ANNUAL REPORT 1992-'93

NATIONAL RESEARCH CENTRE FOR CASHEW
(Indian Council of Agricultural Research)
PUTTUR 574 202, DAKSHINA KANNADA
Karnataka INDIA

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A promising germplasm collection

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DIRECTOR'S INTRODUCTION

National Research Centre for Cashew was established in April 1986 at Puttur, Dakshina Kannada District, Karnataka. This Research Centre also serves as headquarters for All India Coordinated Research Project on Cashew which is currently having seven centres functioning under State Agricultural Universities in different states.

LOCATION

The headquarters of National Research Centre for cashew is located 5 Km away from Puttur town (12.45' N latitude and 75.42' E Longitude) and is about 90m above MSL. It is contemplated to acquire a total area of 69.02 ha of land for laying out field experiments at Puttur, out of which 66 ha has been acquired.

Besides the main campus at Puttur, an Experimental Station at Shathigodu, which is 13 km away from the main campus also forms part of this Research Centre. This Experimental Station was started as Cashew Seed Farm under Central Plantation Crops Research Institute in the year 1972. Presently, Entomology laboratory is located at this Experimental Station.

MANDATE

The National Research Centres are conceived with the idea of undertaking mission oriented research projects. The mandate of the National Research Centre for Cashew is as under :

* Evolving high yielding varieties of cashew and breeding varieties for resistance/tolerance to pest such as tea mosquito.

* Evolving varieties with high protein, lysine and other biochemical parameters.

* Standardization of agrotechniques for achieving higher production and productivity with sustainability in view.

* Transfer of technology to farmers and extension

agencies on improved production techniques through training, demonstration and extension literature.

STAFF AND BUDGET

While establishing National Research Centre for Cashew, Puttur, 62 posts (14 Scientific; 9 Technical; 6 Administrative; 2 Auxiliary; 31 Supporting staff) were deployed from CPCRI. During VII plan period, additional 14 posts (1 Scientific; 5 Technical; 2 Administrative; 1 Auxiliary and 5 Supporting Staff) were sanctioned. During 1990-91, six more scientific posts were deployed from CPCRI. During VIII plan period an additional 34 posts have been sanctioned which brings the total staff component to 116. A total of 68 posts have been filled up. The sanctioned budget for the financial year 1992-93 was :

	Allocation (Rs in lakhs)	Expenditure (Rs in lakhs)
Non Plan	32.50	32.43
Plan	73.00	72.98
AP Cess Fund	0.97	0.30
Revolving Scheme	2.10	2.08

RESEARCH ACTIVITIES

Research Projects of this Research Centre have been organised into Crop Improvement, Agrotechniques, Crop Protection, Quality Analysis and Post-Harvest Technology and Transfer of Technology. Besides Research Projects under these heads, an AP Cess Fund project on "Screening and biochemical evaluation of cashew germplasm in relation to tea mosquito infestation" and a Revolving Fund for production of grafts are also in operation. Salient results in different research projects are as under.

Crop Improvement : Research projects pursued under this have a common objective of evolving varieties with high yield coupled with better quality and multiple pest resistance. These objectives are contemplated to be achieved through germplasm collection, varietal improvement and screening and identification of varieties for tea mosquito tolerance.

A total of 24 trees were identified for desirable characters such as bold nuts, cluster bearing habit, low apple to nut ratio, big apple, medium dwart plant habit and spreading

habit from Orissa, Karnataka and Kerala. Sixteen clonal accessions have been planted in the National Cashew Gene Bank bringing the total number of accessions planted so far to 285. Under progeny trial-I, the combination H-10 (M 37/3xT.No.1) performed better in all the replications with an yield of 8 kg/tree/year. Among the selfed lines in progeny trial-II, maximum yield of 6.5 kg/tree/year was recorded in S-16(M 16/1xM 16/1). Among the 15 cross combination in progeny trial-III the highest mean yield (7.5 kg/tree/year) was recorded in H-20 (BLA 139/1xM10/4). Based on yield, a total of eight individual trees have been identified from three progeny trials. A total of 121 hybrid seedings of the five cross combinations of the previous have been planted to improve the nut size in released varieties. A new trial with seven hybrids and three selections has been laid out. In the maximisation of yield plot, performance of M44/3 was better than M 10/4. Bud proliferation from cotyledonary nodes was best (6-9 buds/explant) in MS supplemented with BA at 0.5-1.0 mg/l concentration. Initiation of nodal cultures from 1-2 month old seedlings was best in MS media supplemented with BA + Kn (5mg each) + IBA (0.5-3.0mg/l). Callus initiation in shoot and leaf sections excised from young seedlings has been achieved on MS medium supplemented with 2,4-D and BA.

Leaf peroxide, and shoot lignin tend to increase during infestation by tea mosquito. Leaf lipids undergo changes during infestation. Starch and sugar content in the leaf of cotton, neem and henna increased during infestation. Infestation resulted in increased shoot lignin content in all the host plants studied. Matured shoots were least preferred by tea mosquito for oviposition and survival. Tender shoot is the most preferred by tea mosquito for its multiplication although it lays eggs on tender shoots, green shoots and matured shoots.

Agrotechniques : Research projects under Agrotechniques programme contemplate to enhance the production of existing gardens by developing suitable orchard management practices. Research projects on nutritional aspects, cropping systems and orchard management are being pursued.

In an experiment on response of high yielding varieties

of cashew to different levels of N, the mean yield increased with increased application of N from 250g to 750g/tree/year.

Cumulative yield data also revealed linear response to N application. The yield of variety M 6/1 was higher both in seedlings and grafts. Different irrigation treatments affected the morphological characters. Soil moisture status under different irrigation treatments has been assessed. Growing acacia, casuarina and subabul with cashew upto five years affects adversely the growth of cashew. Measurements on photosynthetic parameters like Pn, E, WUE, Gs have also indicated that growing acacia adversely affects the growth of cashew. Highest yield was realised from plot intercropped with pineapple while plot intercropped with acacia yielded lowest. During initial three years, forest trees did not adversely affect the growth of cashew. In the experiment on cashew with fruit crops, custard apple, ber and garcinia are not getting established. Growth characters like height, girth and ground coverage were affected by the plant density in an experiment on high density planting of cashew. Maintaining the plant density of 625 trees/ha continued to yield higher compared to other treatments. Off season grafting can be successfully carried out with green scion of about 60 days during flushing, flowering/fruiting period. Similarly, decapitated flowered lateral shoots of 2.5 to 3 months could be successfully grafted. *Mangifera indica*, *Buchanama lanzan*, *Holigrana* sp and *Semecarpus anacardium* are not graft compatible with cashew. The cost of establishment and maintenance of top worked plot and replanted plot during the first three years was Rs. 15205 and Rs. 9790/ha respectively. An 'On Farm Trial' of top working has been initiated in KCDC plantation at Kunthur. Pruned trees continued to yield higher than unpruned trees. Paddy coleoptile bioassay for IAA has been standardised. A new trial to understand the basic aspects of pruning has been initiated.

Crop Protection : Research projects in Crop Protection programme attempt to develop integrated pest management packages against stem and root borers and effective chemical and biological control of tea mosquito and other sucking pests.

Prophylactic control trial against stem and root borer

(Plocaederus ferrugineus) was repeated at three months interval and after completion of four rounds, lowest infestation of four per cent was noticed in neem oil and coal tar+diesel (1:2) treatments. The entomopathogenic fungi *Beauveria bassiana, B. brongniarti* and *Metarhizium anisopliae* brought mycosis in grubs of stem borer with mortality of 90 per cent, 50 per cent and 40 per cent respectively when the spore suspension was applied under laboratory condition.

Among three alternate hosts tried for tea mosquito bug *(Helopeltis antonii)* egg parasitoid *Telenomus* sp emergence was noticed in the case of *H. theivora*. In field condition, parasitization by *Telenomus* was observed throughout the year. The population and damage were observed at weekly intervals to develop economic threshold for this pest.

Among the various plant products tested against tea mosquito bug, only pongamia oil emulsion in water had high knock down mortality of 90.8 per cent. Among the ethanol extracts, pongamia oil and neem seed kernel extract showed better knock down effect with the mortality of 75 and 66.7 per cent respectively. Carbaryl Flo a new formulation, was found to be as effective as Carbaryl WP with lower tea mosquito bug incidence.

Quality Analysis and Post-Harvest Technology : Studies on biochemical changes during storage of nuts both at ambient temperature and low temperature were continued. During storage, kernel suger, starch and shell CNSL content decrease significantly. Neutral lipids tend to increase during storage. Kernel lipids, starch and shell CNSL tend to increase while phenols and amino acids tend to decrease during development of nuts. Storage of bulk nuts upto eight months, does not affect the processing quality as assessed by shelling percentage. Changes in shell CNSL, kernel starch, protein and sugar content, however have been observed during storage. Hot water dip treatment to extend the storage life of cashew apples was not successful.

Transfer of Technology : The projects under this programme contemplate to disseminate the technologies developed to farmers and extension agencies by conducting training programmes, distribution of planting material, bringing out

extension literature and establishing demonstration plots in collaboration with Directorate of Cashewnut Development, Cochin and Srikshethra Dharmastala Rural Development Project, Dharmasthala.

During the year 32,912 grafts were sold with the realisation of revenue of Rs. 2,63,296 under the Revolving Fund Scheme. A total of 41,806 successful grafts of different varieties were produced. A total of nine training programmes on, Vegetative Propagation of Cashew, (6), Cashew Production Technology (2) and Crop Protection in Cashew (1) were conducted and a total of 72 persons including farmers, students, gardeners and officials from Karnataka (41), Kerala (13), Tamil Nadu (6), Uttar Pradesh (10), Andhra Pradesh (1) and Maharashtra (1) were trained. Demonstration plots established earlier were monitored. Two meetings of farmers maintaining cashew demonstration plots and a "Field Day" for cashew growers of Dakshina Kannada district were also organised.

Library : The library of this Research Centre has 639 reference volume and has been subscribing 35 Indian and 10 International journals. During the year an amount of Rs. 1,97,802 has been spent towards strengthening the library facilities.

ABOUT THIS REPORT

This is the seventh Annual Report brought out by this Research Centre. This has been compiled according to research projects taken up on Crop Improvement, Agrotechniques, Crop Protection, Quality Analysis and Post-Harvest Technology and Transfer of Technology. In the following pages results of research projects of NRCC are summarised followed by summary report of All India Coordinated Research Project on Cashew.

Puttur
Dated 30th Sept. 1993

(M.K. Nair)
DIRECTOR

REPORTS ON ONGOING PROJECTS

CROP IMPROVEMENT

A total of 24 trees were identified for desirable characters such as bold nuts, cluster bearing habit, cw apple to nut ratio, big apple, medium dwarf plant habit and spreading habit from Orissa, Karnataka and Kerala. Sixteen clonal accessions have been planted in the National Cashew Gene Bank bringing the total number of accessions planted so far to 285.

Under progeny trial I, the combination H-10 (M 37/3 x T.No.1) performed better in all the replications with an yield of 8kg/tree/year. Among the selfed lines in progeny trial II, maximum yield (6.5kg/tree/year) was recorded in S-16 (M 16/1 x M 16/1). Among the 15 cross combination in progeny trial III, the highest mean yield (7.5 kg/tree/year) was recorded in H-20 (BLA 139/1x M 10/4). Based on yield, a total of eight individual trees have been identified from three progeny trials. A total of 121 hybrid seedings of the five cross combinations of the previous year have been planted to improve the nut size in the released varieties. A new trial with seven hybrids and three selections has been laid out. In the maximisation of yield plot, performance of M 44/3 was better than M 10/4.

Bud proliferation from cotyledonary nodes was best (6-9 buds/explant) in MS supplemented with BA at 0.5 - 1.0 mg/l concentration. Initiation of nodel cultures from 1-2 month old seedlings was best in MS media supplemented with BA+Kn (5mg each) + IBA (0.5 - 3.0 mg/l). Callus induction in shoot and leaf sections excised from young seedlings has been achieved on MS medium supplemented with 2,4-D and BA.

Leaf proxides and shoot lignin tend to increase during infestation by tea mosquito. Leaf lipids undergo changes during infestation. Shoot lignin and leaf starch and sugar contents increased in all the host plants studied. Matured shoots were least preferred by tea mosquito for oviposition and survival. Tender shoot is the most preferred by tea mosquito for its multiplication although it lays eggs on tender shoots, green shoots and matured shoots.

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

(KRM Swamy, MG Nayak and KV Nagaraja)

The major objectives of this project are collection of both indigenous and exotic germplasm material, establishment of National Cashew Gene Bank for conserving the available genetic diversity, and cataloguing the existing germplasm. During the year sixteen clonal accessions have been planted in the National Cashew Gene Bank bringing the total number of accessions planted so far to 285. During the survey for germplasm collection in Orissa, Karnataka and Kerala, twenty four collections were identified for various desirable characters.

Germplasm Collection :

Cashew germplasm collection survey was undertaken in Orissa (Puri and Ganjam districts), Karnataka (Kolar district) and Kerala (Cashew Research Station, Madakkathara) during April - May 1992. Seven trees from Orissa, fourteen trees from Karnataka (Maidan part) and three trees from Kerala (Cashew Research Station, Madakkathara) were identified for bold nuts, cluster bearing habit, low apple to nut ratio, big apple, medium dwarf plant habit and spreading habit (Table 1).

During October 1992, scion sticks collected from 14 trees identified in Kolar district of Karnataka were brought to NRC Cashew and were grafted on the root stock seedlings of VTH 174. The graft success ranged from 60 to 100 per cent.

Bulk seednuts of Brazilian origin received from Kerala Nut food Company, Kollam, with nut weight between 5.7 and 12.2g were sown in polythene bags after treatment with captan (1%). The available seedlings of this material along with the seedlings of medium dwarf materials identified earlier (VTH 752/2, VTH 762/4, S 11/1, S 11/2 and H. Gollahally-1) would be utilized for identifying dwarf root stocks (Table 2).

Germplasm conservation :

Sixteen clonal accessions (NRC 270 - 285) have been planted at 6mx6m spacing in the National Cashew Gene Bank (6 soft wood grafts/accession) during July 1992. Of the sixteen accessions, twelve were collected from Regional Fruit Research Station, Vengurla, Maharastra (ten bold nut types; one medium nut type; one small nut type with no CNSL), one from Karnataka (bold nut type) and three from Kerala (two Brazilian types, one CNSL free type with smooth bark). With this, the total number of accessions planted so far in the germplasm conservation block has gone upto 285 (Table 3).

Germplasm evaluation :

Selected aceessions were characterised for the leaf phenols and orthodihydroxy phenols. Matured leaves from 24 accessions (3 plants/accession) were analysed for their phenols and orthodihydroxy phenols. Accessions exhibited variation for phenols and OD phenols contents (Table 4). The phenolic content was less than

Table 1. **Salient features of cashew germplasm collections made from Orissa and Karnataka during 1992-93.**

Name	Age of tree (Years)	No. of fruits/ panicle	Apple colour	Apple wt. (g)	Nut wt. (g)	Remarks
Orissa						
Algnia - 113	15	1-2	Yellow	60	11.0	
Kirthipura-1	22	8-10	Yellow	35	5.5	
Kirthipura-2	22	8-10	Yellow	35	4.0	
Badaputti-1	40	5-6	Pink	60	7.0	
Badaputti-2	13	6-8	Yellow	35	6.0	
Badaputti-3	12	10-15	Yellow	20	3.5	
Dhawli-1	15	20-25	Yellow	30	3.0	
Karnataka						
Kothur-1	25	3-4	Yellow	80	10.0	
Kothur-6	40	6-9	Yellow	50	9.0	
Hadigere-1	15	2-3	Yellow	80	10.0	Medium dwarf
H Gollahally-1	15	5-6	Red	30	4.5	
Dinnahally-1	10	1-2	Yellow	150	10.0	
Hebri-1	10	6-10	Pink	50	10.0	
Hebri-2	11	3-6	Yellow	100	8.5	
Hebri-3	11	2-3	Yellow	70	11.0	
Chickadasarahally 1	30	1-2	Red	70	10.0	
Chickadasarahally-6	30	1-2	Pink	100	10.0	
Chickadasarahally-8	15	—	—	—	—	Medium dwarf
Hogalagere-1a	30	8-10	Yellow	60	6.0	
H Gollahally-1a	15	—	—	—	—	Medium dwarf
H Gollahally-1b	15	—	—	—	—	Medium dwarf
Kerala (CRS, Madakkathara)						
Ullal-12-2 (T.No. 242)	4	—	Red	30	4.0	Medium dwarf
Panama 2-1/27	4	1-2	Red	250	9.0	
Panama 6-2/10	4	—	—	—	—	Spreading habit

Table 2. **Seedlings raised for field evaluation**

Source	Name	Mean Nut weight (g)	No. of seedlings available
Brazil (Through Kerala Nut Food Company Kollam, Kerala)	Brazil-I	12.2	6
	Brazil II	8.6	31
	Brazil-III	5.7	24
CPCRI Regional Station, Vittal, Karnataka	VTH 762/2 1	3.5	3
	VTH 762/4 1	3.5	5
	S 11/1	5.0	32
	S 11/2	5.0	12
Mulabagal Taluk of Kolar, Karnataka	H Gollahally-1	6.0	6

Table 3. **Clonal germplasm accessions planted in the National Cashew Gene Bank**

	No. of accessions
Existing	269
Primary collections planted during 1992-93	
Karnataka	1
Maharashtra	12
Kerala	3
Total	285

1.0 mg/g in ten accessions (NRC 140, 141, 152, 153, 121, 130, 131, 132 and 137) and it was more than 4.0 mg/g in four accessions (NRC 107, 116, 189 and 183).

Studies on yield stabilization in cashew were also undertaken. For this purpose, the accessions planted during 1988, 1989 and 1990 were selected (15 accessions for each year, 5 early/5mid/5late season flowering types). Plant height (m), trunk girth (cm) at 15 cm from ground level, canopy spread-North South and East West (m), number of leaders/m^2, number of productive and unproductive laterals/m^2 were recorded. The mean values for these growth parameters are presented in Table 5.

Trunk girth at 15 cm from ground level was recorded during January 1993 for the accessions planted during 1986-91 (Table 6). In the accessions planted during 1986, 1987, 1988, 1989, 1990 and 1991, the trunk girth in majority of the accesions ranged from 45.1 -55.0, 40.1 - 50.0, 30.1-40.0, 20.1-30.0, 15.1-25.0 and 10.1-15.0 cm, respectively (Table 6).

Accessions have been grouped on the

Table 4. Leaf phenols and orthodihydroxy phenols content in selected cashew accessions.

