days for fourth and fifth instar nymphs. In all age groups after five days of feeding all nymphs survived except in the fourth instar group wherein all nymphs were dead due to wilting of the shoot. In the fifth instar group some nymphs became adults after second day onwards and general reduction in feeding on foliage was observed.

Considering all these factors, fourth instar nymphs were chosen for testing the susceptibility/ tolerance of cashew accession and duration of feeding was fixed for 48 hours. In order to find out nonpreference, antibiosis and tolerance mechanism of resistance if any, feeding for a period of six days was fixed for first instar nymphs. The damage caused on shoot and midrib of tender leaves was only taken into consideration for screening for resistance to tea mosquito bug.

ii) Screening of cashew varieties/accessions to tea mosquito bug.

Four month old grafts of cashew varieties/ accessions, viz., Vengurla-1, 2, 3, 4 and 5, Bapatla-1, 2, 3 and 4, Ulfal-1, Bla-139-1, Vridhachalam-1 and 2, VTH 107/3, M 45/4, K-7-1, M 68/1, M 26/2, M 33/3, Kunthur-24 (field tolerance to tea mosquito bug) and susceptible check were screened by preferential feeding method. For which, the tender portion (terminal portion) of shoot of grafts of different accessions (6-8 Nos.) including Kunthur-24 and susceptible check were confined together in a single cage. Two fourth instar nymphs were transferred to each graft with an idea that atleast one nymph will always be available for feeding on each graft. The feeding period was restricted for 48 hours and each set was replicated four times.

Out of 20 varieties/accessions screened, no variety/accession has shown any resistant/moderately resistant reaction to tea mosquito bug (Table 2.30). However, six varieties/accessions viz., Vengurla-1 and 3, Bapatla-2 and 3, VTH 107/3 and M 68/1 had shown moderately susceptible reaction.

Table 2.30 Laboratory screening of cashew varieties/accessions for resistance to tea mosquito by preferential feeding method (@ two-fourth instar nymphs/graft and feeding period 48 h).

Accession No./ variety	Shoot damage score (0-4 scale)*	Midrib damage score (0-9 scale)*	Laminar damage score (0-9 scale)*
Vengurla-1**	3.0	4.0	2.7
Vengurla-2	4.0	5.8	1.9
Vengurla-3**	2.5	3.8	2.0
Vengurla-4	3.8	4.5	1.7
Vengurla-5	3.8	5.7	3.3
Bapatla-1	3.3	3.9	2.1
Bapatla-2**	2.8	3.7	2.8
Bapatla-3**	2.8	2.8	1.7
Bapatla-4	3.5	4.8	2.0
Ullal-1	3.5	4.0	2.9
Bla-139-1	4.0	7.0	3.8
VRI-1	3.8	5.4	3.3
VRI-2	3.8	5.2	2.1
VTH-107/3**	3.0	4.2	1.8
M 45/4	3.3	5.7	2.1
M 7/1	4.0	6.4	3.2
M 68/1**	3.0	3.9	1.8
M 26/2	3.3	5.0	3.7
M 33/3	3.8	4.0	2.2
Kunthur-24	3.5	4.5	2.1
Susceptible check	3.5	3.5	2.0

* Reactions	Damage score on shoot	Damage score on midrib
Resistant	0.1-1.0	0-1
Moderately resistant	1.1-2.0	2-3
Moderately susceptible	2.1-3.0	4-6
Susceptible	3.1-4.0	7-9

** Accession with Moderately susceptible reaction

In the second experiment, four month old grafts of seven varieties/accessions viz., Bapatla-1, 2, 3 and 4, Ullal-1, Kunthur-24 and susceptible check were screened by using first instar nymphs/graft with a feeding period for six days. The experiment was replicated for four times. The observations indicated that no mortality of nymph was noticed after six days of feeding and also given indication about the absence of any non-preference or antibiosis mechanism. All varieties were found to be susceptible except Bapatla-2 which has shown moderately susceptible reaction (Table 2.31).

Table 2.31. Laboratory screening of cashew varieties/accessions to tea mosquito bug by preferential feeding method (@ 2 first instar nymphs/graft and feeding period for six days).

