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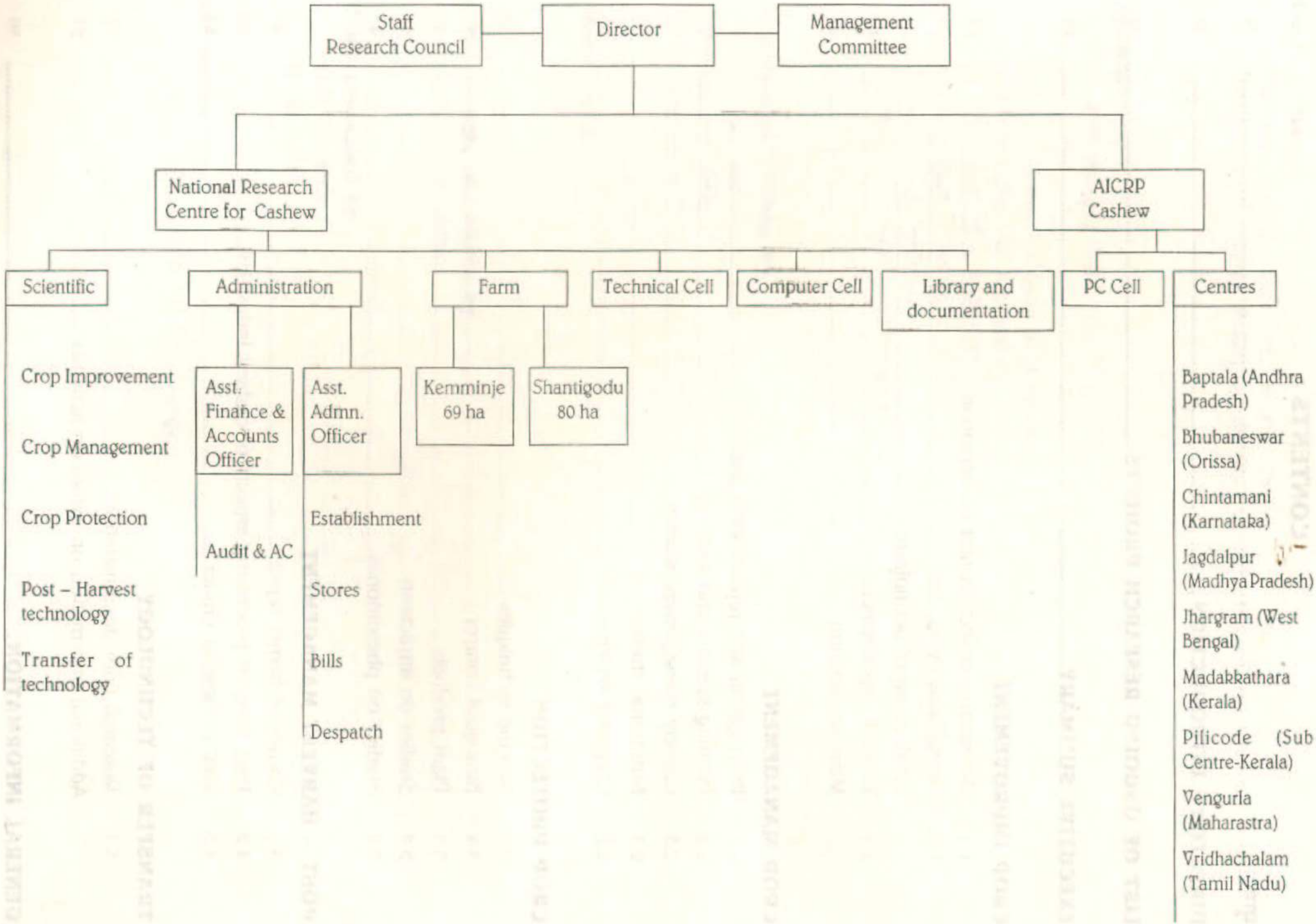
CONTENTS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भूमिका