Type	Accession No.	Name/parentage	Phenols (mg/g)	Orthodihydroxy phenols (mg/g)
Related species	142	*Anacardium microcarpum*	0.219	0.077
	152	*A. Orthonianum*	0.296	0.008
	153	*A. pumilum*	0.574	0.129
CNSL free	116	CNSL-free-Ullal	4.770	0.700
	188	VTH 785/4 I	2.340	0.580
	189	VTH 789/1 II	5.250	1.130
Purple plant	121	Purple Plant-Ullal	0.364	0.080
Semi dwarf	119	40 Mozambique	1.630	0.390
	185	VTH 762/4 I	3.290	1.280
Big apple	92	AP 29	2.860	1.200
	120	Nairobi	3.350	0.660
	138	Selection-1 (VTH 107/3 I)	2.970	1.350
	140	VTH 155 L	0.412	0.136
	183	711/4 Brazil	4.090	1.840
Bold nut	92	AP-29	2.860	1.200
	107	B-1	4.790	2.020
	112	M-5	2.610	1.120
	120	Nairobi	3.350	0.660
	131	Selection-2 (VTH 40/1 I)	0.685	0.244
	140	VTH 155 L	0.412	0.136
	141	VTH 12/1 II CYT	0.210	0.038
	183	VTH 711/4 Brazil	4.090	1.840
	190	VTH 146/1 I	2.350	0.850
Cluster bearing & high yield	122	Kunthur-24	3.130	1.080
	101	VHB-2	3.060	1.260
	130	VTH 30/4 I	0.343	0.098
	131	Selection-2 (VTH 40/1 I)	0.685	0.244
	132	VTH 50/2 I	0.147	0.015
	137	VTH 105/2 I	0.422	0.115
	138	Selection-1 (VTH 107/3	2.970	1.950
	140	VTH 155 L	0.412	0.136

basis of cumulative yield/plant recorded for the germplasm accessions planted during 1986, 1987 and 1988 (Table 7). Majority of accessions planted during 1986 had the cumulative yield/plant ranging from 1.00-3.00 kg. The cumulative yield/plant was less than a kg in all accessions planted during 1987 and 1988.

Table 5. **Morphological observations in selected accessions**

Character		1988	1989	1990
Plant height (cm)	Early	3.2	2.7	2.1
	Mid	2.9	2.3	1.9
	Late	3.3	2.1	2.5
Trunk girth (cm)	Early	35.1	23.6	19.8
	Mid	32.1	22.7	18.7
	Late	37.1	20.8	20.6
Canopy spread (cm) NS X EW	Early	4.2 x 4.3	2.5 x 2.5	2.3 x 2.2
	Mid.	3.5 x 3.5	2.8 x 2.6	2.2 x 2.3
	Late	3.4 x 3.2	2.4 x 2.2	2.4 x 2.4
No. of leaders/m²	Early	12.6	7.9	4.9
	Mid	10.6	6.8	4.9
	Late	11.7	5.9	5.2
No. of productive laterals/m²	Early	10.3	7.0	6.9
	Mid	15.0	6.9	4.1
	Late	9.9	6.1	4.4
No. of unproductive laterals/m2	Early	7.3	9.0	8.2
	Mid	3.8	7.8	8.6
	Late	8.2	7.8	9.0

Table 6. **Trunk girth of cashew accessions in the Gene Bank**

Year of planting	No. of accessions	Trunk girth group (cm)	Accessions	
			No.	%
1986	56	35.1 - 40.0	3	5.3
		40.1 - 45.0	7	12.6
		45.1 - 50.0	15	26.8
		55.1 - 60.0	13	23.2
		60.1 - 65.0	3	5.3
1987	30	35.1 - 40.0	2	6.6
		40.1 - 45.0	10	33.4
		45.1 - 50.0	9	30.0
		50.1 - 55.0	6	20.0
		55.1 - 60.0	3	10.0
1988	67	20.1 - 25.0	2	3.0
		25.1 - 30.0	3	4.5
		30.1 - 35.0	27	40.3
		35.1 - 40.0	24	35.8
		40.1 - 45.0	11	16.4
1989	60	15.1 - 20.0	9	15.0
		20.1 - 25.0	22	36.7
		25.1 - 30.0	21	35.0
		30.1 - 35.0	8	13.3
1990	42	15.1 - 20.0	23	54.8
		20.1 - 25.0	17	40.5
		25.1 - 30.0	2	4.7
1991	14	10.1 - 15.0	13	92.9
		15.1 - 20.0	1	7.1

Table 7. Yield of cashew accessions in the Gene Bank

Year of Planting	No. of accessions	No. of annual harvests	Cumulative yield (kg/plant)	accessions No.	%
1986	56	5	< 1.00	4	7.1
			1.00 - 2.00	23	41.1
			2.00 - 3.00	16	28.6
			3.00 - 4.00	6	10.1
			4.00 - 5.00	4	7.1
			5.00 - 6.00	2	3.6
			5.00 - 7.00	1	1.8
1987	30	4	< 1.00	15	50.0
			1.00 - 2.00	14	46.6
			2.00 - 3.00	1	3.4
1988	67	2	< 1.00	49	73.1
			1.00 - 2.00	14	20.9
			2.00 - 3.00	4	6.0

Gen.II (176): Varietal improvement of cashew.

(PM Kumaran and Thimmappaiah)

This project envisages the crop improvement in terms of high yield potential coupled with other desirable characters like high shelling percentage, resistance/tolerance to tea mosquito and better quality. These objectives are contemplated to be achieved through hybridization, selection and varietal evaluation.

Hybridization and Selection :

A total of 65 hybrids and 10 selfs are under evaluation in six set of experiments at CPCRI, Regional Station, Vittal (1984 planting) and NRCC, Puttur (1986, 1991, 1992 planting). Besides these, a total of 29 elite lines are being evaluated in three experiments for the economic characters like yield, shelling percentage, nut size, kernel weight and size of apple.

Progeny trial-I.

The trial was laid out at CPCRI, Regional station, Vittal with 18 cross combinations and a control (M44/3) in 1984 (RBD 6 plants per plot in three replications). The performance of the Cross Combinations in terms of yield is presented in Table 8. The mean yield varied from 2.7 kg/tree/year (H-4, 13/12 Sanyasi putuka self) to 8 kg/tree/year (H-10, M37/3 x T No 1). The performance of H 10 was better in all the replications with an yield increase of 150 per cent over control. The next best combination was H-16 (1/3 Ceylon X A 17/6)

Table 8. **Performance of different cross combinations under Progeny trial-I**

H.No.	Combinations	Mean yield (kg)				% increase/ decrease	Mean cumulative yield (6 years)
		R-I	R-II	R-III	Mean		
H-1	M 44/3 x M 44/3	4.7	6.5	8.9	6.7	109.0	3.3
H-2	13/12 Sanyasi x M 44/3	8.2	4.5	5.6	6.1	90.6	3.1
H-3	A 18/4 x 7/10 Teta	6.7	4.7	5.6	5.7	78.1	2.8
H-4	13/12 Sanyasi-Self	1.9	2.4	3.8	2.7	15.6	2.1
H-5	BLA-139-1 x T.No. 1	2.8	5.8	3.7	4.1	28.1	2.3
H-6	BLA-139-1 x 13/5 Kodur	6.1	6.5	3.3	5.3	65.6	2.8
H-7	M 10/4 x WBDC V	3.7	8.2	2.2	4.7	46.9	2.5
H-8	M 37/3 x M 37/3	5.8	6.0	5.2	5.6	78.1	2.9
H-9	M 37/3 x A18/3	5.0	5.3	5.4	5.2	62.5	2.7
H-10	M 37/3 x T.No. 1	9.3	7.6	7.1	8.0	150.0	3.9
H-11	WBDC-V x WBDC-V	2.6	7.1	1.6	3.8	18.7	1.7
H-12	A 18/4 x A 18/4	1.6	8.9	1.5	4.0	25.0	1.8
H-13	A 18/4 x 13/5 Kodur	3.9	6.0	3.6	4.5	40.6	2.3
H-14	1/3 Ceylon x 13/5 Kodur	4.3	4.3	7.7	5.4	68.8	3.1
H-15	1/3 Ceylon x 1/3 Ceylon	5.0	3.9	3.5	4.1	28.1	2.3
H-16	1/3 Ceylon x A 18/4	5.1	7.1	9.7	7.3	128.1	3.7
H-17	M 37/3 x 13/5 Kodur	4.1	4.8	2.1	3.7	15.6	2.1
H-18	1/3 Ceylon x Mys. Kotekar	5.6	7.3	7.4	6.0	112.5	3.2
Control	M 44/3-OP	1.5	3.6	4.6	3.2	—	1.6

with a mean yield of 7.3 kg/tree/year and with an increase of 128 per cent over control.

Progeny trial - II.

This trial was laid out as an observational trial with seven selfed lines in two replications (4 plants per replication) at CPCRI, Regional Station, Vittal in 1984. The performance of the S-1 lines, in terms of yield is presented in Table-9. The maximum mean yield (6.5 kg/tree/year) was recorded

Table 9. **Performance of the selfed lines under progeny evaluation trial - II**

Self No.	Description	Mean yield (kg)		Mean	Mean cumulative yield (6 years)
		R-I	R-II		
S-20	M 37/3 x M 37/3	3.3	4.5	3.9	1.6
S-11	M 10/4 x M 10/4	2.5	4.4	3.4	2.2
S-16	M 16/1 x M 16/1	9.0	4.0	6.5	2.6
S-120	1/3 Ceylon x 1/3 Ceylon	3.0	2.3	2.6	1.5
S-127	T.No. 270 x T.No. 270	4.5	1.3	2.9	1.6
S-34	T.No. 1 x T.No. 1	4.2	5.1	4.6	3.3
S-12	M 44/3 x M 44/3	4.4	2.8	3.6	1.7

in S-16 (M 16/1 self). The minimum mean yield (2.6 kg/tree/year) was recorded in S-120 (1/3 Ceylon self).

Progeny trial - III :

This trial with a total of 15 cross combinations and a control (M 44/3) is laid out in Completely Randomised Block design with 2 replication (4 plants/plot). The performance of these combinations in terms of yield is presented in Table 10. Among the 15 cross combinations and one control (M 44/3), the highest mean yield (7.5 kg/tree/year) was recorded in H-20 followed by H-28 (M16/1 x 13/5 Kodur, 5.4 kg/tree/year). The least mean yield was recorded in control (M 44/3, 0.5 kg/tree/year) and H-29 (T.No.1 x 7/10 Tetagunta, 0.7 kg/tree/year).

Based on the yield, eight individual trees have been identified from progeny trials (Table 11). All these plants gave more than 12 kg at the eighth year of planting (sixth harvest). The highest individual tree yield (16.1 kg/year) was recorded in S 16/1. Two plants of VRI-II (M 44/3) are also included in this list which are S-1 of M 44/3. Rest of them are all hybrids of various combination. In general the hybrids performed better than the selfs.

Wide variation with respect to individual tree yield was observed among plants within and between combiantions. Among 342 plants evaluated in progeny trial I, the yield in 18 per cent of the plants ranged from 6.1 to 8.0 kg. Similarly, the yield of 26 per cent of plants in progeny

Table 10. Performance of different cross combinations under Progeny trial - III

H.No.	Cross Combination	Mean yield (kg)			Mean cumulative yield (6 years)
		R-I	R-II	Mean	
H-19	A 18/4 x BLA-139-1	1.7	2.9	2.3	1.8
H-20	BLA-139-1 x M 10/4	6.4	8.6	7.5	3.7
H-21	A 18/4 x M 10/4	2.6	4.3	3.4	1.6
H-22	A 18/4 x Vetore-56	3.7	2.2	2.9	1.7
H-23	7/10 Tetagunta x A 18/4	2.3	3.2	2.7	1.3
H-24	BLA 139-1 x A 18/4	3.5	4.7	4.1	2.0
H-25	7/10 Tetagunta x BLA 139-1	3.8	6.6	5.2	1.9
H-26	M 37/3 x 7/10 Tetagunta	1.9	3.5	2.7	1.6
H-27	M 44/3 x 9/8 EPM	2.7	6.3	4.5	2.2
H-28	M 16/1 x 13/5 Kodur	5.5	5.3	5.4	2.2
H-29	T.No. 1 x 7/10 Tetagunta	0.3	1.2	0.7	0.9
H-30	WBDC-V x M 10/4	3.5	5.3	4.4	2.1
H-31	Mys. Kotekar x 13/5 Kodur	4.5	1.7	3.1	1.2
H-32	T.No. 1 x M 10/4	8.4	2.1	5.2	1.8
H-33	WBDC-V x 13/5 Kodur	1.8	2.3	2.1	0.7
C-III	Control M 44/3	0.5	—	0.5	0.5

Table 11. Details of individual trees giving an yield of 12 kg/tree/year at 8th year of planting.

Hybrid No./ Tree No.	Combination	Yield/ tree (1992) (kg)
H 1/10	M 44/3 x M 44/3	13.2
H 1/18	M 44/3 x M 44/3	12.5
H 10/4	M 37/3 x T.No. 1	12.5
H 10/6	M 37/3 x T.No.1	12.9
H 16/3	1/3 Ceylon x A 18/4	14.7
H 18/18	1/3 Ceylon x Mys. Kotekar	13.0
H* 32/4	T.No.1 x M 10/4	13.3
S** 16/1	M 16/1 x M 16/1	16.1

* From progeny trial III

** From progeny trial II

trial-II ranged from 2.1 to 4.0 kg. In trial III, 19 per cent of the plants had yield ranging from 2.1 to 4.0 kg (Table 12).

Hybridization for improving the nut size of released varieties

Hybridization programme was continued to improve the nut size in released varieties (M 44/3, BLA-139-1 and V-5). A total of 121 hybrid seedlings of the five cross combinations of the previous year (1991) were planted in the field at a spacing of 6mx6m (Table 13). The percentage of germination varried from 80 to 96 per cent. The hybridization programme to improve the nut size in released varieties was continued. The details of the cross combinations, number of flowers pollinated, initial nut set and the percentage of nut set are given in Table 14. A total of 2028

Table 13. Details of cross combinations, hybrid seed sown and percent of germination.

Cross combinations	Nuts sown	% germination
BLA-139-1 x VTH 711/4	12	91.6
BLA-139-1 x VTH 40/1	21	80.9
V-5 x VTH 711/4	36	94.4
V-5 x VTH 40/1	21	80.9
VRI-II X VTH 40/1	75	96.0
	165	91.0

Table 12. Variation in individual tree yield among the experimental plants in three progency trials.

Yield Range (kg)	Progeny trial					
	I		II		III	
Replanted seedlings/gaps	32	(9)**	30	(23)	4	(15)
< 2 Kg	60	(20)	30	(23)	15	(26)
2.1 - 4.0	57	(16)	34	(26)	17	(30)
4.1 - 6.0	75	(21)	14	(10)	10	(17)
6.1 - 8.0	62	(18)	11	(8)	4	(7)
8.1 - 10.0	27	(7)	4	(3)	3	(5)
> 10 kg	29	(8)	5	(4)	3	(5)

** Values in parantheses represent the percentage.

flowers were pollinated using pollen of two selected parents with the initial nut set of 27.7 per cent.

Evaluation of NRCC hybrids and selections.

A trial consisting of seven hybrids (five from progeny trial at Vittal and two from Puttur), three selections and one control (M 44/3) was laid out. Soft wood grafts of the above lines were planted in the field (six plants per plot in four replication) and details of the lines with their nut characters are presented in Table 15.

Maximisation of yield plot :

In the maximisation of yield plot established in 1986, the cumulative mean yield of M 44/3 and M 10/4 was 1.1 kg and 0.5 kg/tree respectively. The yield per plot

Table 14. Details of the hybridization for the improvement of nut size in released varieties.

Female parent	Male parent	No. of flowers pollinated	Initial set recorded	Initial nut set %
V-5	VTH 40/1	948	272	28.7
V-5	VTH 711/4	422	112	26.5
BLA-139-1	VTH 40/1	337	47	13.9
BLA-139-1	VTH 711/4	85	25	29.4
VRH-II	VTH 40/1	110	53	48.2
VRH-II	VTH 711/4	128	25	19.5
		2028	534	27.7

Table 15. Details of the NRCC hybrids and selections planted in the field.

	T.No.	Combination	Nut wt (g)	Kernel wt (g)	Shelling %
*	H 6/1	BLA 139-1 x 13/3 Kodur	8.0	22.2	28.0
*	H 32/4	T.No.1 x M 10/4	8.7	2.1	25.0
*	H 15/14	1/3 Ceylon x 1/3 Ceylon	7.9	2.2	28.0
*	H 17/11	M 37/3 x 13/5 Kodur	8.1	2.8	28.0
*	H 23/1	7/10 Tetagunta x A 18/4	7.9	1.9	25.0
**	H 39	VTH 36 x VTH 30	9.2	2.3	25.6
**	H 79	VTH 12 x VTH 30	10.1	2.2	22.7
	NRC-I	VTH 107/3	7.6	2.1	28.8
	NRC-II	VTH 40/1	9.2	2.1	28.6
		VTH 174	7.0	2.0	28.5
	VRH-I	Control M 4/3	5.1	1.4	28.3

* From progeny trial planted at Vittal

** From progeny trial planted at Puttur

(0.6 ha) recorded at 6th year of planting was 65.2 kg (130.4 kg/ha) and the cumulative yield per plot was 343 kg (572 kg/ha). The cost of cultivation for 1991-92 was Rs. 2257 (Rs. 4534/ha) and the cumulative cost of cultivation at the end of sixth year for the plot was Rs. 9,597 (Rs.16731/ha). In this plot two rows of each variety were irrigated fortnightly at 200 litres/tree starting from January to March. Although the yield difference in M 10/4 was not significant, in M 44/3 there was an increase in yield due to irrigation (13 per cent more than the unirrigated). During this year, in M44/3 the yield in irrigated and unirrigated plots was 3.3 and 2.8 kg/tree /year respectively.

Evaluation of recommended varieties :

In the trial planted in 1986 with clonal material, 12 recommended varieties were evaluated in R B D with three replications and six plants per plot. The yield difference among the varieties was not significant in the sixth year of planting. The highest yield (850 g/plant) was recorded in BLA 39/4 followed by EPM 9/8 (564 g/plant) and M 10/4 (560g/plant). The cumulative mean yield of M 44/3 and BLA 39/4 was 699 g/plant/year and 587 g/plant/year respectively.

Evaluation of hybrids planted during 1987.

Hybrid seedlings (145 Nos.) from 33 cross combinations planted in 1987 under closer spacing (6m X 6m) were evaluated. In the fifth year after planting, the cross combination VTH 12 X VTH 11 gave the highest yield (1.7 kg/plant/year), followed by VTH 36 X VTH 30 (1.2 kg/plant/year), VTH 12 X VTH 93 (1.08 kg/plant/year) and VTH 59 X VTH 30 (1.04 kg/plant/year). Trees with high yielding potential have been identified (Tr. No. 62, 69, 46, 38, 120, 14, 18, 114, 99, 30) and in these, tree No 62 (VTH 93 X VTH 59) was the highest yielder (2.3 kg/tree/year).

Physiological studies in recommended varieties :

A total of 72 plants in three replication (2 plants/variety) were identified from 12 recommended varieties planted in 1987. Photosynthesis, transpiration, stomatal conductance, intercellular CO_2 were measured in the selected plants during post-harvest (June 1992) and the pre-harvest seasons (January 1993) and the average values are presented in Table 16. The highest photosynthesis was recorded in BLA 39/4 (10.88µ mol $CO_2/m^2/Sec$) followed by H-2/12 (10.22) and the minimum was in BLA 139-1 (7.97). In the pre-harvest season, in all the types studied the photosynthesis was less than the post-harvest season of 1992. The highest photosynthetic efficiency, however, was recorded in Ullal-1 (8.40) followed by T.No.56 (7.84).

Table 16. The photosynthetic effeciency of recommended varieties

Variety	Photosynthesis µmol $CO_2/m^2/Sec$	
	(Post-harvest season 1992)	(Pre-harvest season 1993)
T.No. 56	9.95	7.84
H-3 - 17	9.18	7.20
T.No. 1	8.43	7.30
M 10/4	9.90	5.80
H 2/11	9.55	7.81
Ullal-1	9.48	8.40
BLA 139-1	7.97	6.10
EPM - 9.8	9.65	7.60
M 44/3	9.01	5.20
H-3-13	8.17	6.30
H 2/12	10.22	6.80
BLA 39/4	10.88	5.60

Gen.III : Tissue culture studies in cashew for micropropagation and somaclonal variation.