Accession No. / variety	Shoot damage score (0-4 scale)	Midrib damage score (0-9 scale)	Laminar damage score (0-9 scale)
Bapatla-1	3.3	4.9	3.6
Bapatla-2	2.5	3.7	3.3
Bapatla-3	3.5	5.1	3.5
Bapatla-4	3.5	5.0	5.1
Ullal-1	3.3	4.0	4.0
Kunthur-24	4.0	5.2	4.9
Susceptible Check	3.5	5.1	4.6

Reactions	Shoot damage score	Midrib damage score
Resistant	0.0-1.0	0-1
Moderately resistant	1.1-2.0	2-3
Moderately susceptible	2.1-3.0	4-6
Susceptible	3.1-4.0	7-9

In the third experiment, two-year old grafts of four field tolerant accessions collected from Goa were screened. Two accessions per cage were screened. The two-fourth instar nymphs/graft were fed for 48 hours. It was replicated two times. Among them, Goa-11 has shown reaction ranging from moderately resistant to moderately susceptible reaction (Table 2.32) which will be confirmed again in future studies with fresh new grafts.

Table 2 32. Laboratory screening of field tolerant accessions of Goa to tea mosquito bug by preferential feeding method (@ two-fourth instar nymphs/graft and feeding period for 48h).

Accession No	Shoot damage score* (0-4 scale)	Midrib damage score (0-9 scale)	Laminar damage score (0-9 scale)
Goa-17	3.0	4.1	3.2
Goa-11	2.0	4.3	1.4
Gos-2	3.5	4.7	1.0
Goa-11	1.5	3.0	0.6
Goa-12	2.5	3.6	2.0
Goa-11	1.0	5.2	2.2

Reactions	Shoot damage score	Midrib damage score
Resistant	0.0-1.0	0-1
Moderately resistant	1.1-2.0	2-3
Moderately susceptible	2.1-3.0	4-6
Susceptible	3.1-4.0	7-9

SUPPORTIVE PROGRAMME

The maximum percentage of success with soft-wood grafting has been recorded in the month of September (82.3%). A total of 40 officials from different State organisations and farmers underwent training on Cashew Production Technology and Vegetative Propagation. During the 1988 planting season, 18,489 cashew grafts have been distributed of which 12,194 grafts among farmers and 6295 among government agencies. During the period, 25,000 grafts have been made for distribution for 1989. Twenty cashew demonstration plots have been established in collaboration with Directorate of Cashew Development, Cochin in Puttur and Belthangady taluks of Dakshina Kannada. Soft wood grafts of released varieties were planted in these plots.