राष्ट्रीय काजू अनुसंधान केन्द्र ने सातवी पंच वर्षीय योजना के दौरन सन् 1986 की शुरुवात से एक दशक पूर्ण कर लिया है। इस कार्यकाल के दौरान केन्द्र में योग्य साधनों से परिपूर्ण संशोधन हेतू फसल सुधार, फसल प्रबंध और फसल सुरक्षा प्रयोग शालाओं की स्थापना की है। विश्व बैंक के सहायता से राष्ट्रीय कृषि अनुसंधान परियोजना के अंतर्गत जैव प्रौद्यौगिकी के लिए सुविधाएँ उपलब्ध किये गये हैं। इस मुख्य विदेशी निर्यात फसल में कीट नियंत्रण में जैविक पद्धतियों की शुरुआत की गयी है।

इस वर्ष में किए गए मुख्य कार्यक्रम में है, काजू जनन द्रव्य का पूर्णांश। सन् 1986 से पूर्व काजू जनन द्रव्योंका संग्रह और संरक्षण पौद संतति से होता था। जब से राष्ट्रीय काजू अनुसंधान केन्द्र स्थापित हुआ है, सिर्फ क्लोन जनन द्रव्यों का संग्रहण किया गया और 320 एक्सेशन युक्त राष्ट्रीय काजू जीन बैंक स्थापित हुआ है। 1986 में संग्रहित पहली बैच में रोपित 56 एक्सेशन का पूर्णांश IPGRI काजू डिस्क्रिपूटर्स व्दारा किया गया।

जिन पेड़ों की किस्मों को मुल्यांकन में शुरु के सालो में लगाया गया था वे अब फलन स्थिति में आ चुके हैं। कुछ एक साल बाद निर्यात बाजार के लिए उपयुक्त उच्च उपज किस्मों का पहचानना संभव हो जाएगा। बहुप्ररोह प्रेरित निस्पंद संवर्धन में प्रारंभिक सफलता भी हासिल हुई है और पहले बैच के पादपकों को पौधा घर में स्थानांतरित करना संभव हुआ है।

विश्व के बदलते परिवेश में कदम से कदम मिलाने के लिए जैविक खेती की शुरुवात की गई है। काजू कीट के नियंत्रण में वानस्पितिक कीट नाशक की उपलब्धियाँ उत्साहवर्धक है।

केन्द्र, उच्च किस्म की पौध सामग्री की बढ़ती माँग को उपलब्ध कराने का भरसक प्रयास कर रही है। इस वर्ष के दौरान, नर्सरी कार्यक्रम में एक लाख कलमों के उत्पादन का लक्ष्य था जो वर्ष 1996 में रोपण के लिए उपलब्ध होगी।

शोध परियोजनाओं की प्रमुख उपलब्धियाँ निम्नलिखित पृष्ठों में प्रतिवेदित की गई है।

ई वी वी भास्कर राव

(ई.वी.वी. भास्कर राव)

कार्यवाहक निदेशक

DIRECTOR'S INTRODUCTION

The National Research Centre for Cashew has completed one decade since its inception in 1986 during the VII Plan period. Within this period, the Centre has established well equipped laboratories for taking up research in Crop Improvement, Crop Management and Crop Protection. Facilities have also been built with the assistance received from World Bank-aided National Agricultural Research Project for taking up Biotechnology work. For rationalizing the pesticide use in this important export oriented crop, programme on developing integrated pest management practices including Biocontrol have been initiated.

One of the important programmes taken up during the year is characterization of cashew germplasm. Prior to 1986 the cashew germplasm was collected and conserved as seedling progenies. Since the establishment of National Research Centre for Cashew, only clonal germplasm accessions have been collected and a National Cashew Gene Bank with 320 accessions have been established. The 56 accessions which were planted in the first batch of 1986 collections are characterized by using IPGRI cashew descriptors.

Trees in the variety evaluation trials initiated during the earlier years have now attained the bearing stage and within the next couple of years it will be possible to identify high yielding varieties suitable for export market. Preliminary success is also achieved in multiple shoot induction in nodal cultures and first batch of plantlets could be transferred to green house.