(Thimmappaiah)

The project was initiated in 1990 with the main objective of standardising micropropagation technique and to induce and exploit somaclonal variation for breeding purpose.

Micropropagation :

Cotyledonary node culture without cotyledonary segments were made on MS supplemented with various concentrations of BA, 2-ip and Kinetin (0.5 - 2.0 mg/l). Bud proliferation was observed at all the concentation of BA and 2-ip but the best was in BA (0.5 - 1.0mg/l) with 6-9 buds per explant. The response in Kinetin media was very poor. Nodal cultures from 1-2 month old seedlings were also initiated on MS supplemented with BA alone (0.5 - 5.0 mg/l), BA (0.5-5.0 mg) + NAA (0.5 - 1.0 mg/l), BA + Kn (5 mg/l each), BA + Kn (5 mg each) + IBA (0.5 - 3.0 mg/l). The best response was in the media supplemented with BA + Kn + IBA with 85-90 per cent establishment and single shoot formation (0.5 - 3.0 cm). Among the three basal media tried (MS, WPM and B-5 with 5 mg/l of BA), the MS medium was the best. The proliferation of nodal cultures was limited in media supplemented with BA (8 mg/l).

Nodal cultures from mature trees (5-6 years) were difficult to establish owing to contamination and shoot necrosis. However, browning of explants could be slightly reduced by initially culturing the explants on agar media supplemented with only three per cent sucrose.

Callus culture :

Callus was induced in shoot and leaf sections excised from young cashew seedlings on a modified MS medium supplemented with 2, 4-D alone (0.5 - 4 mg/l) and 2,4-D (0.5 - 4 mg) + BA (0.1 - 1.0 mg/l). In shoot, initiation varied from 21 to 82 per cent and in leaf from 7 to 50 per cent of the explants. Callus initiation was maximum at higher concentrations of 2, 4-D and it was minimum or negligible at lower concentrations (0.5 - 1.0 mg). Callus in leaf was slow and commenced always from the midrib region. Inclusion of BA (0.1 - 1.0 mg/l) was beneficial for callus growth.

Somatic embryogenesis :

Immature zygotic embryos and nucellar tissues excised from developing nuts (3-4 weeks) were cultured on a modified MS supplemented with 2, 4-D (0.5 - 4 mg/l). Only in ten per cent of the explants there was psuedobulbil like somatic embryo formation. This showed prominent root and poor shoot differentiation both in hormone free medium and medium supplemented with reduced concentration of 2, 4-D. These on subculturing on 2, 4-D/NAA + BA media and on NAA + CW with casein hydrolysate (0.1%) media, resulted in shoot differentiation in the form of scaly leaves/thick leaves with thin roots.

Ad-hoc Scheme : Screening and biochemical evaluation of cashew germplasm in relation to tea mosquito infestation

(KV Nagaraja, D Sundararaju and V. Venugopalakrishna Kurup).

The scheme was initiated in 1988 with an objective of screening the accessions for tea mosquito tolerance and studying the biochemical changes during infestation.

Biochemical studies :

Studies during shorter period of infestation were continued and the results are presented in Table 17. Lipid peroxides in the leaf and lignin in the shoot tend to increase with infestation. Changes in the nucleic acids (RNA and DNA) were, however, not significant.

Changes in the leaf lipids during infestation by tea mosquito were studied and the results presented in Table 18 indicated that total lipids increased initially

Table 17. Biochemical changes in cashew during shorter period of infestation

Period of infestation (hr)	Leaf			Shoot			
	RNA	DNA	Peroxides	RNA	DNA	Peroxides	Lignin
0	1.56	1.66	4.37	6.65	0.46	3.58	9.9
6	3.42	6.30	7.30	7.56	0.55	4.03	11.4
12	2.42	7.28	12.06	7.78	1.07	1.64	13.4
18	2.62	3.58	12.58	4.74	0.92	2.09	10.4
24	2.45	5.78	23.05	5.30	0.36	2.12	10.9

RNA and DNA — Expressed as mg/g fresh weight
Peroxides — Expressed as n moles MDA/g fresh weight
Lignin — Expressed as A 350/g fresh weight

Table 18. Changes in leaf lipids in cashew during shorter period of infestation

Period of infestation (hr)	Total lipids (mg/g fr wt)	Neutral lipids	Glyco lipids % of total	Phospho lipids
0	10.6	43.4	40.9	15.6
6	60.2	50.3	37.6	12.2
12	62.3	43.4	33.5	23.1
18	21.4	NA	NA	NA
24	10.9	45.3	45.1	9.6

NA - Data not available

followed by a decrease. Neutral lipids formed the major fraction followed by glyco lipids and phospho lipids. Both neutral lipids and glyco lipids from healthy and six hr infested leaf tissue were fractionated into individual components by silicic acid chomatography and the results are presented in Table 19. The composition of glyco lipid did not change appreciably during infestation. In the case of neutral lipids, hydrocarbon fraction tend to increase while sterol esters and glycerides tend to decrease during infestation.

As tea mosqito infests number of other host plants, biochemical changes induced by tea mosquito on alternate hosts like cotton, neem and henna, were studied and the results are presented in Table 20. Starch and sugar content of the leaf in all the host plants studied increased during infestation. Phenols and orthodihydroxy phenols both in leaf and shoot tend to increase during infestation except in cotton. Infestation by tea mosqito results in increased levels of shoot lignin in all the host plants. The biochemical response of these host plants to tea mosquito is similar to that of cashew except that the sugar concentration goes down in cashew during infestation whereas it increases in cotton, henna and neem.

Biochemical changes in a moderately susceptible (VTH 153/1) and a susceptible check (R_2) during infestation by tea mosquito were studied and the results are presented in Table 21. Leaf starch content was not affected after 24 hr of infestation in moderately susceptible accession while it increased in susceptible accession. Leaf phenols in moderately susceptible accession increase while they decrease in susceptible accession during infestation by tea mosquito. Thus biochemical response with respect to leaf starch and phenols during infestation by tea mosquito appears to differ in moderately susceptible and susceptible accessions.

Entomological studies :

During the year, a total of 2817 nymphs were reared and the percentage of nymphs reaching adult stage ranged from 63.4 to 76.9.

Table 19. Composition of leaf neutral and glyco lipids in healthy and 24 hr infested tissue.

Lipids	Composition	% of total	
		Healthy	Infested
Neutral Lipids	Hydrocarbons	8.1	23.5
	Sterol Esters	10.4	5.9
	Triglycerides	13.6	12.0
	Free sterols	14.5	15.3
	Diglycerides	15.4	14.2
	Monoglycerides	37.9	29.1
Glyco lipids	Acyl sterol glycoside	32.8	35.3
	Monogalactosyl diglycerides	20.2	20.6
	Sterol Glycoside	24.6	23.9
	Digalactosyl diglyceride	22.4	20.1

Table 20. Biochemical changes during infestation by tea mosquito in alternate hosts

Host	Tissue	Period of infestation (hr)	Starch (mg/g)	Sugars (mg/g)	Phenol (mg/g)	O D Phenols (mg/g)	Lignin A 350/g
Cotton	Leaf	0	39.82	15.16	2.80	2.48	
		6	94.19	43.10	1.65	1.81	
		12	62.17	31.74	0.68	0.87	
		18	58.72	16.28	0.63	0.71	
		24	77.85	37.84	1.41	1.05	
	Shoot	0		12.93	0.17	0.051	3.2
		6		7.73	0.32	0.191	8.0
		12		14.43	0.26	0.154	11.4
		18		5.29	0.51	0.280	9.9
		24		5.51	0.26	0.185	8.3
Henna	Leaf	0	8.78	15.32	0.84	0.21	
		6	16.31	19.78	0.79	0.25	
		12	17.13	19.76	1.00	0.27	
		18	20.03	7.78	1.82	0.42	
		24	19.15	14.73	1.64	0.41	
	Shoot	0		10.08	0.29	—	9.21
		6		11.94	0.42	—	12.54
		12		17.95	0.39	—	9.96
		18		38.58	1.44	—	9.00
		24		21.53	0.71	—	9.39
Neem	Leaf	0	48.74	28.59	1.36	0.635	—
		6	74.00	123.40	3.71	1.318	—
		12	90.86	202.19	3.04	1.245	—
		18	47.80	124.20	2.17	0.629	—
		24	45.10	56.95	1.42	0.567	—
	Shoot	0	—	5.43	0.533	0.225	11.55
		6	—	4.62	0.804	0.326	25.55
		12	—	3.11	0.251	0.073	17.63
		18	—	3.20	0.516	0.173	18.67
		24	—	3.73	0.580	0.198	16.04

Values are mean of three individual estimations.

The damage and ovipositional potential were assessed at each phenological stages (tender shoot, green shoot and matured shoot) of three accessions (Kunthur-24, G 11/6 and susceptible check) and the results are presented in Table 22. For this purpose a pair of adults were caged for 48 hr on single shoot with particular phenological stage. After infestation, the number of eggs, damage and survival pattern

Table 21. **Biochemical changes in moderately susceptible and susceptible accessions after infestation for 24 hr by tea mosquito**

Accession	Tissue		Sugars (mg/g)	Starch (mg/g)	Phenol (mg/g)	OD phenols (mg/g)
VTH 163/1	Leaf	Control	5.73	13.74	0.797	0.249
		Infested	7.94	13.23	0.919	0.290
	Shoot	Control	5.69		0.310	0.069
		Infested	3.51		0.232	0.070
R_3	Leaf	Control	3.65	7.08	1.059	0.262
		Infested	5.57	17.35	0.660	0.237
	Shoot	Control	4.94		0.207	0.071
		Infested	3.92		0.337	0.095

Table 22. **Damage, Ovipositional potential and survival of adults at different phenological stages of cashew**

		Damage (0-4 scale)		No. of eggs laid/graft	Plant parts in which oviposited	Survival of adult/graft	
		Shoot	Leaf			No reared	No survived
G.11/6	Tender shoot	3.5	1.5	13.2	Midrib Petiole and shoot	2.0	2.0
	Matured shoot of cropping season	0.8	0.6	3.8	Petiole and shoot	2.0	1.3
	Matured shoot of rainy season	0.9	0.9	1.8	Petiole and shoot	2.0	1.9
Kunthur -24	Tender shoot	3.0	1.6	14.7	Midrib Petiole and shoot	2.0	2.0
	Green shoot	3.0	1.0	11.4	Midrib Petiole and shoot	2.0	2.0
	Matured shoot	1.0	0.3	3.0	Petiole and shoot	2.0	1.2
Susceptible check	Tender shoot	3.3	2.2	15.5	Midrib Petiole and shoot	2.0	2.0
	Green shoot	3.0	1.5	13.7	Midrib Petiole not shoot	2.0	2.0
	Matured shoot	1.3	0.8	5.2	Petiole	2.0	1.5

were recorded. Results indicated that ovipositional preference and survival pattern on matured shoot were least.

Damage and ovipositional preference at different phenological stages of cashew with two field tolerant accessions (VTH 153/1 and Kunthur - 24) were studied and the results presented in Table 23 indicated least damage and oviposition in the matured shoot stage. In Kunthur-24, however, relatively lower oviposition was observed in green shoot stage.

Survival of tea mosquito nymphs at different phenological stages of cashew was studied and the results are presented in Table 24. The nymphs were reared from the first instar to adult stage on tender shoot, green shoot and matured shoot. Tender shoot was most preferred by tea mosquito for its multiplication although it lays eggs on tender shoot, green shoot and matured shoot.

Table 23. Damage and ovipositional preference on different phenological stages of cashew

Accession	Damage 0-4 Scale								No. of eggs laid/graft			
	Shoot				Leaf							
	M	JF	TS	GS	M	JF	TS	GS	M	JF	TS	GS
VTH 153/1	1.5	4.0	3.0	2.5	0.9	3.6	1.5	0.3	1.0	3.2	5.0	7.5
Kunthur-24	0.3	3.7	3.3	2.8	0.2	3.9	2.4	1.0	1.7	7.8	8.3	3.0

M - Matured shoot, TS - Tender shoot
JF - Just flushing GS - Green shoot

Table 24. Survival of nymphs on different phenological stages of cashew

Phenological stage	No. of nymphs reared	% of nymphs reached adult stage	Sex ratio Female/Male
Matured shoot	57	0	—
Green shoot	87	5.8	1:0.7
Tender shoot	58	65.5	1:1.2

AGROTECHNIQUES

In an experiment on response of high yielding varieties of cashew to different levels of N, the mean yield increased with increased application of N from 250g to 750g/tree/year. Cumulative yield data also revealed linear response to N application. The yield of variety M 6/1 was higher both in seedlings and grafts.

Different irrigation treatments affected the morphological characters. Soil moisture status under different irrigation treatments was assessed.

Growing acacia, casuarina and subabul with cashew upto five years affected adversely the growth of cashew. Measurements on photosynthetic parameters, like Pn, E, and WUE, also indicated that growing acacia adversely affects the growth of cashew. Highest yield was realised from plot intercropped with pineapple while plot intercropped with acacia yielded lowest. During initial three years, forest trees did not adversely affect the growth of cashew. In the experiment on cashew with fruit crops, custard apple, ber and garcinia are not getting established.

Growth characters like height, girth and ground coverage are affected by the plant density in an experiment on high density planting of cashew. Maintaining the plant density of 625 trees/ ha continued to yield higher compared to other treatments.

Off season grafting can be successfully carried out with green scions of about 60 days during flushing, flowering/fruiting period. Similarly, decapitated flowered lateral shoots of 2.5 to 3 months could be successfully grafted. *Mangifera indica, Bucranama lanzan, Holigrana sp* and *Semecarpus anacardium* are not graft compatible with cashew.

The cost of establishment and maintenance of top worked plot and replanted plot during the first three years was Rs. 15205 and Rs. 9790/ha respectively. An 'On Farm Trial' of top working has been initiated in KCIXC plantation of Kunthur.

Pruned trees have continued to yield higher compared to unpruned trees. A new trial to understand the basic aspects of pruning has been initiated. Paddy coleoptile bioassay for IAA has been standardised.

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

(N. Yadukumar)

This experiment aims at evaluating the eight promising selections for various characters identified from germplasm collection of cashew maintained at CPCRI, Regional Station, Vittal. The experiment was planted at Vittal during 1983 with the varieties WBDC-V, M 6/1, M 10/4, M 44/3, T.No.1, A 18/4, 13/5 Kodur and BLA 139-1 as sub plot treatments. The two other factors are (1) three levels of nitrogen, Viz., 250, 500 and 750g/plant/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.

Yield :

The mean yield of nuts/tree increased with increased application of N from 250g to 750g/tree/year. Among the grafts the highest yield was recorded in M 6/1 (3.7 kg/tree/year) followed by M 44/3 (3.67 kg) and A 18/4 (3.01kg). In the seedlings population highest yield was recorded in A 18/4 (2.80 kg) followed by M 6/1 (2.6 kg) and M 10/4 (2.52 kg) (Table 25). Cumulative yield data showed that there was linear response to N application. Varietal response to different doses of N however, differed in different years. Highest yield was recorded both in seedlings and graft population of M 6/1 (Table 26)

Table 25. Nut yield as affected by 3 levels of N (kg/tree)

Varieties	N levels (g/tree)			Mean	Seedling	Graft
	N 250	N 500	N 750			
WBDC-V	1.46	1.01	3.14	1.87	1.6	2.14
M 6/1	2.85	2.91	3.77	3.18	2.64	3.71
M 10/4	2.50	2.69	3.09	2.75	2.53	2.99
M 44/3	1.86	2.55	3.31	2.57	1.47	3.67
A 18/4	2.24	3.17	3.28	2.90	2.78	3.01
Tr. No. 1	1.28	1.66	2.35	1.76	1.53	2.00
Kodur 13/5	1.83	1.99	2.19	2.07	1.94	2.19
BLA-139-1	1.52	1.77	1.62	1.64	0.86	2.41
Mean	1.94	2.24	2.81			

CD for Main Plot. N levels x planting materials — 0.778
Sub plot — 0.950

Table 26. **Cumulative nut yield for 6 years (kg/tree) as affected by 3 levels of N**

Varieties	N levels (g/tree)			Mean	Seedling	Graft
	N_{250}	N_{500}	N_{750}			
WBDC-V	7.45	6.97	10.71	8.38	7.69	9.07
M 6/1	11.76	13.16	15.59	13.42	11.54	15.13
M 10/4	9.47	8.84	11.69	10.00	9.32	10.65
M 44/3	7.65	10.48	11.92	10.06	8.03	11.89
A 18/4	7.70	10.04	12.08	9.94	11.04	8.85
Tr.No.1	6.97	8.60	10.16	8.57	7.71	9.44
Kodur 13/5	8.80	9.64	11.55	9.79	9.22	10.40
BLA 139-1	8.06	9.92	10.23	9.40	7.20	11.58
Mean	8.48	9.63	11.74			

CD for main plot (N) 1.78, CD for sub plot (var) 1.85

Agr. III(a) : Economic feasibility of drip irrigation and graded doses of NPK on the productivity of cashew.

(N. Yadukumar)

This experiment was laid out in 1989 in split plot design with four replications at Experimental Station, Shanthigodu. The main plot treatments are drip irrigation at 20, 40, 60 and 80 liters per tree once in four days during dry months. A control (no irrigation) is also included. The sub plot treatments are : (1) No fertilizer (2) 250gN, 62.5g P_2O_5 and 62.5g K_2O/tree; (3) 500g N 125g P_2O_5 and 125g K_2O/tree; (4) 750gN, 187.5gP_2O_5, 187.5gK_2O/tree. Besides working out the irrigation requirements, fertilizer use efficiency will also be studied.

Growth characters :

Observations on growth showed significant increase in height, girth and spread in the case of irrigated plants compared to control plants. Among the irrigation treatments, however, the difference was not significant with respect to all the above growth characters. Increased application of NPK fertilizers treatments, however, affect the growth parameters significantly (Table 27-29). Plants were irrigated through drippers having water flow rate of 2.5 and 5.0 litres/hr. In the case of I_1 and I_2 treatments two drippers (placed at 1m distance from trunk) having water flow rate of 2.5 and 5.0 litres/hr respectively were used. When the system was run for four hr once in four days, the total quantity of water applied was 20 and 40 litres per tree respectively. In the case of I_3 and I_4 treatments three and four drippers (placed at 1m. distance) having 5 litres/hr discharge rate for each dripper were used to make upto 60 and 80 litres/tree respectively. In

Table 27. Ground coverage as affected by irrigation and fertilizer treatments (square metre

Irrigation treatments	Fertilizer treatments				Mean
	M_1	M_2	M_3	M_4	
I_1	7.6	8.6	8.9	8.3	8.35
I_2	9.8	10.2	11.2	12.1	10.82
I_3	10.4	11.8	12.8	13.1	12.02
I_4	12.8	12.9	13.2	14.1	13.25
I_5	13.2	13.8	14.3	15.2	14.12
Mean	10.76	11.46	12.08	12.56	11.71

Table 28. Height (cm) as affected by irrigation and fertilizer treatments

Irrigation treatments	Fertilizer treatments				Mean
	M_1	M_2	M_3	M_4	
I_1	296.50	325.00	320.75	289.75	308.00
I_2	322.25	308.25	345.75	348.75	331.25
I_3	348.25	335.75	327.75	340.00	337.93
I_4	353.50	341.50	341.50	359.75	349.18
I_5	327.25	360.50	358.50	376.50	355.75
Mean	329.55	334.35	338.35	342.95	

CD for irrigation 18.27
CD for fertilizer NS

Table 29. Girth (cm) as affected by treatments

Irrigation treatments	Fertilizer treatments				Mean
	M_1	M_2	M_3	M_4	
I_1	31.75	29.50	27.50	28.75	29.37
I_2	32.75	32.50	34.50	34.50	33.56
I_3	36.00	31.25	30.50	32.50	32.56
I_4	34.50	34.00	32.75	32.25	33.37
I_5	32.50	34.00	36.00	33.00	33.87
Mean	33.50	32.25	32.25	32.20	

CD for Irrigation (Main Plot) 3.126
CD for Fertilizer (Sub Plot) NS

order to study soil moisture depletion and wetting front within the available moisture range, the moisture content at different depths and at different radial distances were determined for two types of drippers having water discharge rates of 2.5 and 5.0 litres/hr.