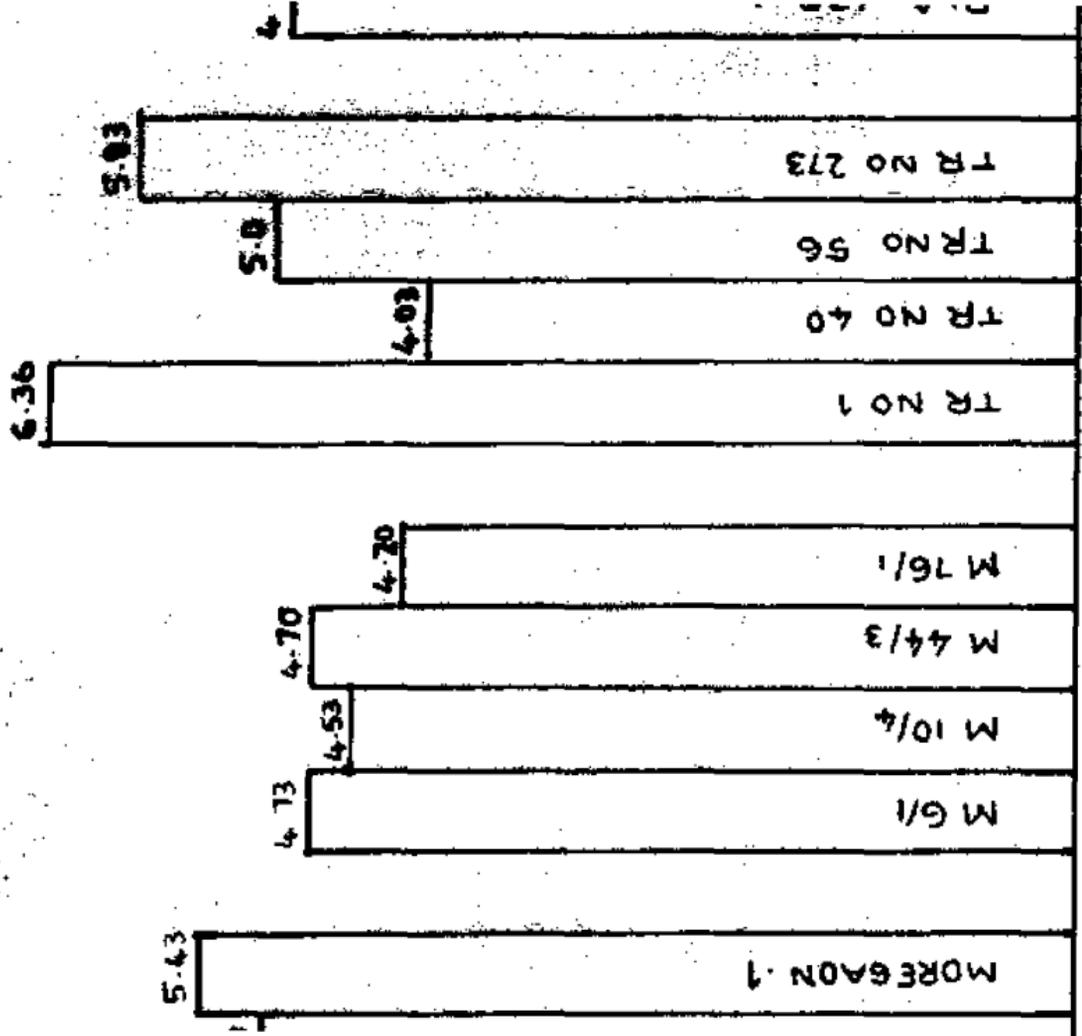


Table 4.8. Flowering, apple and nut characters of cashew types in CYT at Vital.

Season	Season of flowering	Duration of flowering	Apple colour	Apple shape	Apple: nut ratio	Average wt./nut (g)	Shelling %	Kernel count
Ansur-1	Mid Nov-Dec.	Long	Yellow	pear	10.0:1	4.9	23.9	390
Vetore-56	Mid Nov-Dec.	Medium	Yellow	pear	9.0:1	5.2	24.4	373
WBDC-V	Mid Nov-Dec.	Long	Red	pear	12.5:1	4.7	27.0	333
Moregaon-1	Mid Nov-Dec.	Long	Yellow	pear	8.8:1	4.8	25.4	436
M 6/1	Mid Nov-Dec.	Long	Yellow	pear	6.9:1	4.9	26.0	355
M 10/4	Mid Nov-Dec.	Medium	Yellow	pear	8.0:1	5.0	26.8	348
M 44/3	Mid Nov-Dec.	Medium	Yellow	pear	7.1:1	5.1	28.9	316
M 76/1	Mid Nov-Dec.	Medium	Yellow	pear	7.6:1	4.6	24.7	400
Tr. No. 1	Mid Nov-Dec.	Medium	Yellow	pear	8.3:1	5.2	25.3	339
Tr. No. 40	Mid Nov-Dec.	Long	Yellow	pear	9.3:1	4.8	26.4	336
Tr. No. 56	Mid Nov-Dec.	Long	Yellow	pear	8.0:1	5.5	24.3	328
Tr. No. 273	Mid Nov-Dec.	Medium	Yellow	pear	8.0:1	5.2	26.5	313
Bla-139-1	Mid Nov-Dec.	Medium	Yellow	pear	7.4:1	4.9	25.5	334
Bla-256-1	Mid Nov-Dec.	Long	Yellow	pear	9.6:1	5.3	23.9	350
Bla-266-1	Mid Nov-Dec.	Long	Yellow	pear	8.6:1	4.4	26.2	379
H-3-17	Mid Nov-Dec.	Long	Pink	pear-long	11.2:1	5.6	24.3	320

*Long = 80 days Medium = 61.8 days

for height, girth and spread characters. In contrast to this, T. No. 1 of Bapatla was tallest having a very large canopy. With regard to other desirable characters M 44/3 and M 10/4 of Vridhachalam had a lower percentage of non-fruiting laterals and a higher fruitset/bunch.

The flower, fruit and nut characters recorded are presented in Table 4.8. The varieties were found to vary less for flowering and nut characters and more for fruiting characters. All the varieties in the trial exhibited midseason (November-December) flowering except for M 10/4, M 44/3 and Bla 139-1 which were slightly earlier than others. In duration, majority of varieties under Vridhachalam were medium, while Anakkayam and Vengurla types were of longer duration types. The apple colour was predominantly yellow in most of the varieties except in WBDC-V and H-3-17 where it was red and pink respectively. Similarly, the shape of the apples were pear except H-3-17 where it was pear-long. In size, apples of Ansur-1 and WBDC-V of Vengurla were bigger (apple to nut ratio, 10:1). The nut size was uniformly medium (4.4 to 5.5g) in most of the varieties. The shelling percentage was also medium ranging from 23.9 to 28.9% and kernel count was higher varying from 313 to 436 per pound.