In order to keep pace with the changing global trend, organic farming trials have been initiated. The results obtained

on the botanical pesticides in the control of cashew pests are encouraging.

The Centre has been striving to cater to the ever increasing demand of quality planting material. During the year, nursery programme was taken up with the target of one lakh grafts production which will be available for planting in 1996. Salient results obtained in different research projects are reported in the following pages.

EVV Bhaskara Rao

(EVV BHASKARA RAO)

(Act. Director)

LIST OF ONGOING RESEARCH PROJECTS

Project No.	Project	Project leader/ Associate
	1. CROP IMPROVEMENT	
1.1	Collection, conservation, cataloguing and evaluation of cashew germplasm.	KRM Swamy MG Bhat PS Bhat
Ad-hoc scheme	Collection of cashew germplasm from forest plantations in Karnataka.	KRM Swamy Thoyajaksha
1.2	Varietal improvement of cashew.	MG Bhat KRM Swamy
1.3	Tissue culture studies in cashew for micro-propagation and somaclonal variation.	Thimmappaiah Shirly R Samuel
	2. CROP MANAGEMENT	
2.1	Propagation and rejuvenation studies in cashew.	MG Nayak
2.2	Planting systems and planting density trials in cashew.	MG Nayak
2.3	Canopy management studies in cashew.	MG Nayak
2.4	Comparative efficacy of slow release nitrogenous fertilizers for cashew.	N Yadukumar
2.5	Economic feasibility of drip irrigation and graded doses of NPK on the productivity of cashew.	N Yadukumar
2.6	Development of suitable cashew based cropping systems.	N Yadukumar
	3. CROP PROTECTION	
3.1	Formulating IPM schedules for stem and root borers infesting cashew.	TN Raviprasad PS Bhat
3.2	Evaluation and mass multiplication of bio-control agents against TMB.	TN Raviprasad

3.3	Devising eco-compatible plant protection measures against TMB.	PS Bhat TN Raviprasad

4. POST – HARVEST MANAGEMENT

4.1	Investigations into the causes of nut rejects during harvest, storage and processing.	KV Nagaraja D Balasubramanian
4.2	Developing data base on processing aspects of cashew industries in India.	D Balasubramanian
4.3	Design, development and evaluation of raw cashew nut grader.	D Balasubramanian

5. TRANSFER OF TECHNOLOGY

5.1	Research cum demonstration plots.	Sreenath Dixit

EXECUTIVE SUMMARY

National Research Centre for Cashew was established in 1986 to increase production and productivity of cashew. Mandate of the Research Centre include evolving high yielding varieties with desirable quality parameters, standardization of agrotechniques and transfer of proven technologies. To achieve the mandate, various research projects (17 no.s) have been taken up in the areas of crop improvement, crop management, crop protection, post-harvest management and transfer of technology.

Crop Improvement

National Cashew Gene Bank (NCGB) at present has 320 accessions. A total of 24 trees have been identified for desirable characters such as high yield, cluster bearing, short duration, higher shelling percentage, bold nut, long apple and big sized flowers etc. from forest plantations at Kundapur, Moodabidri and Puttur. Out of 320 accessions, 56 accession planted in 1986 were screened for tea mosquito tolerance and all were found to be susceptible. In yield evaluation trial, VTH 539/2 showed highest annual yield (2.56 kg/tree) and cumulative yield of 3.93 kg/tree in the fifth harvest compared to M 44/3. The proportion of hermaphrodite flowers ranged from 0.93 per cent 34.69 per cent among different varieties. Among 33 hybrids, VTH 12 (M 44/3) x VTH 11 (M 10/4) performed better with yield of 4.55 kg/tree in the sixth harvest compared to control yield of 1.43 kg/tree in M 44/3. During the year, released varieties BLA 139-1, M 44/3, Ullal-2 were crossed with bold types such as Kankadi, Vetore-1, Vetore-2, Bhedasi, Shirtal and, Humbarmal.