In the above plot in general the moisture contents at field capacity and wilting point were determined earlier. At field capacity and wilting point the moisture content was found to be 25 per cent and 12 per cent respectively.

Results showed that in the case of 2.5 litres/hr water flow rate at drip point, the moisture content in the first day of irrigation was 25.08 per cent and at 45 cm distance it was 12.16 per cent. This had reduced to 15.14 per cent at drip point and 12.43 percent at 45 cm distance three days after irrigation (Table 30)

Table 30. Moisture distribution with a discharge rate of 2.5 litres/hr for four hours once in four days on the thirtieth irrigation (%)

Days after irrigation	Vertical distance (cm)	Radial distance (cm)			
		0	15	30	45
0	0-25	24.95	17.78	20.07	12.50
	25-50	22.34	20.61	14.24	11.20
	50-75	27.95	21.10	20.24	12.80
	Mean	25.08	19.89	18.18	12.16
1	0-25	25.83	28.25	29.94	12.90
	25-50	21.57	26.63	26.12	14.20
	50-75	17.90	21.16	24.41	13.20
	Mean	21.70	25.34	26.85	13.43
2	0-25	19.88	18.56	22.80	11.80
	25-50	23.42	20.81	23.25	13.00
	50-75	23.00	25.27	17.57	12.80
	Mean	22.1	21.61	21.20	12.53
3	0-25	19.12	21.12	25.65	13.47
	25-50	12.91	13.59	15.18	12.20
	50-75	13.41	14.74	13.56	11.80
	Mean	15.14	16.61	18.13	12.49

Results also showed that moisture in the available range (12 to 25 per cent) spreads upto 45 cm radially and moves as deep as 75 cm from the drip point on the thirtieth irrigation.

In the case of five litres/hr water flow rate at drip point, the moisture content was 29.75 per cent and at 45 cm distance it was 20.4 per cent in the first day of irrigation. This had reduced to 19.52 per cent at drip point and 13.3 per cent at 45 cm distance three days after irrigation (just before the next irrigation) (Table31). Results also showed that moisture in the available range (12 to 25 per cent) spreads upto 45 cm radially and moves as deep as 75 cm from the drip point on the thirtieth irrigation. In the case of control plot the soil moisture per cent was 12.33 at 0 to 75 cm depth 1 meter away from the base of the trunk (Table 32).

Table 32. Moisture content in control plot (Recorded in March)

Depth (cm)	Moisture at 1 metre away from the trunk (%)
0-25	12.20
25-50	11.05
50-75	13.75
Mean	12.33

Table 31. Moisture distribution with a discharge of 5 litres/hr for four hours once in four days on thirtieth irrigation (%)

Days after irrigation	Vertical distance (cm)	Radial distance (cm)				Mean
		0	15	30	45	
0	0-25	32.20	31.49	28.93	20.5	28.28
	25-50	27.65	28.65	28.47	18.2	25.74
	50-75	29.41	29.36	23.32	22.5	26.73
	Mean	29.75	29.73	26.91	20.4	
1	0-25	33.10	24.58	22.17	16.20	24.01
	25-50	26.42	21.31	24.09	15.50	21.88
	50-75	23.92	27.52	24.86	18.30	23.65
	Mean	27.81	24.53	23.70	16.66	
2	0-25	26.78	28.82	29.15	14.1	24.71
	25-50	18.14	19.58	27.23	13.20	19.53
	50-75	19.74	23.44	20.36	14.10	19.41
	Mean	21.55	23.94	25.58	13.80	
3	0-25	18.72	25.11	19.66	13.20	19.17
(Before	25-50	22.38	18.44	26.47	14.20	20.62
next	50-75	17.47	20.80	16.55	12.50	16.83
irrigation)	Mean	19.52	21.45	20.89	13.30	

Agr. IV : Cashew based cropping systems - Inter and mixed cropping with cashew.

(N. Yadukumar and B Nagaraja)

An experiment was laid out in 1987 with an objective of finding out a suitable crop that could be profitably grown during initial years of establishment of cashew orchard.

Growth characters :

Growth characters of cashew grown with different forest species are presented in Table 33. Growing acacia, casuarina, and subabul with cashew upto five years after planting adversely affected the growth cashew.

Photosynthesis and related parameters :

Observations taken using LCA-3 photosynthesis system on photosynthetic and related parameters in cashew grown in different cropping systems also indicated that acacia adversely affected cashew (Table 34). The net photosynthesis (P_n) stomatal conductance (CS) and water use efficiency (WUE) decreased in cashew when intercropped with acacia compared to cashew monocrop.

Biomass studies :

The total biomass produced by acacia, casuarina and subabul per plot and per hectare in different treatments upto five years after planting is presented in Table 35. Maximum number of poles were produced from acacia followed by casuarina and subabul. At existing market rate,

Table 33. Growth characters of cashew under different cashew based cropping systems

Cropping systems	Height (cm)	Girth (cm)	Canopy (cm)	Ground coverage (%)
cashew monocrop	360	36	453	22.0
cashew + acacia	302	26	297	14.3
cashew + subabul	293	33	339	16.6
cashew + casuarina	319	35	341	16.6

Table 34. Photosynthesis and other parameters under different cashew based cropping systems

Cropping systems	P_n (μ mol CO_2 $M^{-2}S^{-1}$)	CS (mol $m^{-2}s^{-1}$)	Ci (Mul/l)	E (mmol H_2O m^{-2} s^{-1}	WUE (μmol CO_2/mmol H_2O)/Sec
cashew monocrop	9.6	0.80	256	6.65	1.44
cashew + acacia	2.7	0.72	236	8.02	0.37
cashew + casuarina	4.6	0.80	204	7.24	0.63
cashew + subabul	6.1	0.79	214	7.05	0.86

Table 35. Biomass produced by tree species (ton/plot) and revenue realised from useful poles

Crops	Leaves and twigs (dry weight)	Stems and branches (dry wt.)	Poles of 5m and above		Rate/pole (Rs)	Total revenue
			Nos. /plot	Nos./ha		
acacia	1.01	3.7	92	2392	15	35,880
casuarina	0.69	2.8	72	1872	30	56,160
subabul	0.90	1.6	35	910	15	13,650

casuarina poles fetched maximum price and the same was highly profitable also (Rs. 56,160/ha.).

Yield :

The yield data during the initial three to five years after planting is presented in Table 36. Highest yield was realised from the plot intercropped with pineapple, while plot intercropped with acacia yielded lowest. Considerable increase in yield in acacia and casuarina plot was mainly due to reduction of population to 78 and 50 per cent respectively by thinning in both cases, three and four years after planting. The yield from guava was only 13.3 kg/ plot of six plants five years after planting. The low yield is attributed to non realisation of the crop in the summer season due to heavy fruit drop in the initial stage of setting. As pineapple was replanted after four years the yield was not realised and the growth of the replanted pineapple is poor due to shade of cashew.

Table 36. Initial yield of cashew under different cropping systems

Cropping systems	Yield kg/384 M^2 plot			
	3 years after planting	4 years after planting	5 years after planting	Cumulative yield
cashew monocrop	2.54	4.40	5.60	12.54
cashew + annual crops*	2.31	3.20	4.60	10.11
+ annual crops**	1.75	3.40	3.60	8.75
cashew + pineapple	4.51	5.40	8.80	18.71
cashew + guava	2.98	3.30	5.30	11.58
cashew + Mucuna spp.	2.06	4.13	4.46	10.65
cashew + acacia	0.40	1.33	2.03	3.76
cashew + casuarina	0.86	2.50	4.06	7.41
cashew + subabul	1.35	2.60	4.12	8.07

* For the first two years intercrops grown were tapioca and pigeon pea

** For the subsequent three years intercrops grown were cashew and sunflower, sweet potato and cucumber (1 year)

Agr. V : Orchard management - Comparison of hedge and square system of planting under pruned and unpruned conditions.

(N. Yadukumar)

This project was started in 1980 with the main objective of increasing yield/unit area by adopting optimum population through proper spacing, system of planting and pruning. The treatment details are given below :

Design : Split plot Replication : 3

Treatments

Main plot	Sub-plot
5 x 5m square	Pruned
6 x 6m square	Unpruned
8 x 8m square	
3 x 4m hedge	
6.5 x 4m. hedge	
8 x 4m hedge	

The plants have been maintained well by attending initial shape pruning. Central leader system of pruning will be imposed in 1993 when once the plants attain proper canopy.

Agr. VI : Development of suitable cashew based cropping systems

(N. Yadukumar and B. Nagaraja)

Two experiments, namely cashew with forest species and cashew with fruit crop were laid out at Kemminie and Shanthigodu respectively after clear felling of existing cashew based cropping systems.

Cashew with forest species :

Observations on growth characters showed that growing forest species with cashew did not affect girth, height, spread and ground coverage even three years after planting indicating that forest species can be grown without any detrimental effect on cashew in the initial three years (Table 37).

Observations on photosynthesis, PAR, transpiration and stomatal conductance in cashew when grown with forest species also showed no symptom of competition till three years after planting (Table 38).

Cashew with fruit crops :

Despite the utmost care taken, the fruit crops, custard apple (Sitaphal) and

Table 37. Growth characters of cashew as affected by growing forest species

Treatments	Population/ plot	Girth (cm)	Height (cm)	Spread (cm)	Ground CO_2 verage (m^2)
cashew + casuarina + acacia	20-42-21	15.8	165	164	2.10
cashew + acacia + casuarina	20-42-39	13.6	126	151	1.78
cashew + bamboo	20-15	15.2	151	174	2.36
cashew + subabul	20-225	15.0	152	167	2.19
cashew + ailanthus	20-57	13.6	143	158	1.95
cashew high density	40	13.6	133	137	1.48
cashew alone	20	14.0	135	160	2.01

Table 38. Photosynthesis, PAR, transpiration, stomatal conductance as affected by growing forest species in cashew orchard

Treatments	PAR (µmol m^{-2} s^{-1})	PN (µmol $CO_2 m^{-2}$ s^{-1})	Transpiration (mmol H_2O $m^{-2}s^{-1}$)	CS (Mol/m^2/s)	Intercellular CO_2 concentration Mul/l
cashew + casuarina +acacia	790	6.58	5.66	0.284	239
cashew+acacia + casuarina	836	4.48	6.90	0.280	249
cashew + ailanthus	1415	6.20	8.96	0.654	261
cashew + bamboo	1333	5.28	9.04	0.542	265
cashew + subabul	1053	6.72	6.08	0.224	222
cashew high density	1137	9.48	8.12	0.852	266
cashew alone	1342	7.58	6.58	0.270	225

ber have not established well. Garcinia grew well during rainy season, but started wilting when exposed to open sun during peak summer season. Nearly 20 percent of the population died due to this. The remaining plants have been protected by providing shade.

Agr. VII : Comparative efficacy of slow release nitrogenous fertilizers for cashew.

(N. Yadukumar)

The experiment was laid out in 1990 with M 44/3 cashew grafts. The treatment will be imposed three years after planting. Till then, the recommended doses 500g N, 125g P_2O_5 and 125g K_2O of fertilizers are applied in the form of urea, rock phosphate and muriate of potash. The treatment details are given below:

Design : RBD Replications : 3

Treatments :

Applications of fertilizers @ 500g N, 125g P_2O_5 and 125g K_2O/tree/year in the forms as described below. The fertilizer dose from 1 to 10 also has 125g P_2O_5 and 125g K_2O tree/year besides urea.

1. Urea in two split doses/year
2. Urea in one application
3. Urea in perforated polybags once in a year
4. Urea in perforated polybags once in two years
5. Urea formaldehyde once in a year
6. Urea formaldehyde once in two years
7. Neem coated urea once in a year
8. Neem coated urea once in two years
9. Lac coated urea once in a year
10. Lac coated urea once in two years
11. NP tablet once in a year and 125g K_2O in the form of muriate of potash.
12. NP Tablet once in two years and 125g K_2O in the form of muriate of potash.

Phy III : High density planting of cashew

(N Yadukumar)

An experiment was initiated in 1982 to assess the effect of different plant densities on growth and yield.

Growth characters:

Studies on growth characters revealed that the girth decreased with increasing plant density whereas, the trend was reverse in the case of plant height. (Table 39). Percent ground coverage by the canopy of the plants increased with decreased plant density per unit area except in the case of treatment five where the density was 2500 for the first seven years and later on reduced to 625 plants/ ha by thinning. After thinning, canopy coverage reduced and gradually increased to 96.5 per cent within three years of thinning. But 100 per cent ground coverage was not achieved in this treatment even three years after thinning due to initial lanky growth and bending in most of the plants, thereby some area is always exposed to sunlight.

Yield :

Maintaining the plant density of 625 trees/ha (Table 40) resulted in continued higher yield compared to other treatments (503 kg/ha). The yield in general was low

during the season 1991-92. Hence, in all the treatments, the yield recorded in 1992 was lower than that of the previous year (1991).

Table 39. Growth characters as affected by plant density

Treatment	Density Nos/ha	Girth (cm)	Height (cm)	Average ground cover-age/tree (M^2)	Ground cover-age in the given area (%)
T_1	156	79	715	37.6	58.6
T_2	278	76	687	30.6	84.0
T_3	625	75	850	20.7	100.0
T_4	*1111	70	882	19.3	100.0
T_5	*2500	71	872	15.4	96.5

* The density upto 7 years was 1111 plants/ha and 555 plants/ha after thinning

** The density upto 7 years was 2500 plants/ha and 625 plants/ha after thinning

Table 40. Yield of nuts under different plant densities (8,9 and 10 years after planting)

Treatment	Plant density	Yield (kg/ha)			Cumulative yield (Kg/ha)
		1990	1991	1992	
T_1	156	240	311	281	832
T_2	278	297	469	395	1161
T_3	625	468	619	503	1590
T_4	*1111	395	594	369	1268
T_5	*2500	256	374	344	974

**T_4 1111 plants/ha upto 7 years and 555 after thinning

**T_5 2500 plants/ha upto 7 years and 625 after thinning

Hort. II(a) : Demonstration of beneficial effects of pruning in cashew

(MG Nayak)

Based on the results from an earlier experiment a trial on leader shoot pruning was initiated at Experimental Station, Shanthigodu during the year 1988 with an objective of demonstrating the beneficial effects of pruning on a large scale.

Among sixty trees (VTH 174) planted during the year 1976, thirty were pruned and the remaining thirty served as control. Pruning was done during the second week of August by heading back the leader shoots to two thirds of their original length

and upto 60 per cent of leader shoots in a tree. The three years mean yield of trees selected for pruning before initiating the trial was 3.65 kg while that of control was 3.08 kg. Higher yield (5.88 kg) recorded after the first year of pruning justified the need for pruning in older plantations (Table 41). In the subsequent harvests also, the pruned trees continued to yield higher although the yield in general was poor.

An 'On farm' trial was initiated in KCDC plantations at Kunthur in 1992 to confirm the results of leader shoot pruning. Sixty trees each were utilised for control, leadershoot pruning and for pruning the deadwood alone. The initial observation during 1992-93 harvest season indicated positive effect on crop yield and it was similar to that of ongoing pruning trial.

Table 41. Mean yield (kg/tree) of pruned and unpruned trees

		Yield (kg/tree)	
		Pruned	Unpruned
Three years mean before imposing pruning treatment		3.65	3.08
After imposing pruning treatment	1988-89	5.88	2.61
	1989-90	2.32	1.17
	1990-91	3.93	1.36
	1991-92	2.19	1.23
	Mean	3.58	1.59

Hort. IV : Studies on off season graft production in cashew.

(MG Nayak and KRM Swamy)

This project was started with an objective of finding out the possibility of producing soft wood grafts of cashew during off season including flushing, flowering and fruiting and drier months. The studies indicated that off season grafting can be successfully carried out by utilizing green scion sticks, (2.5 - 3 month old) with a mean graft success of 59.0 and 51.9 per cent respectively.

Softwood grafting with green scion sticks

Soft wood grafts were prepared utilizing 45 and 60 day old green scion sticks during November 1992 to February 1993. Soft wood grafts prepared with 60 day old green scion sticks gave a mean graft success of 59.0 per cent whereas, the success was 34.1 per cent with 45 day old scions (Table 42). Thus, off season graft production can be successfully carried out with 60 day old green scion sticks during flushing/ flowering/ fruiting period.

Softwood grafting with decapitated flowered lateral shoots as scions

Soft wood grafts were prepared utilizing the decapitated flowered lateral

Table 42. Graft success with green scion sticks during 1992

Month of grafting	Age of scions (days)	No. of grafts prepared	Graft success (No.)
Nov.	45	1300	400 (30.7)
Dec.	45	1575	580 (36.8)
Total		2875	980 (34.1)
Nov.	60	1000	615 (61.5)
Dec.	60	1350	735 (54.4)
Jan.	60	7175	3996 (55.7)
Feb.	60	3300	2726 (67.4)
Total		12825	7572 (59.0)

Figures within parantheses indicate per cent success

Off season grafting with 60 day old green scion sticks

shoots (2.5 - 3 month old) as scion during January-February 1993. A mean graft success of 51.9 per cent was recorded (Table 43). Thus, off season graft production is possible with the use of decapitated flowered lateral shoots (2.5 - 3 month old) as scions.

Soft wood graft production under low cos humidity chamber :

Studies were continued with the us of low cost humidity chamber during 199 93 to find out the possibility of increasin the graft success during drier months.

Table 43. **Graft success with decapitated flowered lateral shoots as scion during 1993**

Month of grafting	No. of grafts prepared	Graft success (No.)
Jan	200	115 (57.5)
Feb	700	352 (51.2)

figures within parantheses indicate per cent success

45 day old flowered lateral shoots used as scions for soft wood grafting during off season

set of soft wood grafts prepared by covering individual graft with a white polythene cap (normal method) was used as control. The mean graft success is presented in Table 44. The per cent graft success with low cost humidity chamber and normal method was similar.

Table 44. **Graft success under low cost humidity chamber**

Month of grafting	No. of grafts prepared	Graft success (%)	
		Low cost humidity chamber	Normal method
Jan	100	76.0	74.0
Feb	100	62.0	66.0
Mar	100	64.0	63.0
Apr	100	72.0	68.0
May	100	71.0	70.0
Total	500	69.0	68.2

Hort V : Root stock studies in cashew

(MG Nayak and KRM Swamy)

This project was started with an objective of screening cashew types at nursery stage for dwarfing character on the basis of morphological and anatomical features. Preliminary studies conducted on different cashew types indicated that the morphological and anatomical characters of seedlings do not serve as an index for selecting dwarfing root stocks at nursery stage. During the cashew germplasm collection survey in Kolar district in 1992, a medium dwarf tree (H Gollahally-1) was identified and the seednuts were collected for evaluation.