The varieties started bearing just after 1-2 years of planting. M 6/1 and M 44/3 of Vridhachalam and T.No. 56 of Bapatla were first to flower and fruit thus indicating precocity in these varieties. In contrast to this, T.No.1 of Bapatla and Bla-256-1 of Anakkayam started flowering and fruiting only after 3-4 years of age. Here the juvenile phase was found to be longer than other varieties. Varieties started bearing regularly from 1976 onwards. The yield data collected for last 11 years (1977-88) both cumulative and recent year yield data (1987) is presented in Table 4.9. The varieties evaluated on the completion of 15 years of orchard life, both on cumulative yield and on individual year yield basis, the two varieties of Vridhachalam, M 10/4 and M 44/3 were found to be high yielding with a cumulative yield of 45.3 and 41.6 kg/plant respectively (4.1 and 3.8 kg/plant/year respectively). Even during 1987 they gave significantly higher yields than others (7.5 and 6.0 kg/plant respectively). Apart from having a high yielding ability, these varieties had other desirable characters like dwarfing habit, low number of non-fruiting laterals and higher fruit-set (Table 4.7), which makes them far superior to others. These varieties had similarly performed better in other centres (Vengurla and Vridhachalam). Because of stable performance and wide adaptability these two varieties have been recommended for large scale adoption in the field. Out of these M 44/3 is also recommended for cultivation through seeds mainly because of its prepotent nature. Among the other types which performed well under the trial are T. No. 1 of Bapatla, Moregoan-1 of Vengurla and Bla-139-1 of Anakkayam.

Table 4.9. Performance of cashew types in the comparative yield trial at Vittal.

Variety	VTH No.	Source	Period:1977-87 Cum. Yld./plant (kg)	Mean yield/ plant (kg)	1987 Mean yield/ plant (kg)
Ansur-1	1	Venguria	16.75	1.52	2.47
Vatore-56	2	Venguria	25.32	2.30	3.90
WBDC-V	3	Venguria	24.29	2.21	3.37
Moregoan-1	4	Venguria	32.64	2.97	3.55
M 6/1	10	Vridhachalam	31.94	2.90	4.65
M 10/4	11	Vridhachalam	45.34	4.12	7.46
M 44/3	12	Vridhachalam	41.64	3.79	5.97
M 76/1	13	Vridhachalam	29.38	2.67	3.34
T. No. 1	34	Bapatla	35.18	3.20	5.54
T. No. 40	35	Bapatla	24.65	2.24	4.21
T. No. 56	36	Bapatla	19.84	1.74	3.61
T. No. 273	37	Bapatla	22.97	2.07	3.44
Bla-139-1	150	Anakkayam	28.65	2.60	2.40
Bla-256-1	151	Anakkayam	24.33	2.21	2.36
Bla-266-1	152	Anakkayam	16.86	1.53	3.38
H-3-17	153	Anakkayam	22.20	2.02	3.17
Mean			27.61	2.52	3.95
CD at p=0.05			14.36	1.31	2.48

Conclusions

Among the 16 cashew types tested for their performance in a comparative yield trial at Vittal, since 1972, the varieties of Vridhachalam origin particularly M 10/4 and M 44/3 were found to be high yielding and possessing desirable characters like dwarfing habit, low number of non-fruiting laterals and a higher fruit set. Hence, these two varieties have been recommended for large scale adoption.

GENERAL INFORMATION

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Scientist S-2 (Soil Science)

Vacant

Scientist S-2 (Statistics)

Shri S. Bhagavan, M. Sc.

(upto September 1988)

TECHNICAL

Farm Superintendent

Shri E. Mohan, M. Sc. (Ag.) T-6

Farm Superintendent

Sri B. Nagaraja, B. Sc. (Ag.) T-6

Technical Information Officer

Dr K. Palanisamy, Ph. D.