Combination of TDZ and NAA at 0.1 mg/l each gave better response with an average of 5.4 buds/explant with nodal cuttings and shoot tips from in vitro raised seedlings of VTH 174 when cultured in 3/4 MS medium. Four plants multiplied by tissue culture have been successfully planted in green house.

Crop Management

Initial graft success under normal and low cost humidity

chamber were similar. Air layers of semi dwarf trees identified at CPCRI Regional Station, Vittal (S 11/1, S 11/2, VTH 762/4, VTH 712 and VTH 713) have been prepared for laying out a field trial to study the dwarfing effects. In a trial on planting systems, maximum ground coverage was recorded in 5 m x 4m spacing both under pruned (56.1m^2) and unpruned (61.8m^2) conditions. Both the annual yield and cumulative yield obtained from hedge system with 5 m x 4m spacing under pruned and unpruned conditions were maximum compared to other systems.

Under high density planting the plot with a population of 555 trees/ha (originally 1111 trees/ha and thinned to 555 after 7 years of planting) gave highest yield of 689 kg/ha three years after planting. In a trial on slow release nitrogenous fertilizers, highest yield 4.96 kg/tree was recoded in the third harvest when NP tablets were applied once in two years

Irrigation and graded doses of fertilizers influenced nut, apple and kernel weights. Yield of intercrop (pine-apple) was maximum (502 kg/plot) where subabul was retained as intercrop for the first five years. PFd (photon flux density), EOL (transpiration) and photosynthetic rate reduced significantly when acacia and casuarina were grown in different combinations with cashew. Cashew yield in the fifth year (24.22 kg/ha) was affected when grown with casuarina and acacia.

Crop Protection

Changing the feed once in six days with spraying water daily resulted in higher survival of young grubs of *Plocaederus* spp. (95% to 97%) which economised the bark requirement. Mortality of CSRB grubs (72.4%) was noticed in soil mixed with neem cake even in sample drawn after 180 days. Nimbecidine and neem oil treated trees were free from CSRB infestation upto three months after last round of treatment. Among the plant products tested against TMB, lowest infestation was recorded with Nimbecidine followed by Limanool. Among leaf extracts tested against TMB, damage rating was less for *Adhatoda vasica* compared to other treatments *(Vitex negundo and Thevatia nereifolia).*

Post – Harvest Management

Storing rawnuts upto 8 months did not adversely affect shelling percentage, peeling outturn and per cent kernel rejection. Per cent wholes recovered was considerably less in nuts processed without steam roasting compared to steam roasted nuts. Kernel rejects from immature nuts had higher FFA, lower lipid peroxides, starch and sugars. Data base on processing aspects of cashew industries is being established at the Centre.

Transfer of Technology

Communication behaviour of demonstration farmers was studied and all the farmers (30) consulted NRC for Cashew for information on cashew. Most of them (87%) evaluated the new information based on their past experience. Only 14 farmers communicated information to other farmers while the remaining did not communicate to others. About 40,000 softwood grafts were produced and distributed to farmers and departmental agencies. A total of 75 technical enquiries were replied. Three training courses were organised wherein 69 persons participated.