Survey for identification of dwarf types

While surveying the cashew growing areas in Kolar district of Karnataka for Cashew germplasm during April 1992, a medium dwarf tree (H Gollahally-1) was identified. The seednuts from this medium dwarf tree from H. Gollahally and tre identified at CPCRI, RS, Vittal wer collected and sown in polythene bag (Table 45). The bulk seednuts of Brazili origin with nut weight ranging between 5 and 12.2g received from Kerala Nut Foo Company, Kollam, Kerala, were also sow in polythene bags after treatment wit captan (1%). The available seedlings wi be planted in the field with closer spacin in order to isolate dwarf types.

Intergenetic grafting of cashew

In order to explore the possibility o utilizing Indian marking nut/oriental cashew (*Semecarpus anacardium*), as a root stoc for cashew (*Anacardium occidentale* L.) th seednuts of marking nut were collected fro Dharwad and sown in polythene bags fo raising seedlings which will be utilized a root stocks for cashew. The scion stick

Table 45. Cashew seednuts of medium dwarf trees and bulk seednuts of Brazilian origi sown during November 1992 for raising seedlings.

Tree No./ Collection No.	Source of collection	Mean nut weight (g)	No. of seeds sown
VTH 762/2 I	CPCRI, RS, Vittal	3.5	50 (3)
VTH 762/4I	-do-	3.5	50(5)
S 11/1	-do-	4.3	50 (32)
S 11/2	-do-	4.6	50 (12)
H Gollahally-1	Mulabagal Taluk	6.0	50 (6)
Brazil-I	Kerala Nut Food Co., Kollam, Kerala	12.2	33 (6)
Brazil-II	-do-	8.6	76 (31)
Brazil-III	-do-	5.7	66 (24)

Figures within paratheses indicate the number of seedlings available for planting.

Six month old seedlings of Brazilian nuts and semi dwarf types. (L to R. Brazil-I, Brazil-II, Brazil-III, H-Gollahally-1, S 11/1, S11/2, VTH 762/4 I and VTH 762/2 I).

(40 Nos.) of marking nut tree were grafted on cashew root stocks but they were not found to be graft compatible. Other tree species belonging to *Anacardiacae*, namely, *Mangifera indica*, *Buchanania lanzan* and *Holigrana sp*, were also tried as root stocks for cashew without much success.

Hort. VI : Comparing the economics of top working with replanting of cashew

(KRM Swamy and PS Bhat)

This project was started with the objective of comparing the economics of top working with replanting of cashew. The cost of establishment and maintainance of top worked plot and replanted plot during the first three years was Rs. 15,205 and Rs. 9790/ha respectively. An "On Farm trial" of top working was also initiated in the

KCDC Plantation at Kunthur. Thirty 14 year old trees were top worked with VTH 30/4 by adopting soft wood grafting technique during September-October 1990. Adjacent to this plot, 30 cashew trees were completely removed and replanted with one year old grafts of VTH 30/4 during 1990. Of the 30 top worked trees, 11 trees died due to stem and root borer (*Plocaederus ferrugineus*) infestation during 1990-91. Swabbing of the trunk of top worked trees with 0.2 per cent carbaryl was taken up at bimonthly interval as a prophylactic measure against stem and root borer. Fresh infestation was not noticed during the year. The height and girth of grafted shoots of the top worked trees and replanted cashew grafts were recorded after 2.5 years of grafting/planting (Table 46). The shoot length of top worked trees ranged from 166.8 to 375.7 cm with a mean of 257.7 cm. The girth of shoots above the graft joint ranged from 13.8 to 26.0 cm with a mean of 20.0 cm. The plant height of replanted cashew grafts ranged from 100 to 200 cm with a mean of 150 cm. The girth of plants 15 cm above ground level ranged from 11.0 - 17.0 cm with a mean of 13.9 cm. The growth of the grafted shoots of the top worked trees was very vigorous as compared to that of the replanted cashew grafts. The yield of the top worked trees ranged from 1.34 to 2.46 kg/tree with a mean of 1.87 kg/tree (Table 46). The cost of establishment and maintenance of 0.2 ha each of top worked and replanted plots during the first three years was Rs. 3041 (Rs. 15205/ha) and Rs. 1958 (Rs. 9790/ha) respectively (Table 47).

'On Farm Trial' of top working at Kunthur.

An "On Farm Trial" of top working was established in the KCDC Plantation, Kunthur during May 1992. Sixty 11 year old trees were utilized for top working. The pre-trial yield of these trees was 0.75 kg/tree. The selected trees were headed back to a height of 1.0 m from ground level and the cut surface was treated with

Table 47. Cost of establishment and maintenance of 0.2 ha each of top worked and replanted plots during the first three years.

Year	Amount spent (Rs)	
	Top worked plot	Replanted plot
First	1241	620
Second	845	530
Third	955	808
Total	3041	1958

Table 46. Shoot length, girth and yield of top worked trees and replanted grafts during 1993

Plot	Shoot length/plant height (cm)	Shoot girth/trunk girth (cm)	Yield/plant (kg)
Top worked plot	Min. 166.8	13.8	1.34
	Max. 375.7	26.0	2.46
	Mean 257.7	20.8	1.87
Replanted plot	Min. 100.0	11.0	—
	Max. 200.0	17.0	—
	Mean 150.0	13.8	—

Bordeaux paste. Prophylactic treatment of the stumps was taken up with coal tar and kerosene (1:2) upto a height of 30 cm from ground level and the remaining portion was swabbed with carbaryl (0.2%). The tunk portion was examined frequently for the incidence of stem and root borer and shot hole borer (*Xyloborus perforans* Wall). Stem and root borer infestation was noticed in most of the beheaded trees during July 1992. After extracting the grubs by removing the bark from the affected region, carbaryl (1%) was applied to this region. Carbaryl (0.2%) was applied to the remaining portion of the trunk. During August 1992, incidence of shot hole borer was also noticed in most of the trees. Shot hole borer infestation could not be controlled despite swabbing with carbaryl (0.2%) and drenching with monocrotophos (0.1%) was continued at monthly intervals. Only 20 per cent of the top worked trees (12 Nos.) survived and the remaining trees died due to stem and root borer and shot hole borer infestation. The incidence of different insect pests on top worked trees is presented in Table 48. Sprouting was observed in most of the beheaded trees 45 days after heading them back. During July-August the juvenile shoots of pencil thickness were grafted with the precured scion sticks of VTH 170 by adopting soft wood grafting technique. The per cent graft success ranged from 50 to 100. The expenditure incurred for establishing and maintaining 0.4 ha top worked plot at Kunthur during the first year was Rs. 2455 (Rs. 6138/ha). From each tree (11 year old) approximately 0.5 cubic meter of firewood was obtained (total 30 cubic meters). By sale of firewood (Rs. 60/cubic meter) a total revenue of Rs. 1800 was realised. Therefore, about 70 per cent of the establishment cost can be realised by sale of firewood (Table 49).

Table 48. Pest incidence on top worked cashew trees at KCDC Kunthur

Insect pest	No. of trees infested	Infestation (%)
Steam and root borer	34	57.0
Shot hole borer	52	87.0
Stem and root borer and shot hole borer	34	57.0
Borer in the graft joint	5	8.4

Table 49. Cost of establishment and maintenance of 0.4 ha top worked plot during first year at KCDC., Kunthur

Item of expenditure		Amount (Rs)
Heading back of trees (30 cubic meter of fire wood. Cutting charges @ Rs. 20/- cubic meter)		600
Maintenance of plot (15 Mandays @ Rs. 30)		450
Terracing and fertilizer application (60 Nos. @ Rs. 3)		180
Scion collection, grafting, etc. (10 Mandays @ Rs. 30)		300
Plant protection chemicals :		
Carbaryl 1 kg	Rs. 270	
Monocrotophos 500 ml	180	
Lime 5 kg	25	925
Copper sulphate 4 kg	220	
Coal tar 10 litres	150	
Kerosene 20 litres	80	
Total		2455

Hort. VII : Studies on endogenous growth substances in relation to flowering and fruiting in cashew

(MG Nayak)

This project was initiated with an objective of standardising the techniques for extraction, isolation and identification of hormone and hormone like substances associated with flowering and fruiting in cashew.

A paddy coleoplite bioassay was standardised to detect the presence of auxin like activity. Five locally available paddy varieties were tested for their response to IAA at various concentrations (0 to 100 µg). Among the varieties tested (Jyothi, Phalguna, Shakthi, KKP-2 and Rajakayamme), Jyothi, responded well as assessed by its coleoptile elongation followed by Rajakayamme, a local tall growing type (Fig. 1). The methanolic extract of

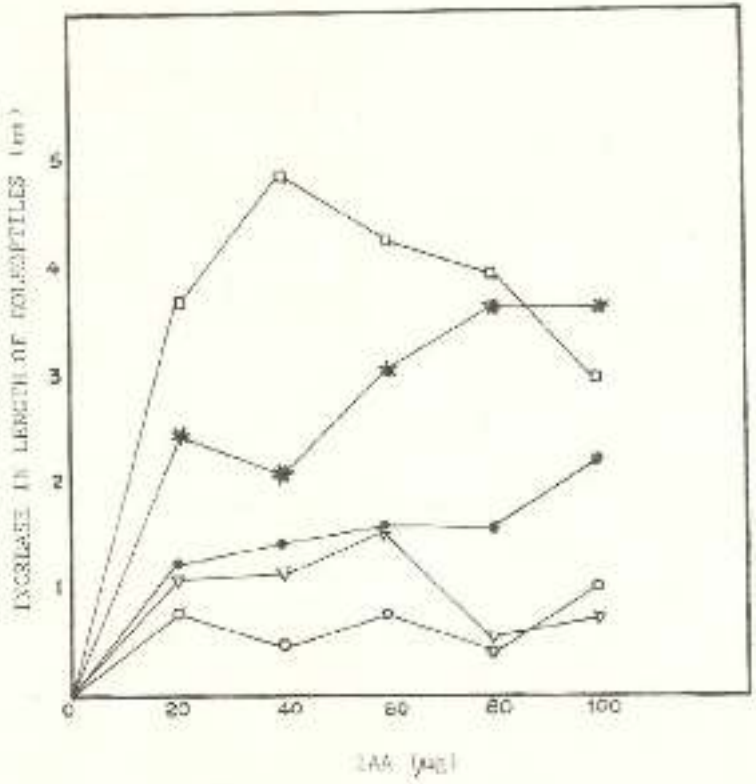


Fig. 1. Response of paddy varieties to various concentrations of IAA.

□—□ Jyothi, ×—× Rajakayamme, ●—● Phalguna, ▽—▽ Shakthi
○—○ KKP-2

young shoot tips of a cashew variety (V-1) when bioassayed using paddy coleoptiles had shown similar effects of IAA on paddy coleoptiles (Table 50).

Table 50. **Response of paddy coleoptiles (Var. Jyothi) at different concentrations of methanolic extract of cashew shoot tips (Var - V-1)**

		Mean length of coleoptiles* (mm)	
		12 hr	24 hr
Control (2% sucrose)		6.0	6.5
Methanol	100 µl**	6.2 (0.2)	7.0 (0.5)
	200 ml	6.6 (0.6)	7.0 (0.5)
	300 µl	6.1 (0.1)	7.0 (0.5)
Extract	100 µl	7.8 (1.8)	8.1 (1.6)
	200 µl	8.1 (2.1)	8.8 (2.3)
	300 µl	7.9 (1.9)	8.5 (2.0)

* Initial length of coleoptiles was 5 mm.
Ten coleoptiles were used for each replication and values are mean of 3 replications.
** Final volume of the solution was made upto 5 ml with 2% sucrose.
Figures within parantheses indicate the increase in length over control.

Hort. VIII : Pruning studies in Cashew

(MG Nayak)

This project was initiated with an objectives of understanding the pruning effects with respect to dwarfing and canopy containment, flushing and flowering and branching habit of cashew. Further it envisages to understand the mechanism of yield improvement due to leader shoot pruning. For this purpose a field trial with four cashew varieties namely VRI-1 (intensive branching and early flowering type), Ullal-1 (extensive branching and late flowering type), VTH - 30/4 (extensive branching and late flowering type) and NRCC Selection-1 (extensive branching and late flowering type) has been laid out at Experimental Station, Shanthigodu, during the year 1992 with three replications in a Completely Randomised Block Design. Pruning treatments will be imposed in the third year of planting.

CROP PROTECTION

Prophylactic control trial against stem and root borer *(Plocaederus ferrugineus)* was repeated at three months interval and after completion of four rounds, lowest infestation of four per cent was noticed in neem oil and coal tar + diesel (1:2) treatments. The entomopathogenic fungi *Beauveria bassiana, B. brongniartii* and *Metarhizium anisopliae* brought mycosis in grubs of stem borer with mortality of 90 per cent, 50 per cent and 40 per cent respectively when the spore suspension was applied under laboratory condition.

Among three alternate hosts tried for tea mosquito bug *(Helopeltis antonii)*, egg parasitoid *Telenomus* sp. emergence was noticed in case of *H. theivora*. In field condition, parasitization by *Telenomus* was observed throughout the year. To develop economic threshold for this pest, the population and damage were recorded at weekly intervals.

Among the various plant products tested against tea mosquito bug, emulsion of pongamia oil in water only had high knock down mortality of 90.8 per cent. Among the ethanol extracts, pongamia oil and neem seed kernel extract showed better knock down mortality of 75.0 and 65.7 per cent respectively. Carbaryl Flo, a new formulation, was found to be as effective as carbaryl WP with lower tea mosquito bug incidence.

Ent. V : Developing integrated pest management package against cashew stem and root borers

(P. Shivarama Bhat)

Work under prophylactic, biological and mechanical methods were continued during this year to develop an integrated pest management package against cashew stem and root borer.

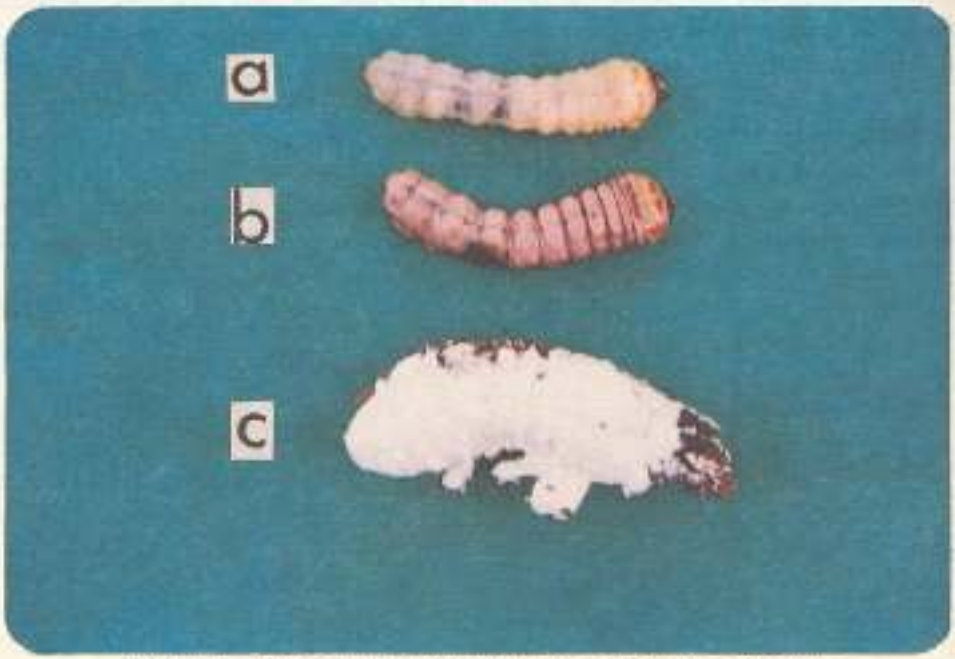
Prophylactic control trial

Prophylactic control was repeated and the details of the treatments are presented in Table 51. After completion of four rounds, lowest infestation was noticed in neem oil and coal tar + diesel (4 per cent). The cost of application was least for Neemark (Rs. 1.21/tree/round) followed by aldrin and neem oil. Although coal tar + diesel was effective, the cost involved in application was very high (Rs. 4.62/tree/round).

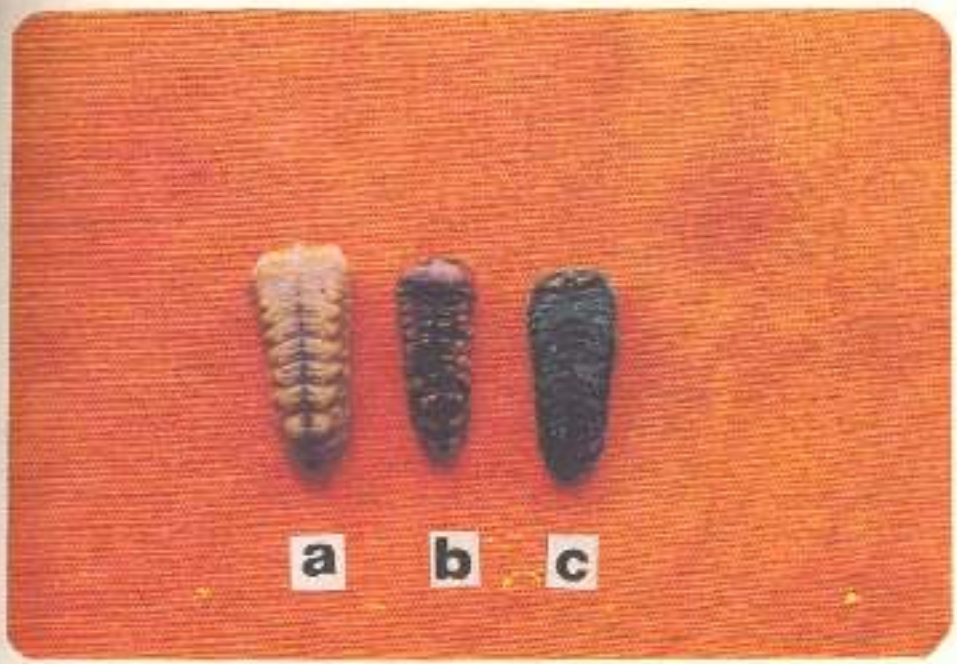
Testing the efficacy of pathogens :

Efficacy of bio-control agents like *Beauveria bassiana*, *B. brongniartii* and *Metarhizium anisopliae* was studied under laboratory condition in bringing about mycosis of the grubs.

All the three pathogens were multiplied on sterilized jowar grain and fifteen



Mycosis in *Plocaederus ferrungineus* due to *Beauveria bassiana*
(a-healthy, b-initial symptoms, c-dead with mycelial growth)



Mycosis in *Plocaederus ferrugineus* due to *Metarhizium anisopliae* (a-healthy, b-initial symptom, c-dead with mycelial growth).

Table 51. Stem and root borer incidence under prophylactic control trial

Treatment	Per cent trees attacked after				
	First round	Second round	Third round	Fourth round	Cost/tree/round (Rs.)
Coal tar + Diesel (1:2)	4	4	4	4	4.62
Neemoil (6%)	0	0	0	4	2.18
Neemark (0.4%)	4	4	4	8	1.21
Aldrin (0.2%)	4	8	8	8	1.98
Carbaryl (0.2%) + Sevidol G*	4	8	—	—	3.10
Control	4	8	12	12	—

* Basal application was done at 75g/tree after swabbing the trunk with carbaryl 0.2%

day old culture was used for experimental purpose. The spore suspension was prepared by macerating the spawn in distilled water. The three methods tried were (i) direct spraying of spore suspension over the body of the grub (ii) soaking the bark pieces in spore suspension and allowing the grubs to feed and (iii) mixing the fungal suspension in saw dust and allowing the grubs to feed.