ADMINISTRATION

Asst. Administrative Officer

Ms. Jane Frances Mary Lewis

Asst. Accounts Officer

Vacant

Office Superintendent

Shri A. Keshava Shabaraya

Participation in Symposia/Conferences

1. National Group meeting on Production and Generation of Planting materials in Plantation Crops.	EVVB Rao Room Singh	14 Jan
2. Entomology Group discussion at Cashew Research Station (KAU), Madakkathara.	EVVB Rao D. Sundararaju	4 Feb
3. 13th Indian Cashew Development Council Meeting at Directorate of Cashewnut Development, Cochin.	EVVB Rao	5 Feb
4. Annual Research Council Meeting of NRC-Spices at Calicut.	EVVB Rao	8-9 Feb
5. Review Meeting of Union Minister for Finance & Commerce, Government of India, New Delhi on Cashew Research Programmes, Achievements and Thrust.	EVVB Rao	28 Feb
6. Directors/Project Co-ordinators Conference at Indian Institute of Horticultural Research, Bangalore.	RC Mandal EVVB Rao	8-11 Apr
7. ICAR Regional Committee No. VIII meeting at CIFT Cochin.	EVVB Rao	16-17 Aug
8. National Symposium on Coconut Breeding and Management at KAU, Trichur.	EVVB Rao	23-26 Nov
9. District Conference on Increasing Cashew Production & Productivity in Dakshina Kannada, CPCRI, Regional Station, Vittal.	RC Mandal EVVB Rao PM Kumaran N Yadukumar KV Nagaraja Thimmappaiah KRM Swamy D. Sundararaju	15 Nov
10. PLACROSYM VIII at Cochin.	RC Mandal EVVB Rao PM Kumaran KRM Swamy N. Yadukumar Thimmappaiah D. Sundararaju E. Mohan KV Nagaraja	28 30 Dec
11. Sub Group Meeting on Spices & Cashew at Cochin.	EVVB Rao	29 Dec

RESEARCH PUBLICATIONS

1. Bhagavan, S. and Kumaran, PM (1988). Yield and yield attributes in cashew- An analysis through multivariate approach. PLACROSYM VIII 28-30 Dec 1988, Cochin, Kerala.
2. BHASKARA RAO, EVV (1988). CASHEW In: Fruits: Tropical and Sub-Tropical (Ed. TK Bose) (In press).
3. BHASKARA RAO, EVV (1988). Cashew Research-Programmes, Achievements and Thrust. The Cashew, Oct-Dec 1988.
4. BHASKARA RAO, EVV, PILLAI, RV and JACOB MATHEW (1988). Relative Drought Tolerance and Productivity of Released Coconut Hybrids. Paper presented at National Symposium on Coconut Breeding and Management, Kerala Agricultural University, 23-26 Nov 1988.
5. BHASKARA RAO, EVV (1988). Future Strategies for Development of Cashew in Dakshina Kannada District. Paper presented at District Conference on Increasing Production and Productivity of Cashew in DK District, CPCRI, Vittal 15 November 1988.
6. PILLAI, RV, BHASKARA RAO, EVV and KUMARAN, PM. (1988). Characterisation of coconut cultivars. Paper presented in the Symposium on Coconut Breeding and Management, KAU, Vellanikkara 23-26 November 1988.
7. SWAMY, KRM and THIMMAPPAIAH (1988). Variability in cashew germplasm collection and effects to characterise them, PLACROSYM VIII, 28-30 Dec 1988, Cochin, Kerala.
8. NAGARAJA, K.V. (1988). Biochemical characterisation of root region soils from Areca based cropping systems, Curr. Sci. 57, 1078-1079.
9. ANNAPOORNA RAI, K. and NAGARAJA, K.V. (1988). Tea mosquito (*Helopeltis antonii*) induced biochemical changes in cashew (*Anacardium occidentale*). Cashew Bulletin, XXV No. 1&2, 8-11.

TECHNICAL REPORTS/PUBLICATIONS

1. Report on CASHEW RESEARCH: PROGRAMMES, ACHIEVEMENTS & THRUST, Submitted to Hon. Union Minister for Finance & Commerce, New Delhi, 28 Feb-2 Mar. 1988.
2. Report on CASHEW for the Proceedings of Group Meeting on Production and Generation of Planting Materials in Plantation Crops, CPCRI, Kasaragod, Jan. 1988.
3. Proceedings of Entomology Group Discussion held at Cashew Research Station, Madakkathara, 4 Feb. 1988.

DETAILS OF IMPORTANT VISITORS

Date of visit	Name and Address
20 Jan 1988	Dr KL Chadha, Deputy Director General (Hort.) ICAR, New Delhi.
23 Feb 1988	Dr V Rajagopalan, Vice Chancellor, TNAU Coimbatore.
20 Jul 1988	GS Achar, MLA, Byndoor, Karnataka.
20 Jul 1988	B Narayana Nayak, Ex-MLC & President, Dakshina Kannada Krishik Samaj, Mangalore - 3.
8 Aug 1988	Dr LN Mandal, Professor BCKV, Katyani. Member QRT
25 Oct 1988	UV Biet Linh, Director of FRT, NPD of Cashew. Project/UNDP-FAO, Vietnam. Visit of Vietnam Scientists of Cashew Study Tour to India
25 Oct 1988	Nguyen Man, DP, NPD, Vietnam.
25 Oct 1988	NGO Twan Ky, FRI, Vietnam.
25 Oct 1988	Hoang Huv Moai, DP, NPD, Vietnam.
25 Oct 1988	Noang Tuyen Minh, Expert of State Committee for Science and Technology, Vietnam.
28 Dec 1988	Philip Jacob, Department of Agronomy, Allahabad Agricultural University, Allahabad. With other eight Post-graduate students on Study Tour

CROP MANAGEMENT : A. AGRONOMY

In NPK trial, application of 1000g N, 250g P and 250g K ($N_2P_2K_2$) per tree per year gave the highest nut yield (11.34kg) compared to the control at Chintamani. Foliar application of urea with 2 per cent insecticides recorded the maximum nut yield of 8.26kg/plant at Bhubaneswar.