In the case of *Beauveria bassiana*, due

to infection, black spots started appearing on the body of the insect and later the whole body turned pinkish. The grubs became very sluggish and stopped feeding before death due to microbial infection. Within few days of death whitish mycelial growth started appearing on the body of the insect. Direct application of spore suspension brought about 90 per cent mortality 45 days after treatment. The mortality was delayed in the case of soaking the bark and mixing with saw dust. After 45 days of treatment, mortality was 60 per cent in both the applications (Table 52).

The symptoms due to infestation by *Beauveria brongniartii* was similar to *B. bassinna*. The development of infection and mortality is presented in Table 53. The mortality was 50 per cent when spore suspension was applied directly over the insect body.

Due to infection by *Metarhizium anisopliae*, irregular black patches started appearing on the body of the insect. At later stages, the grub became sluggish and finally died. Greenish powdery mass was clearly visible throughout the body of the insect after complete sporulationn. The per cent mortality was 40.0 due to direct application and 20.0 when applied indirectly (Table 54).

Table 52. Development of mycosis in cashew stem and rootborers due to *Beauveria bassiana*

Mode of application	15 DAT*		30 DAT		45 DAT	
	Infected %	Dead %	Infected %	Dead %	Infected %	Dead %
Direct	70	60	80	60	90	90
Soaking the bark	20	10	40	10	60	60
Mixing with saw dust	0	0	20	0	60	60
Control	0	0	0	0	0	0

*DAT - Days after treatment

Table 53. Mycosis in cashew stem and root borers due to *Beauveria brongniartii*

Mode of application	15 DAT*		30 DAT		45 DAT	
	Infected %	Dead %	Infected %	Dead %	Infected %	Dead %
Direct	20	10	20	20	50	50
Soaking the bark	10	0	10	10	20	20
Mixing with saw dust	10	10	10	10	20	20
Control	0	0	0	0	0	0

* DAT - Days after treatment

Table 54. **Mycosis in cashew stem and root borers due to *Metarhizium anisopliae***

Mode of application	15 DAT*		30 DAT		45 DAT	
	Infected %	Dead %	Infected %	Dead %	Infected %	Dead %
Direct	60	40	60	40	60	40
Soaking the bark	10	10	20	10	20	20
Mixing with saw dust	0	0	10	0	20	20
Control	0	0	0	0	0	0

* DAT - Days after treatment

Light and CNSL trap studies

Light and cashewnut shell liquid (CNSL) traps were ineffective in attracting adult beetles.

Trap crop studies

Silk cotton has been planted as a trap crop in infested cashew plantation at Shathigodu.

Ent. VI : Biological control of tea mosquito bug and other sucking pests.

(D Sundararaju)

The project was initiated to study and evolve biological control measures for tea mosquito and other sucking pests of Cashew.

a. **Culturing of *Telenomus* Sp. egg parasitoid of tea mosquito bug (TMB).**

The culturing of egg parasitoid was attempted on the eggs of three host insects viz., red cotton bug *(Dysdercus cingulatus)*, mirid bugs *(Pachypeltis mesaerum* and *Helopeltis theivora)*. The results indicated that none of the adult female parasitoids oviposited on eggs of the host insects except in *H. theivora*. The level of parasitization observed was 22.2 per cent (Table 55).

Table 55. **Culturing of *Telenomous* sp. on the eggs of different host insects.**

Host	No. of eggs exposed	No. of eggs parasitized	% parasitization
Red cotton bug (*Dysdercus cingulatus*	71	Nil	0.0
Mirid bug (*Pachypeltis mesaerum*)	37	Nil	0.0
Tea mosquito bug (*Helopeltis theivora*)	63	14 (2)	22.2 (3.2)

Figures within parentheses indicate adult parasitoids visually confirmed.

Simultaneously, culturing was also attempted on the eggs of tea mosquito. The tender shoots of potted seedlings of cashew and cotton without leaves were exposed for oviposition by gravid females of tea mosquito for 24 hr. A transparent plastic bottle cage with a nylon cloth sleeve having one day old single pair of parasitoids was secured tightly over top portion of the tender shoots of cashew and cotton having one day old eggs. This plastic bottle cage was transferred to new plants containing host eggs at two days interval. By this method condensation of water vapour inside the cage has been completely avoided. But most of the parasitoids escaped on the same day of release as well as within a period of five days time through nylon sleeve. Parasitization, however, was observed in some of the cages. After two days of exposure, the seedlings containing parasitised eggs were maintained under nursery condition upto 45 days. On the fortyfifth day, the level of parasitisation was ascertained by examining eggs under microscope and a maximum of 19.5 per cent parasitization was observed. Further, most of the shoots containing host eggs were dried completely.

b. Survey on other natural enemies of TMB.

During the survey one more species of egg parasitoid resembling *Erythmelus helopeltidis* has been collected. In almost all the locations, one species of mite has been observed near the vicinity of eggs of TMB (Table 56). The results revealed the occurrence of *Telenomus sp.* throughout the year whereas the occurrence of the *Chaetostricha* was observed only during cropping season. Nymphal or adult parasitoids was not observed.

Several incidence of *H. theivora* was observed during August-September on *Chromolaena odorata*, a perennial weed occurring in cashew plantations both at Kemminje and Shanthigodu. Further migration and multiplication of *H. theivora* in the post monsoon flushes of cashew emerging after September was found to be very meagre and this pest confines to itself on *C. odorata*. As continuous population of *Helopeltis* genus was observed throughout the year (*Helopeltis antonii* during cropping season and *Helopeltis theivora* on *C. odorata* during off season), the chances of establishment of parasitoid are promising.

c. Studies on conservation and enhancement of egg parasitoid *Telenomus* sp. of TMB.

Studies were undertaken throughout the year to find out the activities of parasitoids in order to develop suitable conservation and enhancement methods by manipulation of its environment in a favorable way.

1. Studies on seasonal occurrence of parasitoid during off season and cropping season of cashew.

In the tender flushes and partially matured shoot (green shoot), the eggs of TMB are laid on midrib and petiole of leaf, as well as in the shoot region, whereas, in the matured shoot, the eggs are laid only in the petiole of leaf and shoot region. With a view to find out the extent of emergence and carry over of parasitoids during ensuing season, eggs laid only on mid ribs of leaves were collected at weekly intervals from July to third week of September from

Table 56. Emergence of parasitoids from eggs, nymphal and adult population of *H. antonii* during 1990-92.

	Details of eggs observed at three locations						No. of days taken for emergence of egg parasitoids (Range)			Total No. of nymphs and adults observed at		
	I		II		III							
	A	B	A	B	A	B	I	II	III	I	II	III
June 90 and 91	17	2	30	2	11	5	21-22	12-32	14-16	—	—	—
July 91	6	5	130	18 (1)	110	40	7-40	6-30	4-31	—	—	5
Aug. 91	10	5	95	8	39	6	16-33	12-20	13-32	1	4	1
Sep. 91	2	—	61	9	35	4	—	17-29	25-42	1	4	20
Oct. 91	2	—	93	32 (2)	13	3 (2)	—	5-32	16-67	—	5	—
Nov. 91	12	2 (1)	138	14 (3)	96	24 (1)	7-17	2-48	12-34	15	23	17
Dec. 91	17	2	238	35 (9)	112	14 (1)	8	13-45	10-36	15	60	18
Jan. 91 and 92	18	4 (2)	183	20 (3)	144	12	12-59	20-60	20-35	6	18	19
Feb. 92	77	16 (6)	294	10 (2)	266	62 (5)	2-18	2-27	18-43	18	108	45
Mar. 92	35	11 (4)	256	5 (2)	227	25 (5)	2-30	8-21	2-26	17	41	25
Apr. 92	34	1 (1)	41	3 (1)	63	5	20	26-60	14-20	12	13	9
May 92	73	5	83	9 (2)	163	44 (7)	32-66	5-64	2-55	12	32	21
Total/range in days	305	53 (13)	1642	166 (25)	1279	244 (21)	2-66	2-64	2-67	97	308	180
% parasitization		17.4 (4.3)		10.1 (1.5)		19.1 (1.6)				Nil	Nil	Nil

I, II, III : Locations (I = Mane; II = Panemangalore; III = Konaje)

– Number of eggs collected in respective month of two years.

Numer of parasitoids (*Telenomus* sp. (Latios group) and *Chaetostricha* sp.) emerged out in respective months in two years.

Figures in parantheses indicate *chaetostricha* sp.

the post harvest flushes which mostly emerged during the period from March to May. The emergence of parasitoids was observed upto 90 days after which the eggs of TMB were dissected to find out the unemerged and dead parasitoids, if any. During dissection of eggs, two types of chorion (egg cuticle) were observed. In the hatched eggs (unparasitised eggs), only whitish shrivelled chorion was observed whereas, the parasitized eggs maintained almost full shape of the egg with a outer normal whitish chorion and inner melonised brownish chorion. Therefore the eggs with melonised chorion were counted as parasitized eggs.

Similarly, the eggs of TMB were collected from the last week of September onwards and from the post monsoon flushes which were exposed to routine chemical control measures. The extent of parasitization was recorded (Table 57). Maximum of 54.3 per cent parasitization was observed in the post harvest flushes. The emergence of parasitoid was observed upto 23 days from the egg samples collected in the second week of September which coincides with emergence of post monsoon flushes. The carry over of parasitoids from post harvest flushes to post monsoon flushes has been confirmed besides continuous multiplication of parasitoids in the freshly laid eggs in the matured shoot and in the petiole of leaves during rainy season

The parasitisation was also found to be continuous in the post monsoon flushes (cropping season flushes) and the emergence of parasitoid was observed upto 78 days from the eggs collected during first week of November. The studies give an indication that whenever the synchronization of host eggs and adult parasitoids occur in a desired proportion, the pest population will be maintained at a minimum. Further the prolonged emergence of parasitoids ensures its availability throughout the year and a portion of its population has a chance of escaping from residual toxicity of any one of the recommended insecticides if applied as chemical control against its host insect (TMB).

2. **Studies on the extent of parasitization by exposing the host eggs during different months under field condition.**

The gravid females of TMB were allowed to oviposit for 24 hr on tender shoots of potted cashew grafts and cotton seedlings. These plants were exposed in the periphery of cashew plantation and care was taken to exclude the activities of ants from test plants. Forty five days after exposure, the shoots containing eggs were observed under microscope and the number of eggs having emergence hole were counted and also were confirmed for melonised egg case and the remaining eggs were observed for emergence of parasitoids for another 45 days under laboratory condition. On fortysixth day the eggs were dissected for confirmation of parasitization (Table 58). Parasitization was observed from April to July end. Continuous emergence of parasitoids upto 80 days was also observed from the eggs exposed during July indicating the carryover of the parasitoid to ensuing season (post monsoon flushes) and continuous multiplication in the eggs of TMB laid in the matured flushes.

Table 37. Seasonal occurrence of egg parasitoid during off season and cropping season of cashew.

Months		Weeks I	II	III	IV	Total No./ Average %/Range of the days
Jul	T.E.	127	102	105	—	334
	T.P.	24.4	18.6	24.8	—	22.6
		(3.9)	(8.8)	(9.5)		(7.4)
	D	32	45	29	—	
Aug	T.E.	43	71	94	129	337
	T.P.	51.2	40.5	37.2	54.3	45.8
		(20.9)	(10.8)	(7.5)	(8.5)	(11.9)
	D	34	48	25	41	25-48
Sep.	T.E.	95	89	54	22	
	T.P.	32.6	50.6	40.7	45.5	41.3 & 45.5
		(1.1)	(12.4)	3	(31.8)	(6.8 & 31.8)
	D	—	23	28	42	
Oct	T.E.	98	149	134	109	490
	T.P.	51.0	33.6	52.2	28.4	41.3
		(26.5)	(3.5)	(24.6)	(8.3)	(15.7)
	D	58	20	66	15	15-66
Nov	T.E.	106	126	125	112	469
	T.P.	34.0	34.9	32.8	14.3	29.0
		(12.3)	(5.6)	(9.6)	(0.9)	(7.1), 1C, 1E.
		1C	1E			
	D	78	17	16	—	16-78
Dec	T.E.	143	128	109	124	504
	T.P.	273	32.8	27.5	33.1	30.2
		(11.9)	(6.3)	(13.8)	(16.1)	(12.0).7C
		4C		2C	1C	
	D	33	53	43	28	28–53

T.E. = Total number of eggs observed
T.P. = Total percentage of parasitisation
D = No. of days taken for emergence of last parasitoid
Figures in parantheses indicate % of adult parasitoids visually confirmed.
C = Number of adult parasitoids of *Chaetostricha* sp.
E = Number of adult parasitoids of *Eiythmelus helopeltidis*?
Total number of eggs underlined indicate that no. of eggs collected after chemical control - eggs samples collected once in 10 days time.

3. Ant exclusion studies for enhancement of parasitization.

During the survey, it was visually confirmed that the movement of ants on the ventral side of the leaf interfered the oviposition of parasitoids. The parasitoids require 20-40 min time for successful oviposition and any movements by other

Table 58. Extent of parasitization in the field exposed eggs during different months.

Months	No. of eggs exposed	% of parasitization observed upto 45th day	% of parasitization observed upto 45th day	Total % of parasitization	No. of days taken for emergence of last parasitoid
Apr* 92	33	33.3	9.1+	42.2	—
May*	42	40.5	4.8+	45.3	—
Jun*	37	29.7	21.6	51.4	71
Jul*	136	22.8	19.1	41.9	80
++Aug*	123	2.4	4.1	6.5	—
++Sep	162	1.2	1.9E	3.1	59
Oct	53	—	—	—	—
Nov	78	—	—	—	—
Dec	60	—	—	—	—
Total	724				

\+ % of parasitization was confirmed on 46th day itself

++ These eggs laid in cotton plants

E *Erythmelus helopeltidis?*

* Oviposition by adult parasitoids of *Telenomus* sp was visually confirmed.

insects delays the oviposition process. Since, the ants are the main insect fauna noticed on cashew, studies were undertaken to exclude the ants (Table 59).

d. Collection of dispersion statistics of tea mosquito bug for calculating ET and EIL.

To determine the economic thresh-

Table 59. Effect of different treatments on exclusion of ants from cashew tree.

Treatment	Maximum duration of ant exclusion observed (hr)
Swabbing with petroleum lubricant oil	12
Banding with petroleum grease in the middle of trunk	12
Swabbing with aldrin 2%	12
Swabbing with carbaryl WP2%	12
Swabbing with molasses baited with carbaryl 50% W @ 50g/tree	12
Phorate 10% granule @ 50g/tree as band application on soil around the collar of the tree	7

old levels and economic injury levels, study of dispersion statistics of the pest is required. In order to determine the pest population precisely at a minimum time, effective sampling plan is required. Therefore, attempts were made to record the population and damage level at weekly intervals from 20 trees during peak period of pest infestation (October to April). Simultaneously total damage and population are also being assessed for 15 trees at monthly intervals.

Ent.VIII : Testing the efficacy of plant products against tea mosquito bug *Helopeltis antonii* Signoret.

(P. Shivarama Bhat and D Sundararaju.)

This project is aimed at testing the efficacy of various plant products reported to possess insecticidal properties, against teamosquito bug *(Helopeltis antonii)*. During the year, different plant parts or products ofneem, pongamia, custard apple, *Tephrosia vogeli* and cashew were tested mainly for knock down and residual action against nymphs and adults.

Efficacy of neem and pongamia products

Both water and ethanol extracts of neem oil, neem cake, neem seed, neem leaf, pongamia oil and pongamia seed were tested at five per cent concentration. The percent mortality was corrected using Abott's formula to eliminate the error due to natural mortality in the treatments. The damage score was calculated in the scale of 0-4. The results are presented in Tables 60 and 61.

Among the water emulsions, pongamia oil showed highest knock down action with 90.8 per cent mortality. The damage score was also lowest for this

Table 60. **Efficacy of water extract on neem and pongamia products against tea mosquito bug *Helopeltis antonii***

Treatments	% mortality (M) and damage score (DS) within 48 hrs of feeding in shoots collected							
	0-DAT*		3-DAT		7-DAT		15-DAT	
	M	DS	M	DS	M	DS	M	DS
Neem oil	50.8	2.0	30.0	2.3	14.2	2.5	0	2.3
Neem cake	30.0	2.7	25.8	2.9	13.3	2.8	4.2	2.9
Neem seed	30.0	2.7	33.8	2.2	4.2	2.9	4.2	2.7
Neem leaf	48.3	1.9	35.5	2.3	4.2	2.8	0	2.8
Pongamia oil	90.8	1.4	59.2	1.7	44.2	2.7	4.2	2.7
Pongamia seed	30.8	3.0	25.8	2.6	17.5	2.7	0	2.9

* DAT - Days after treatment

Table 61. **Efficacy of ethanol extract of neem and pongamia products against tea mosquito bug *Helopeltis antonii***

Treatments	% mortality (M) and damage score (DS) within 48 hrs of feeding in shoots collected							
	0.DAT*		3-DAT		7-DAT		15-DAT	
	M	DS	M	DS	M	DS	M	DS
Neem oil	41.7	2.0	41.7	1.9	43.3	2.5	20.0	2.3
Neem cake	58.3	1.8	33.3	2.1	0	2.2	6.7	2.3
Neem seed	66.7	2.4	43.3	2.0	33.3	2.6	13.3	2.5
Neem leaf	41.7	1.7	56.7	2.5	21.7	2.9	0	2.6
Pongamia oil	75.0	2.1	55.0	1.9	58.3	2.2	6.7	2.4
Pongamia seed	41.7	1.5	48.3	2.3	50.0	2.8	0	2.8

* DAT - Days after treatment

treatment. This was followed by neem oil with 50.8 per cent mortality. In all the remaining treatments, the mortality was less than 50 per cent. Pongamia oil had higher residual activity for about seven days. Other treatment did not show residual action properties by 15 days after treatment. None of the other products showed notable residual activity.

Among ethanol extracts, pongamia oil and neem seed kernel showed better knock down effect with the mortality of 75.0 and 66.7 per cent respectively. Most of the other products showed less than 50.0 per cent mortality. The damage score ranged from 1.5 to 2.4 for different treatments. Ethanol extract of pongamia products and neem oil had higher residual activity for about seven days compared to their water extracts. The efficacy, however, reduced considerably by 15 days after treatment.

Efficacy of other plant products

The efficacy of *Annona reticulata* seeds and leaves, *Annona squamosa* seeds, *Tephrosia vogelii* leaves and matured cashew leaves is presented in Tables 62 and 63. The water extracts of all these plant products exihibited less than 50 per cent mortality. The highest was recorded for *A. squamosa* seeds (46.7 per cent). The grade of damage ranged from 1.9 to 2.7 in different treatments. *A. reticulata* seed had little residual action upto seven days bringing about 25 per cent mortality. The ethanol extracts of these plant products also showed similar trend. *A. reticulata* and *A. squamosa* showed knock down mortality of 46.7 per cent and 40.0 per cent respectively. *Tephrosia vogelii*, *A. reticulata* and cashew leaves did not exhibit knock down or residual actions.

Observational trial with Carbaryl Flo

Carbaryl is one of the effective insecticides in the control of tea mosquito bug. In the recently concluded project on chemical control against this pest, carbaryl dust was found to be suitable for dusting young cashew plantations. An observa-

Table 62. **Efficacy of water extract of certain plant products against tea mosquito bug *Helopeltis antonii***

Treatment	% mortality (M) and damage score (DS) within 48 hrs of feeding in shoots collected							
	0-DAT*		3-DAT		7-DAT		15-DAT	
	M	DS	M	DS	M	DS	M	DS
A.reticulata seeds	33.3	2.1	25.0	2.4	25.0	2.3	0	2.8
A.squamosa seeds	46.7	1.9	16.7	2.0	19.5	2.0	0	2.8
T.vogelii leaves	13.3	2.4	8.3	2.3	8.4	2.2	0	2.6
Cashew leaves	20.0	2.3	0	2.6	0	1.8	0	3.0
A.reticulata leaves	0.0	2.7	8.3	2.6	0	2.3	0	2.9

* DAT - Days after treatment.

Table 63. **Efficacy of ethanol extract of certain plant products against tea mosquito bug *Helopeltis antonii***

Treatment	% mortality (M) and damage score (DS) within 48 hrs of feeding in shoots collected							
	0-DAT*		3-DAT		7-DAT		15-DAT	
	M	DS	M	DS	M	DS	M	DS
A.reticulata seeds	46.7	2.8	25.0	3.0	13.3	2.7	0	2.9
A squamosa seeds	40.0	2.6	36.1	3.0	13.3	2.4	0	2.9
T.vogelii leaves	6.7	2.8	8.3	3.0	0	2.7	0	2.8
Cashew leaves	6.7	2.8	0	2.9	0	2.8	0	3.0
A.reticulata leaves	6.7	2.8	0	2.9	0	2.9	0	2.9

* DAT - Days after treatment.

tional trial was conducted to test the efficacy of Carbaryl Flo, a new formulation of this insecticide. This formulation was found to be as effective as carbaryl WP with lower tea mosquito bug incidence (Table 64). Malathion (0.1 per cent) and chlorpyriphos (0.05 per cent) also tested during the study were not found effective.

Table 64. Efficacy of Carbaryl Flo and some other insecticides against tea mosquito bug

Treatments	Damage before treatment		Damage after 30 days					
			I treatment		II treatment		III treatment	
	%	score	%	score	%	score	%	score
Carbaryl WP (0.1%)	15.6	0.4	22.5	0.5	9.7	0.2	2.8	0.1
Carbaryl Flo (0.1%)	17.7	0.4	30.0	0.8	16.3	0.5	5.5	0.2
Endosulfan (0.05%)	21.2	0.6	28.5	0.8	36.7	1.1	9.1	0.3
Chlorpyriphos (0.05%)	16.1	0.3	40.9	1.3	36.0	1.1	25.6	0.6
Malathion (0.1%)	18.3	0.5	27.1	0.7	44.2	1.3	25.3	0.7
Phorate sachets	23.9	0.6	44.9	1.2	39.7	1.3	32.7	1.1
Control	24.3	0.7	56.7	1.9	48.9	1.5	33.1	1.0

QUALITY EVALUATION AND POST-HARVEST TECHNOLOGY

Studies on biochemical changes during storage of nuts both at ambient temperature and low temperature were continued. During storage, kernel sugar, starch and shell CNSL content decrease significantly. Neutral lipids tend to decrease while glyco and phospo lipids tend to increase during storage. Kernel lipids, starch and shell CNSL tend to increase while phenols and amino acids tend to decrease during development of nuts. Storage of bulk nuts upto eight months does not affect the processing quality as assessed by shelling percentage. Changes in shell CNSL, kernel starch, protein and sugar content however, were observed during storage. Hot water dip treatment to extend the storage life of cashew apples was not successful.

Table 68. Biochemical changes during storage of bulk nuts

Constituent	Storage Period (Months)		
	0	4	8
Moisture (%)	1.4	2.43	2.64
Shelling percentage	27.5	24.82	25.0
CNSL (Shell) (ug/g shell)	27.95	31.64	33.0
Lipid (%)	54.9	53.9	53.04
Protein (mg/100 mg flour)	51.06	73.19	70.64
Starch (mg/100 mg flour)	33.3	33.3	52.63
Sugars (mg/100 mg flour)	8.48	8.58	10.88
Lysine (µg/mg Protein)	68.6	44.4	41.58

TRANSFER OF TECHNOLOGY

During the year 32912 grafts were sold with the realisation of revenue of Rs. 2,63,296. A total of 41,806 successful grafts of different varieties were produced.

A total of nine training programmes on, Vegetative Propagation of Cashew (6), Cashew Production Technology (2), and Crop Protection in Cashew (1) were conducted and a total of 72 persons including farmers, students, gardeners and officials from Karnataka (41), Kerala (13), Tamil Nadu (6), Uttar Pradesh (10), Andhra Pradesh (1) and Maharashtra (1) were trained.

Demonstration plots established earlier were monitored. Two meetings of farmers maintaining cashew demonstration plots and a "Field Day" for cashew growers of Dakshina Kannada District were also organised.

Gen.I (443) : Production of parental materials and breeders' stock of cashew

(KRM Swamy, B Nagaraja and MG Nayak)

The objective of this project is commercial multiplication of released varieties and other elite materials of cashew for distribution to development agencies, nurserymen and farmers. This project was started during 1989 under the Revolving Fund Scheme for cashew grafts production.

Soft wood grafts of released cashew varieties and other elite materials were commercially multiplied from July 1992 to February 1993. In order to raise root stock seedlings required for grafting, a total number of 93,750 seednuts (585 kg) of VTH 174 were sown in ploythene bags from May to December 1992. Of the 93,750 seeds sown, a total of 66,965 germinated with a mean germination percentage of 71.4 (Table 69). Out of 63,910 soft wood grafts prepared during July 1992 to February 1993, 41,806 grafts were successful with a mean graft success of 65.4 per cent (Table 70).

During the 1992 planting season, a total number of 32,912 soft wood grafts of different released varieties/elite materials were sold to different development agencies and farmers and an amount of Rs. 2,63,296 was realised.

The cashew scion banks both at Shanthigodu and Puttur were maintained during the year and a total number of 63,911 scion sticks were collected for grafting from these scion banks and other plots.

Table 69. Cashew root stocks raised for grafting during 1992

Month of sowing	No. of nuts sown	No. germinated
May	15,880	14,300 (90.0)
Jun	28,120	23,790 (84.6)
Jul	8,000	6,400 (80.0)
Aug	8,850	6,275 (70.9)
Sep	4,150	3,050 (73.5)
Oct	16,750	10,850 (64.7)
Nov	8,000	1,800 (22.5)
Dec	4,000	500 (12.5)
Total	93,750	66,965 (71.4)

Figures within parantheses indicate per cent germination.

Table 70. Cashew grafts produced during 1992-93

Month of grafting	No. of grafts prepared	Graft success (No.)
Jul	11,820	8,065 (68.2)
Aug	10,125	6,791 (67.1)
Sep	11,200	8,780 (78.4)
Oct	9,415	6,600 (70.1)
Nov	7,950	4,055 (51.0)
Dec	2,925	1,235 (42.0)
Jan	7,175	4,480 (62.4)
Feb	3,300	1,800 (54.5)
Total	63,910	41,806 (65.4)

Figures within parantheses indicate per cent success

Extn. I (443) : Training extension and research workers and farmers

(KRM Swamy and Sreenath Dixit*)
(*From November 1992)

The objective of this project is to establish a link between research personnel of the Institute and extension agencies and farmers by organising training programmes on various aspects of cashew production technology. During the year a total of nine training programmes, on "Vegetative Propagation of Cashew" (6), "Cashew Production Technology" (2) and "Crop Protection in Cashew" (1) were conducted and a total of 72 persons including both officials and farmers were trained.

Six training programmes on "Vegetative Propagation of Cashew" were conducted between April and November 1992. A total of 60 persons including college students (10), farmers (20), farm workers (10), gardeners (14), and officials (6), belonging to Karnataka, Kerala, Tamil Nadu, and Uttar Pradesh were trained (Table 71).

A total number of 72 persons from Maharashtra (1), Karnataka (41), Kerala (13), Andhra Pradesh (1), Tamil Nadu (6) and Uttar Pradesh (10) were imparted training on different aspects of cashew production technology (Table 72)

Table 71. Training programmes conducted during 92-93.

Course Title	Date (s)	Duration (Days)	No. of participants
Vegetative Propagation of Cashew	21-22 Apr 1992	2	10 (Students)
	18-19 Aug 1992	2	11 (Farmers)
	25-27 Aug 1992	3	6 (Officials)
	28-29 Aug 1992	2	14 (Gardeners)
	14 Oct 1992	1	9 (Farmers)
	27 Nov 1992	1	10 (Farm Workers)
	Total		60
Cashew Production Technology	22-24 Sep 1992	3	3 (Officials)
	12-14 Jan 1993	3	1 (Official)
	Total		4
Crop Protection in Cashew	12-13 Nov 1992	2	8 (Officials)
Total			72

Table 72. Statewise distribution of participants of training programmes conducted during 1992-93.

State	No. of participants			Total
	Vegetative Propagation of cashew	Cashew Production Technology	Crop Protection in Cashew	
Karnataka	36	—	5	41
Kerala	12	1	—	13
Maharashtra	—	1	—	1
Andhra Pradesh	—	—	1	1
Tamil Nadu	2	2	2	6
Uttar Pradesh	10	—	—	10
Total	60	4	8	72

Extn. IV(443) : Research cum demonstration plots

(KRM Swamy, PS Bhat and Sreenath Dixit*)
(*From November 1992.)

The objective of this project is demonstration of new technologies developed by the research centre for cashew production in the farmers' fields through establishment of demonstration plots. Thirtyfive cashew demonstration plots established earlier were monitored. Two meetings of farmers maintaining cashew demonstration plots and a "Field Day" for cashew growers of Dakshina Kannada district were also organised.

Thirtyfive cashew demonstration plots of 0.4 to 0.8 ha each which were established earlier (1988-91) in Puttur, Buntwal and Belthangady taluks of Dakshina Kannada district were monitored (Table 73). Of the 35 plots, 11 were established in Belthangady taluk in collaboration with Sree Kshethra Dharmasthala Rural Development Project (SKDRDP). This programme is jointly sponsored by the Directorate of Cashewnut Development, Cochin, and NRC-Cashew, Puttur, under the Central Sector Scheme. The cost of establishment and maintenance of these plots in the form of subsidy towards the purchase of cashew grafts, fertilizers and plant protection chemicals was met by Directorate of Cashewnut Development during the period 1988 to 1993 (Table 74). Of the 35 plots, two plots were dropped (Sri V Krishna Murthy, Adyanadka; Sri KP Sanjeeva Rai, Kodimbady) as these plots were not maintained satisfactorily.

Two meetings of farmers maintaining cashew demonstration plots were conducted on 25 July 1992 and 16 January 1993 and a total of 29 and 22 farmers, attended the meeting respectively (Table 75).

A "Field Day" for cashew growers of Dakshina Kannada district was jointly

Table 73. Cashew demonstration plots established during 1988-91 in Dakshina Kannada district.

Year of establishement	Number of plots established		
	By NRCC	By SKDRDP	Total
1988-89	17	—	17
1989-90	7	6	13
1990-91	—	5	5
Total	24	11	35

Table 74. Subsidy given to farmers maintaining cashew demonstration plots by the Directorate of Cashewnut Development, Cochin, from 1988 to 1993.

Year	Amount of subsidy Rs.
1988-89	12,311
1989-90	20,624
1990-91	28,169
1991-92	24,554
1992-93	23,720
Total	1,09,378

Table 75 Farmers meetings/Field day conducted during 1992-93.

Date	Farmers Meeting/ Field Day	Number of farmers attended
25 Jul 1992	Cashew Demonstration Farmers' meeting	29
16 Jan 1993	Cashew Demonstration Farmers' meeting	22
19 Feb 1993	Field Day for Cashew Growers of D.K. District*	160

* Jointly organised by NRCC, DCD, DKZP.

Distribution of cashew grafts of NRCC selections during Field day by Shri Vinaya Kumar Sorake, MLA, Puttur.

organised by NRC-Cashew, Directorate of Cashewnut Development, Cochin, and Department of Horticulture, Dakshina Kannada Zilla Parishad, on 19 February 1993. A total of 160 farmers from different taluks of Dakshina Kannada district participated (Table 75). The farmers were taken to different cashew demonstration plots in the forenoon and a group discussion was held in the cashew demonstration plot of Sri S Janardhana Bhat at Sediyapu in the afternoon. In the evening the valedictory function was held at NRC-Cashew, Puttur. Dr. MK Nair, Director, CPCRI and NRCC, Sri Vinaya Kumar Sorake, MLA, Puttur, Sri PP Balasubramanian, Director,

Directorate of Cashewnut Development, Cochin, Sri K Raghunatha Bhandary, Deputy Director of Horticulture, Dakshina Kannada Zilla Parishad, Mangalore and Dr. EVV Bhaskara Rao, Project coordinator (Cashew) and Scientist in-charge, NRC-Cashew, Puttur, addressed the farmers. The cashew grafts of NRCC Selection-1 and 2, were distributed to farmers, representatives from different taluks by Sri Vinaya Kumar Sorake.

CONCLUDED PROJECT

Ent.VII : Chemical Control experiments against tea mosquito bug *Helopeltis antonii* S (Heteroptera : Miridae)

(N Bakthavsatsalam (Upto 27 Nov. 1991).
P. Shivarama Bhat and D Sundararaju) (1989-92).

Objectives :

1. To find out the suitable dust formulation against tea mosquito bug in young plantations.
2. To find out the ovicidal action and the residual toxicity of certain recommended insecticides against tea mosquito bug.

Materials and Methods :

Chemical control experiments with dust formulation were taken up two seasons during 1989-91 at KCDC plantations, Elanthila, with formulations namely quinalphos 2%, methyl parathion 2% and carbaryl 1.5%. During 1991-92, the study was undertaken at KCDC plantations, Aryapu, with same dust formulations except methyl parathion. Dustings were given at flushing, flowering and fruiting stages during 1989-91 and flowering and fruiting stages during 1991-92. Per cent shoot damage in an area of 0.5m x 0.5m on all four directions were observed 10, 20 and 30 days of each dusting. Covariance analysis was carried out to find out the effect of dusting on the incidence of tea mosquito bug after 30 days of each dusting.

Ovicidal activity and residual toxicity of nine recommended insecticides were tested during 1990-91. Single gravid female was caged on cashew graft with tender flush for 24 hr. On the third day, grafts containing eggs were sprayed with insecticides using hand sprayer. The emerged nymphs were allowed to feed on tender shoots collected from trees which were also sprayed along with the treatment of grafts. The percentage survival of nymphs after 72 hr of emergence was recorded. Percentage of egg hatch was determined by counting total number of eggs hatched out to total number of viable eggs.

For studying the residual toxicity of insecticides to adults of tea mosquito bug, eight insecticides at recommended concentration were sprayed on young cashew trees with tender flushes. Tender shoots were removed at random from respective trees on third, seventh and fifteenth day after spraying and used as feeding material in rearing cage. The number of adults surviving after 24 hr was recorded. Damage score was calculated in the scale of 0-4. Duncan's Multiple Range Test (DMRT) was adopted for comparing means.

Results and Discussions

Chemical control experiments with dust formulations:

The adjusted shoot infestation percentage and damage score (after covariance analysis) at Elanthila in 1989-90 is presented in Table 1. After 30 days of third dusting both shoot infestion and damage score was least for carbaryl. This was followed by methyl parathion and endosulfan. Quinalphos was found to be least effective. Owing to high residual toxicity and harmful nature of the insecticide to

Table 1. Incidence of tea mosquito bug (adjusted) at Elanthila in 1989-90

Treatment	30 days after I dusting				30 days after II dusting				30 days after III dusting				Cost/ ha/ round (Rs.)
	%		Score		%		Score		%		Score		
Quinalphos	23.5	(29.0)	0.71	(1.10)	14.0	(22.0)	0.52	(1.01)	8.2	(16.6)	0.42	(0.95)	302
Methyl parathion	10.3	(18.7)	0.33	(0.91)	7.2	(15.6)	0.27	(0.88)	5.5	(10.8)	0.09	(0.77)	200
Carbaryl	8.6	(17.0)	0.40	(0.95)	1.0	(5.7)	0.08	(0.76)	0.5	(4.0)	0.02	(0.72)	421
Endosulfan	16.3	(24.3)	0.62	(1.06)	9.9	(18.3)	0.35	(0.92)	3.3	(10.5)	0.12	(0.79)	215
Control	35.6	(36.6)	1.19	(1.30	17.3	(24.0)	0.69	(1.09)	8.6	(17.3)	0.33	(0.91)	-
CD (5%)	(NS)	(NS)		(NS)		(NS)		(NS)		(9.1)		(0.15)	-

Figures in parentheses are transformed values

pollinators, methyl parathion was deleted from the experiment during 1991-92.

The adjusted shoot infestation at Aryapu during 1991-92 in presented in Table 2. The least damage was in the case of carbaryl dusted trees after 30 days of second dusting which was significantly superior over control.

The quantity of dust consumed per hectare for different treatments was in the range of 26.5 to 34 kg/round. The cost of treatment was lower for endosulfan compared to carbaryl dust. Hence, usage of this dust formulation should be restricted to the areas where spraying is not feasible.

Ovicidal activity and residual toxicity to nymphs :

Ovicidal activity was not observed in all the insecticides, as the per cent nymphs emerged ranged from 93 to 100 (Table 3). With respect to residual toxicity to first instar nymphs, significantly least survival was recorded in most of the treatments compared to untreated control. Survival of nymphs was in the range of 0 to 4.4

Table 2. Incidence of tea mosquito bug (adjusted) at Aryapu on 1991-92

Treatments	30 days after I dusting		30 days after II dusting		Cost/ha/round (Rs.)
	%	Score	%	Score	
Endosulfan	13.7 (21.7)	0.40 (0.95)	27.8 (31.8)	0.94 (1.20)	325
Quinalphos	21.6 (27.7)	1.27 (1.33)	24.3 (29.5)	0.99 (1.22)	495
Carbaryl	15.0 (22.8)	0.42 (0.96)	4.5 (12.3)	0.14 (0.80)	535
Control	34.1 (35.7)	0.98 (1.22)	38.3 (38.2)	0.94 (1.20)	—
CD (5%)	(NS)	(NS)	(14.4)	(0.25)	—

Figures in the parentheses are tranformed values

Table 3. Ovicidal action of foliar insecticides on tea mosquito bug

	Treatment	Eggs hatched (%)	Nymphs surviving after 72 hr of hatch (%)
Experiment-1	Ethofenprox 0.015%	100.0	0.0a
	Phosalone 0.07%	100.0	0.0a
	Endosulfan 0.05%	100.0	38.8a
	Control	100.0	37.5b
Experiment-2	Carbaryl 0.1%	100.0	0.0a
	Quinalphos 0.05%	100.0	14.9ab
	Methyl parathion 0.05%	95.3	34.0c
	Dimethoate 0.05%	93.2	14.8bc
	Control	100.0	51.4d
Experiment-3	Monocrotophos 0.05%	95.0	0.0a
	Decamethrin 0.028%	93.1	0.0a
	Control	98.7	73.2b
Experiment-4	Carbaryl 0.1%	100.0	0.0a
	Monocrotophos 0.05%	100.0	0.0a
	Phosalone 0.07%	100.0	4.4a
	Endosulfan 0.05%	100.0	11.4b
	Control	100.0	48.2c

In each experiment, mean followed by common letter is not significantly different at 5% DMRT.

per cent in carbaryl, monocrotophos, phosalone, decamethrin and ethofenprox indicating their higher toxicity to first instar nymphs of tea mosquito bug.

Residual toxicity to adults :

After three days of treatment, adults did not survive in carbaryl and monocrotophos and least number of adults survived in dimethoate and decamethrin. After a week, significantly least survival of adults was observed in carbaryl and monocrotophos. In most of the remaining treatments, survival pattern was comparable with control. Least damage score was recorded for carbaryl and monocrotophos after three days of treatment because of higher residual toxicity of these insecticides. After seven days also, similar trend was observed (Table 4). None of the insecticides tested showed residual toxicity upto 15 days of treatment.