In spacing trial, the maximum yield/plant and yield/block were recorded in 10m x 5m rectangular system with no thinning of plants and 6m x 6m x 6m triangular system at Jhargram centre, respectively.

In cashew based cropping system trial at Bapatla, cluster bean and cowpea gave an yield of 1094kg/ha and 125kg/ha, respectively whereas, horse gram and sesamum did not perform well.

CROP MANAGEMENT : B. NUTRITION

Soft wood grafting was found to be the most successful method for vegetative propagation of cashew. The percentage of graft success ranged between 71.7 to 83.0 per cent during January, February and September at Bapatla; 72.0 to 77.0 per cent (July-September) at Bhubaneswar; 60.0 per cent (October and November) at Chintamani; 49.0 to 59.0 per cent (June, August and September) at Jhargram; 60 to 73 per cent (January, February and July) at Vridhachlam.

A good graft success in top working was obtained at Bapatla (80.0%) and Bhubaneswar (73-80%) centres. In top worked trees with scions of V-4 at Vengurla, an average of 8.64/kg nuts/tree and maximum yield of 14.78kg nuts/tree was recorded.

Screening of vigorous and less vigorous cashew types at Madakkathara revealed the possibility of identifying the less vigorous from the more vigorous using morphological characters at the seedling stage. At Vengurla growth analysis of 17 rootstocks is in progress.

CROP PROTECTION

Spraying of monocrotophos (0.05%), endosulfan (0.05%) and carbaryl (0.1%) at new flushing, panicle emergence and fruiting stage was found to be superior over other treatments in controlling tea mosquito bug at Chintamani and Bapatla centres whereas, spraying of monocrotophos (0.05%) at flushing and endosulfan (0.05%) at flowering stage at Vengurla and endosulfan (0.05%) at flowering and carbaryl (0.1%) at fruiting at Madakkathara were found to be superior.

In the trial on control of foliage/inflorescence pests of cashew with neem products, neem cake extract (2%) at Bapatla was found to be effective.

At Bapatla and Madakkathara neem oil (5%) swabbing upto 1m height from the base of the trunk acted as a good prophylactic measure upto 90 days for stem and root borer. Neem oil + Sevidol 4g at Bhubaneswar and Sevidol 4g (50g/tree) at Jhargram were found to be effective against stem and root borer.

In the survey for pest incidence in Andhra Pradesh, incidence of tea mosquito noticed was confined mostly to the northern coastal districts and stem borer to coastal sandy soils. Mild to moderate incidence of tea mosquito bug was prevalent at Bhubaneswar. In Jhargram the survey revealed leaf and blossom webber, leaf miner

and inflorescence thrips was more severe than tea mosquito in cashew growing tracts of West Bengal. The important predators noticed on cashew inflorescence in unsprayed area were the spiders, mirid bugs and *Chrysopa* larvae at Madakkathara.

Screening of germplasm to locate tolerant/resistant types to major pests of the region has been carried out. V-5 showed the

least infestation for shoot tip caterpillar at Bhubaneswar. Twentyone accessions namely, BZL-120, BZL-239, BZL-244, Anakayam-1, Madakkathara-1, K-22-1, H-3-13, H-3-17, H-680, H-682, H-719, H-1596, H-1597, H-1598, H-1600, H-1602, H-1608, H-1610, M-1-2, A-26-2 and K-16-1 at Madakkathara were found to be comparatively less susceptible to tea mosquito infestation during fourth year of planting.