Conclusions

1. Carbaryl 5 per cent dust was found suitable for management of tea

Table 4. Residual action of recommeded insecticides to adults of tea mosquito bug

Treatment	After 3 days		After 7 days	
	Adult survival**	Damage score	Adult survival	Damage score
Endosulfan 0.05%	5.0 c	3.0 f	5.7 c	3.2 c
Quinalphos 0.05%	4.3c	2.7 ef	5.3 c	2.8 c
Phosalone 0.07%	4.3c	2.3 c	5.7 c	3.0 c
Carbaryl 0.1%	0.0 a	0.3 a	0.3 a	0.8 a
Decamethrin 0.05%	1.3 b	1.7 d	3.7 bc	2.7 c
Monocrotophos 0.05%	0.0 a	0.7 b	1.0 a	1.0 a
Dimethoate 0.05%	1.7 b	1.0 c	3.0 ab	1.7 b
Methyl parathion 0.05%	4.7 c	1.7 d	5.0 c	2.8 c
Control	6.0 c	3.0 f	6.0c	3.0 c

** Survival out of six

Mean followed by common letter in each column is not significantly different at 5% DMRT.

mosquito bug in young cashew plantations wherever spraying in not fesasible.

2. None of the recommended insecticides showed ovicidal action against tea mosquito bug and the extent of egg hatch was in the range of 93 to 100 per cent.

3. Insecticides such as carbayl, monocrotophos, phosalone, decamathrin and ethofenprox were highly toxic to first instar nymphs.

4. Among the recommended insecticides against tea mosquito bug, maximum residual toxicity upto a week was recorded for carbaryl and monocrotophos followed by dimethoate. The shoot damage was minimum for these treatments.

Publications

1. Sundararaju, D., Bakthavatsalam N and Bhat, PS 1993. Ovicical activity and residual toxicity of certain insecticides to tea mosquito bug *Helopeltis antonii* Sign (*Heteroptera : Miridae*). Pestology XVII (2) : 14-19.

2. Bakthavatsalam, N, Sundararaju D and Bhat, PS 1993. Chemical control of tea mosquito bug in cashew with dust formulations. THE CASHEW (Communicated)

SUMMARY REPORT OF ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW

Summary Report of All India Coordinated Research Project on Cashew

During the Seventh Plan the ongoing All India Coordinated Spices and Cashewnut Improvement Project started in 1971 has been bifurcated into two separate projects, one on Cashew and another on Spices. The Coordinator's Cell is located in respective National Research Centres, which were also started during VII Plan. The All India Coordinated Research Project on Cashew has seven centres of which four were started at the inception of AICS & CIP in 1971 (Bapatla, APPU; Anakkayam, KAU; Vengurla, KKV and Vridhachalam, TNAU), one started during V Plan period (Bhubaneswar, OUAT) and two more were added during VI Plan (Jhargram, BCKV and Chintamani, UAS). The budget allocation of the Project for the year 1992-93 was Rs. 24.00 lakhs (Rs. 18.00 lakhs ICAR Share). During 1992-93 the expenditure was Rs. 23.02 lakhs (Rs. 17.26 lakhs ICAR share). The Project mandate is to increase the production and productivity of cashew through:

*Evolving high yielding varieties resistant/tolerant to diseases and pests.

* Standardizing agrotechniques for the crop under different agroclimatic conditions and

*Evolving effective pest and disease management practices

In lieu of X Biennial Workshop of the Project, a National Group Discussion of Cashew Research Workers was held at CPCRI, Kasaragod (Kerala) during 30-31 August and Ist September 1991. The technical programmes decided at the Group Discussion were implemented by the Centres. Summary of the results of current year is given below :

CROP IMPROVEMENT

A total of 859 cashew germplasm accessions (Bapatla-123; Bhubaneswar -76; Chintamani-114; Jhargram-111; Madakkathara-115; Vridhachlam-159 and Vengurla-161) are being maintained and evaluated in different centres. In the germplasm evaluation, the highest yield was recorded by T.No. 10/4 (42.0 kg), T.No. 228 (41.2 kg) and T.No. 71 (31.0 kg) of Bapatla; ME 4/4 (15.95 kg), 4/61 Alangudi (13.19 kg), 3/108 Gubbi (12.75 kg), 1/61 Alangudi (12.35 kg), 5/23 Coondapur (10.30 kg), 8/46 Taliparamba (10.30 kg) and 1/64 Madhuranthakam (6.30 kg) (more than five kg cumulative mean yield/tree) of Chintamani; JGM 66/7 (9.45 kg) and JGM 80/2 (9.04 kg) of Jhargram; and M 26/1 (22.5 kg/tree) and M 15/4 (10.72 kg/tree) of Vridhachalam. During the year a total of 34 new collections (Bapatla-6; Bhubaneswar-5; Jhargram-8 and Madakkathara-15) showing promising characters were added to the germplasm by different centres. From the old germplasm, a total of 214 accessions have been clonally multiplied and planted in the conservation block by Bapatla (92), Chintamani (42) and Vengurla (80).

In the multilocation trial, 18 varieties collected from different centres are being evaluated. Highest yield was obtained from T.No. 129 (1.25 kg) at Bapatla; V-4 (2.4 kg) at Bhubaneswar; H 1600 (3.73 kg)

at Chintamani; VTH 59/2 (4.24 kg) at Bhubaneswar; M 26/2 (12.8 kg) at Madakkathara and V-5 (6.99 kg) at Vridhachalam.

Evaluation of F_1 hybrids showed that three hybrids from Bapatla viz., Hy 3/28, Hy 2/16 and Hy 3/39 gave a mean yield of 17.8 to 24.6 kg/tree. Two hybrids from Madakkathara viz., H 1598 and H 1608 were recommended for release by the Kerala State Varietal Release committee.

A hybrid from Vridhachalam, i.e.., Hy 4 (M 10/4 x E 4/2-1) gave a mean yield of 6.31 kg/tree; the mean yield of two hybrids from Vengurla (Hy 255 and Hy 336) was 15.25 kg and 12.5 kg, respectively.

CROP MANAGEMENT - A. AGRONOMY

In NPK trial, application of N (0, 500, 1000g/plant), P_2O_5 (0,125,250g/plant) and K_2O (0, 125, 125g/plant) showed an increase of yield over control and the increase in yield was linear in Bhubaneswar. Application of N 1000g, P_2O_5 250g and K_2O 250 g was found to be the best among the treatments. At Jhargram maximum yield was recorded at 300g N, 200g P_2O_5 and 600 g K_2O dose of fertilizer application.

Foliar application of urea along with insecticides (2% and 3% urea spray), increased yield at Bapatla and Jhargram. At Madakkathara (3%, 4% and 2% urea spray), Vridhachalam (4% and 3% urea spray) and Vengurla (3% and 4% urea spray) an increase in the yield was recorded.

In the spacing trial, at tenth year of planting, trees planted in 6m x 6mx 6m triangular system gave the highest yield (39.688 kg/block of 25 plants) and the trees planted in 10m x 10m square system gave the minimum yield (25.66 kg/block of four plants) at Jhargram Centre.

At Bapatla, standardization of index leaf in cashew has been done. Nitrogen content in the third leaf is significantly higher than that in the fourth leaf . Leaf samples collected before fertilizer application contained relatively low amount of nutrients, which increased upto 60 days after fertilizer application and decreased thereafter. Yield was found to be correlated positively with leaf nutrient concentration of N, P, K, Ca and Mg.

In the cashew based cropping systems trial at Bapatla, the annual crops suffered due to severe moisture stress; at Vridhachalam, cowpea was found to be a good cover crop; at Vengurla, intercrops like Australian acacia and subabul adversely affected the growth as well as yield of cashew. Eucalyptus and casuarina affected the main crop marginally.

CROP MANAGEMENT - B. HORTICULTURE

Soft wood grafting was found to be a successful method for vegetative propagation of cashew. Highest percentage of graft success was recorded during January (73.5%), December (72.8%), and February (61.7%) at Bapatla; September (75.0%), August (68.23%) and July (58.0%) at Bhubaneshwar; September (60.0%), November (51.1%) and December (48.0%) at Chintamani; July (59.0%), August (67.0%) and September (63.0%) at Jhargram; August (90.9%) and November (67.5%) at Vridhachalam.

Flush grafting was not successful at all the centres. At Vridhachalam, 42 day

old scions grafted on 35 day old root stocks gave the highest success (73.5%). At Vengurla, 21-40 day old root stocks when grafted with 28-42 day old scions gave the highest success (more than 79.2%).

A good graft success in top working was obtained at Bapatla (60-80%), and Bhubaneswar (60-80%) and the success was low (11.7-25.0%) at Jhargram. At Vridhachalam, the top worked trees have been affected by stem and root borer. At Vengurla centre, five year old top worked trees (10 Nos.) gave a mean yield of 5.25 kg/tree.

Screening of root stocks for dwarfing characters is in progress at Madakkathara and Vengurla.

CROP PROTECTION

Treatment T-5 (spraying of monocrotophos 0.05% during flushing, endosulfan 0.05% during flowering and carbaryl 0.1% during fruiting stage) was found to be superior over other treatments in controlling tea mosquito and other pests at Chintamani and Jhargram centres. Whereas, T-4 (spraying of monocrotophos 0.05% at flushing and endosulfan 0.05% at flowering stage) was found to be superior at Vridhachalam and Vengurla in trials on chemical control of cashew pest complex.

In controlling minor pests of cashew such as *Myllocerus* sp., *Hipotima haligramma*, *Lamida moncusalis*, leaf miner, leaf thrips etc., treatment T-5 was found to be effective at Chintamani, Bapatla, Jhargram and Vengurla.

In the trial on control of foliage/ inflorescence pests of cashew with neem products, at Bapatla centre all the neem products tried performed well and maximum yield was recorded in the treatments sprayed with neem cake extract (5%), followed by neem seed kernel extract (5%) spray. At Vridhachalam neem seed kernel extract (5%) and neem oil (2%) recorded minimum tea mosquito damage.

At Bapatla, swabbing of neem seed kernel extract (5%), neem cake extract (5%), neem oil (5%) and application of Sevidol 4G on uninfested trunk during April was found to be a good prophylactic control measure against stem and root borer infestation upto 90 days. At Bhubaneswar, Kaoline swabbing, neem cake extract (5%) resulted in less infestation. At Jhargram, there was absolutely no infestation on the tree treated with HCH (0.2%). The infestation was negligible with neem oil (5%) and neem seed kernel extract (5%). All the treatments were effective at Madakkathara and Vridhachalam.

Bioecology of tea mosquito, leaf miner, leaf and blossom webber, leaf thrips, inflorescence thrips, fruit and nut borer, stem and root borer, shoot tip caterpillar, leaf folder etc. were studied at Bapatla, Bhubaneswar, Chintamani, and Jhargram centres.

Screening of germplasm to locate tolerant/resistant types to major pests of the region have been carried out. At Bapatla, T.No. 274L, 286, 244, 232 and 231 were found to be less susceptible to weevils, T.No. 232 and 71 to leaf miner, and T.No. 228 and 232 to *Hipotima haligramma*. Less infestation was observed on Type 1608 for shoot tip caterpillar

(Bhubaneswar), on accession No. 1998, 1600, 1610, H 26, 5/37, 4/48, 1/84 and 9/88 for inflorescence thrips and fruit and nut borer (Chintamani), on accession No. H 856, H 1388, and H 1589 for tea mosquito (Madakkathara), on M 20/4 for shoot and blossom webber (Vridhachalam) and on 19/1610, 2/15, V-4, M 33/3, M 26/2 and M 44/3 for shoot tip and inflorescence caterpillar (Vridhachalam).

GENERAL INFORMATION

STAFF OF THE INSTITUTE
(As on 31-03-1993)

Managerial	
Project Director	Vacant (Additional Charge : Dr. MK Nair, Director, CPCRI, Kasaragod)
Project Coordinator (Cashew)	Dr. EVV Bhaskara Rao, Ph.D. (Scientist in-charge)
Scientific	
Principal Scientist (Agronomy)	Vacant
Senior Scientist (Agronomy)	Sri N Yadukumar, M.Sc. (Ag) Senior Scientist
Principal Scientist (Plant Breeding)	Vacant
Senior Scientist (Plant Breeding)	Dr. PM Kumaran, Ph.D. Senior Scientist
Senior Scientist (Plant Breeding)	Sri Thimmappaiah, M.Sc. (Ag) Scientist SG
Principal Scientist (Horticulture)	Vacant
Senior Scientist (Horticulture)	Vacant
Scientist (Horticulture/Extension)	Dr. KRM Swamy, Ph.D. Scientist SS
Scientist (Horticulture)	Sri M Gangadhara Nayak, M.Sc. (Ag) Scientist
Senior Scientist (Entomology)	Sri D Sundararaju, M.Sc. (Ag) Scientist SG
Scientist (Entomology)	Sri P Shivarama Bhat, M.Sc. (Ag) Scientist

Scientist (Entomology)	Dr. T.N. Raviprasad, Ph.D. Scientist (from. 11.1.1993)
Scientist (Biochemistry)	Dr. K.V. Nagaraja, Ph.D. Senior Scientist
Senior Scientist (Plant Physiology)	Vacant
Senior Scientist (Soil Science)	Vacant
Scientist (Statistics)	Vacant
Scientist (Cytogenetics)	Vacant
Scientist (Food Technology)	Vacant
Scientist (Agricultural Extension)	Dr. Sreenath Dixit, Ph.D. Scientist (from 30.11.1992)
Technical	
Farm Superintendent	Sri E Mohan, M.Sc. (Ag), T-6 Resigned w.e.f. 10.3.1993.
Farm Superintendent	Sri B Nagaraja, B.Sc. (Ag) T-6
Technical Information Officer	Dr. K Palanisamy, Ph.D. Resigned and relieved on 21.8.1992 (AN).
Administration	
Assistant Administrative Officer	Sri M Ravi Retired w.e.f. 28.2.1993
Assistant Finance and Accounts Officer	Sri A Keshava Shabaraya
Office Superientendent	Sri Ajit Kumar Bolur Acting Assistant Administrative Officer from 1.3.1993

PARTICIPATION IN SYMPOSIA/CONFERENCES

1.	20th Annual Research Council meeting CPCRI Kasaragod	EVVB Rao	21-25 Apr 1992
2.	Summer Institute on "IPM in Horticultural Crops", IIHR, Bangalore	PS Bhat	20-29 May 1992
3.	Meeting of the Directors and Project Coordinators of ICAR under Horticultural Division, IARI, New Delhi	EVVB Rao	5-8 Aug 1992
4.	Meeting convened by Ms. Shantha Sheela Nair, Joint Secretary, Government of India, at Trivandrum	EVVB Rao	20 Aug 1992
5.	Tenth Symposium on Plantation Crops (PLACROSYM-X), CPCRI, Kasaragod	EVVB Rao PM Kumaran KV Nagaraja KRM Swamy	2-4 Dec 1992
6.	Horticulture Division meeting for the review of Medium Term Plan for Plantation Crops, ICAR, New Delhi	EVVB Rao	22-24 Feb 1993
7.	World Conference on Neem, Bangalore	PS Bhat	24-28 Feb 1993
8.	Seminar on "Water Management for Plantation Crops", Centre for Water Resource Development and Management, Trivandrum	N Yadukumar	4 Mar 1993
9.	"Seminar on Cashew" Basavanakoppa Village Shiggaon Tq. Dharwad Dt.	N Yadukumar KRM Swamy Sreenath Dixit	15 Mar 1993
10.	Research Advisory Council meeting of World Bank aided sub-project on Biotechnology, IIHR, Bangalore	EVVB Rao	15 Mar 1993

RESEARCH PUBLICATIONS

1. Sundararaju, D., Bakthavatsalam, N and Bhat PS. 1993, Ovicidal activity and residual toxicity of certain insecticides to tea mosquito bug *Helopeltis antonii* (Heteroptera : Miridae) infesting cashew. **Pestology, XVII (2)** : 14-19.

2. Sundararaju, D., 1993, Compilation of recently recorded some new pests of cashew in India. **The cashew, VII (1)** : 15-19.

3. Sundararaju, D., Joy N. John, 1992, Mass rearing techniques for *Helopeltis antonii* Sign. (Heteroptera : Miridae). An important pest of cashew. **J.Plantation Crops., 20(1)** : 46-53.

PAPERS PRESENTED IN SYMPOSIA/WORKSHOP

1. N Yadukumar and RC Mandal 1993. Effect of irrigation on cashewnut yield. Seminar on "Water management for plantation Crops", Centre for Water Resources Development and Management, Trivandrum 4th March 1993.

2. KKN Nambiar, RD Iyer, EVVB Rao, W. Krishnamurthy Rao, T. Premkumar and MR Hegde (Eds) 1992, Journal of Plantation Crops Vol.20 (Supplement), Proceedings of the Ninth Symposium on Plantation Crops (5-7 Dec. 1990) PP 429, Indian Society for Plantation Crops Kasaragod.

TECHNICAL BULLETINS

1. NRCC Research Highlights 1992-93 : March 1993. 16 pp (Compiled and Edited by EVV Bhaskara Rao and KV Nagaraja).

2. NRCC Annual Report 1991-92 September 1992, 72 pp. (Compiled and Edited by EVV Bhaskara Rao and KV Nagaraja)

3. All Indian Coordinated Research Project on Cashew Annual Report 1991-92. September 1992 pp 141 (Compiled and Edited by EVV Bhaskara Rao and K Palanisamy).

IMPORTANT VISITORS

01 Oct 1992	Dr P Vittal Rai, Vice Chancellor, University of Agricultural Sciences, Dharwad.
09 Oct 1992	Dr A Ramadasan, Principal Scientist, NRC - Spices, Calicut.
07 Jan 1993	Dr RC Mandal, Retired Scientist In-charge, NRC-Cashew, Puttur.
31 Jan 1993	Sri IIT Alva, Special Secretary (Forest) Government of Karnataka, Bangalore.
03 Feb 1993	Dr AM Michael, Vice Chancellor, Kerala Agricultural University, Thrissur.
26 Feb 1993	Dr OP Dubey, Principal Scientist (Entomology) ICAR, Krishi Bhavan, New Delhi
31 Mar 1993	Sri GM Behera, Group Head, Integrated Mission for Sustainable Development, National Remote Senting Agency, Hyderabad.

WEATHER DATA FOR 1992-'93

Month	Temp (°C) Max	Humidity % FN	AN	No. of rainy days	Total Rainfall (m.m.)	Sunshine for previous day (Hrs)	Evaporation (mm)	Wind velocaly (km/hr)
Apr	36.0	87	47	04	043.8	09.4	06.6	04.5
May	34.6	89	53	08	159.6	07.6	05.3	03.3
Jun	30.1	95	78	17	806.2	03.4	03.8	03.5
Jul	28.0	95	83	27	949.9	01.4	03.3	NR**
Aug	27.9	86	84	28	984.2	02.0	03.2	NR**
Sep	29.7	85	75	19	892.5	04.4	03.6	NR**
Oct	31.2	95	66	11	225.4	06.2	03.4	01.4
Nov	31.1	92	61	07	417.2	06.7	03.5	01.6
Dec	32.0	84	38	Nil	000.0	09.8	04.4	03.3
Jan	33.6	88	32	Nil	000.0	09.5	04.5	02.0
Feb	34.4	89	33	Nil	000.0	10.1	05.9	03.1
Mar	35.4	89	41	01	063.0	09.5	05.6	03.6
			Total	122	4541.8			

* Minimum temperature could not be recorded due to faulty thermometer.

** Not recorded due to faulty anemometer.