STAFF OF THE INSTITUTE

(As On 31-03-1995)

Managerial

Director

Dr. MK Nair, Director
CPCRI, Kasaragod
(Additional charge)

Project Coordinator
(Cashew)

Dr. EVV Bhaskara Rao, Ph.D.
Project Coordinator-(Palms)
(Additional charge w.e.f. 14.11.94)

Scientific

Agronomy

Principal Scientist

Vacant

Scientist

Sri N Yadukumar, M.Sc. (Agri.)
Scientist SG

Plant Breeding

Principal Scientist

Vacant

Senior Scientist

Dr. PM Kumaran, Ph.D
(Relieved on 20.5.94)

Senior Scientist

Dr. MG Bhat, Ph.D.
(From 13.5.94, and
Scientist in-charge from 1.10.94)

Horticulture

Principal Scientist

Vacant

Senior Scientist

Dr. KRM Swamy, Ph.D

Scientist

Sri M Gangadhara Nayak, M.Sc. (Agri.)

Scientist

Vacant

Entomology

Senior Scientist

Sri D Sundararaju, M.Sc. (Agri)
Scientist (SG) (On study leave)

Scientist

Sri P. Shivarama Bhat, M.Sc. (Agri)

Scientist

Dr TN Raviprasad, Ph.D

Biochemistry
Senior Scientist

Dr. K V Nagaraja, Ph.D.
(Scientist in-charge till 30-9-1994)

Soil Science

Scientist

Vacant

Plant Physiology

Scientist

Vacant

Statistics

Scientist

Vacant

Genetics and Cytogenetics

Senior Scientist

Sri Thimmappaiah, M.Sc. (Agri.)
Scientist (SG)

Scientist

Ms Shirley Raichal Samuel, M.Sc.
(From 24.8.94)

**Agricultural Structures
and Process Engineering**

Scientist

Sri D Balasubramanian, M.Tech.,
(From 03-8-94)

Agricultural Extension

Scientist

Dr Sreenath Dixit, Ph.D.

Technical

Farm Superintendent

Sri B Nagaraja, B.Sc. (Agri.) T-6

Farm Superintendent

Sri K Lakshminarayana, B.Sc. (Agri.) T-6

Technical Information
Officer

Dr (Ms) Uma Jayaraman, Ph.D., T-6

Administration

Assistant Administrative
Officer

Sri Ajit Kumar Bolur
(From 22.10.93)

Assistant Finance and
Accounts Officer

Sri A Keshava Shabaraya

Office Superintendent

Sri K Sanjeeva
(From 16.9.94)

INSTITUTE JOINT COUNCIL

OFFICIAL SIDE

Dr. MK Nair	Chairman
Dr. PM Kumaran	Member (Till 20-5-94)
Dr. KV Nagaraja	Member
Sri M Gangadharan Nayak	Secretary
Sri A Keshava Shabaraya	Member
Sri Ajit Kumar Bolur	Member

STAFF SIDE

Sri MS Sathyanarayana	Secretary
Sri KR Padmanabhan Nair	CISC Member
Sri P Ravindran	Member
Sri B Ramaprasad	Member
Sri K Balappa	Member
Sri P Krishnappa Poojary	Member

PARTICIPATION IN SYMPOSIA/CONFERENCES/TRAININGS

Training course on Pesticide Residue Analysis, CPPTI, Hyderabad

TN Raviprasad

1 Jun to 31 Aug 1994

National Workshop on non-pesticidal approach to pest management - A new direction, NAARM, Hyderabad

PS Bhat

20-22 Sep 1994

International symposium on plantation crops PLACROSYM XI, Calicut

MG Bhat

KV Nagaraja

N Yadukumar

KRM Swamy

PS Bhat

TN Raviprasad

30 Nov to 3 Dec 1994

National Workshop on Man-power development, in extension education, NAARM, Hyderabad

Sreenath Dixit

13-16 Feb 1995

DBT sponsored short term training course on "Application of tissue culture technology for micropropagation and regeneration of agroforestry species" at CAZRI, Jodhpur

Shirly R Samuel

20 Feb 11 Mar 1995

RESEARCH/POPULAR PUBLICATIONS

Nagaraja, K.V., Bhavanishankar Gowda, P.V., Venugopal Krishna Kurup, V., and Joy N. John., 1994. Biochemical changes in cashew in relation to infestation by tea mosquito bug. **Plant Physiol & Biochem** 21(2) : 91-97.

Nagaraja, K.V., 1994. Utilisation of cashew apple. **Cashew Day Souvenir**, OUAT., Dec, 1994.

Swamy, KRM. 1994. Nursery management in cashew. **Cashew Day Souvenir**, OUAT, Dec, 1994.

Yadukumar, N., Nagaraja, B., and Dixit, S., 1994. Pineapple as an intercrop with cashew. **SAIC Newsletter**. 4:(2)P.6.

PAPERS PRESENTED IN SYMPOSIA/WORKSHOP

Bhat, P.S., and Raviprasad, T.N., 1994. Pathogenicity of entomopathogenic fungi against cashew stem and root borer *Flocacderus ferrugineus* Linn. (Coleoptera : Cramblycidae) In International Symposium on plantation crops (PLACROSYM XI). November 30-3, December 1994, Calicut, India.

Bhat, P.S., Sundararaju, D., and Raviprasad, T.N., 1994. Evaluation of some plant products against tea mosquito bug *Helopeltis antonii* Sig., a serious pest of cashew. In National Workshop on non-pesticidal approach to pest management- A new direction. September 20-22, 1994 at NAARM, Hyderabad.

TECHNICAL REPORTS/BULLETINS/COMPENDIA

1. NRCC Annual Report 1993-94, September 1994, pp. 107. (Compiled and edited by KV Nagaraja, Sreenath Dixit and Uma Jayaraman)
2. All India Coordinated Research Project on Cashew. Annual Report 1993-94, November 1994, pp. 122. (Compiled and edited by EVV Bhaskara Rao, KV Nagaraja and Uma Jayaraman).
3. NRCC Research Highlights 1994-95, March 1995, 16 pp. (Compiled and edited by KV Nagaraja and Sreenath Dixit).

RADIO TALKS DELIVERED

1. Cashew Research and Development activities at NRCC, Puttur-Interview with KV Nagaraja, broadcast from All India Radio, Mangalore on 20 July 1994.
2. Intercropping and its importance in cashew plantation - Interview with N Yadukumar, broadcast from All India Radio, Mangalore on 8 August 1994.
3. Pruning in cashew - Interview with M Gangadhara Nayak, broadcast from All India Radio, Mangalore on 15 January 1995.
4. Plant protection in cashew - Interview with TN Raviprasad, broadcast from All India Radio, Mangalore on 2 February 1995.
5. Advantages of tissue culture and its importance - Interview with Thimmappaiah, broadcast from All India Radio, Mangalore on 15 February 1995.
6. NRCC in the service of cashew development - Interview with Sreenath Dixit, broadcast from All India Radio, Mangalore on 23 February 1995.
7. Cashew varieties for coastal region and their characteristics-Interview with KRM Swamy, broadcast from All India Radio, Mangalore on 28 February 1995.

BOOKS/CHAPTERS

1. Bhaskara Rao, EVV and Swamy, KRM., 1994. Genetic resources of cashew. In : *Advances in Horticulture vol. 9 - Plantation and Spice Crops part-1* (Eds. KL Chadha and P Rethinam), Malhotra Publishing House, New Delhi. pp. 79-97.
2. Swamy, KRM., 1994. Vegetative propagation in cashew. In: *Advances in Horticulture, Vol. 10 - Plantation and Spice Crops part-2.* (Eds. KL Chadha and P Rethinam), Malhotra Publishing House, New Delhi. (November 1994). pp.

IMPORTANT VISITORS

- 03 May 1994 Dr. S.R. Sreerangaswamy, Professor & Head, Centre for Plant Molecular Biology, TNAU, Coimbatore - 641 005.
- 29 Dec 1994 Dr. M.V.R. Prasad, Director, Directorate of Oil Seeds Research, Hyderabad - 500 030.
- 30 Dec 1994 Prakash S Velip, MLA and Chairman of Adarsh Krishi Kharidi Vibhi Prakriya Sahakari Saunstha, Maryadit, Bendurde Balli, Goa.

WEATHER DATA 1994-95

Month	Temp. (°C)		Humidity		Total Rainfall (mm)	Rainy days	Sun shine (MRS)	Evapora- tion (mm)	Wind Velocity (Km/hr)
	Max.	Min.	FN	AN					
Apr	34.8	23.9	90	49	152.20	9	9.1	5.9	1.4
May	35.6	24.4	89	59	156.60	11	7.4	5.6	1.8
Jun	28.1	23.0	96	91	1431.0	27	1.1	1.6	1.5
Jul	27.3	22.5	97	90	1846.5	35	0.4	3.3	1.8
Aug	28.3	23.5	96	79	549.60	25	2.0	2.9	1.3
Sep	30.4	22.3	94	64	183.00	14	5.7	3.5	0.6
Oct	31.8	22.4	96	68	557.90	23	5.2	2.8	0.3
Nov	*	21.0	79	43	004.70	2	8.5	4.5	1.2
Dec	*	17.9	82	38	000.00	0	9.9	4.5	1.3
Jan	*	19.6	93	44	000.20	1	9.3	4.7	0.5
Feb	*	20.6	92	39	000.00	0	10.5	5.6	0.2
Mar	*	21.7	90	44	000.00	0	9.8	6.4	0.02
Total					4881.7				

*Not available