CROP IMPORVEMENT

1 CROP IMPROVEMENT

1.1 GERMPLASM COLLECTION AND CONSERVATION

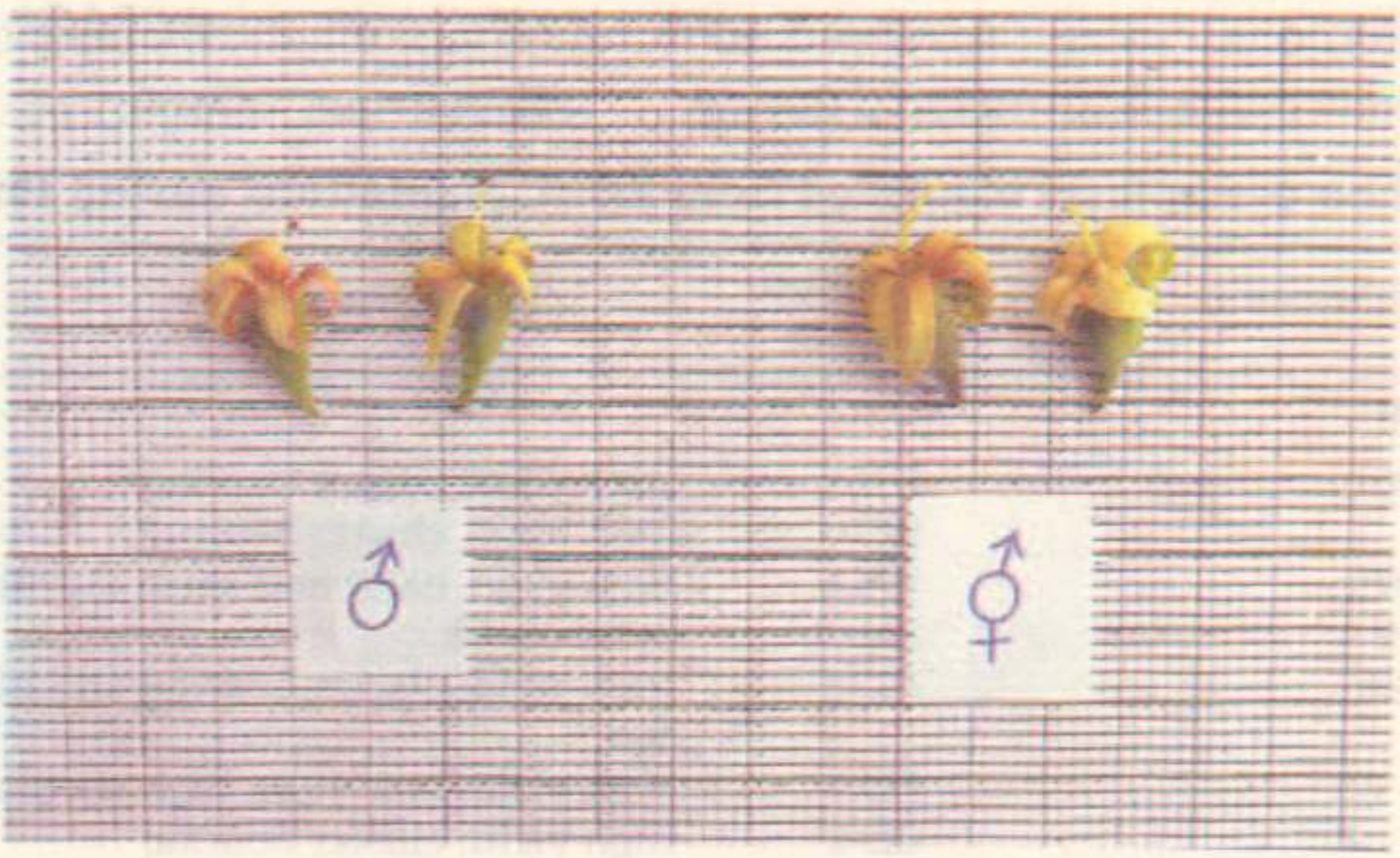
Objectives of the project are collection of both indigenous and exotic germplasm of cashew, conservation in the National Cashew Gene Bank (NCGB), evaluation and cataloguing of germplasm. So far, 320 clonal accessions have been planted in NCGB for conservation.

Plantations of Karnataka Cashew Development Corporation (KCDC)/Forest Plantations in Puttur, Kundapur and Moodabidri Divisions were surveyed for identifying cashew germplasm material during the cropping season of 1996 under an Ad-hoc Research Project. A total of 24 trees were identified for different characters from these plantations (Table 1). Collections include trees with early flowering, short flowering duration, synchronus flowering, once-over harvest, medium to high yield, medium to bold sized nuts, cluster bearing habit, high flowering intensity, high sex ratio, high shelling percentage, low apple to nut ratio, semi dwarf type, big sized flowers (one and half to two times the size of normal flower), big sized flowers with expanded petals, rare leaf shape (oblong - elliptic shape with pointed apex and reflexed leaf margin) etc.

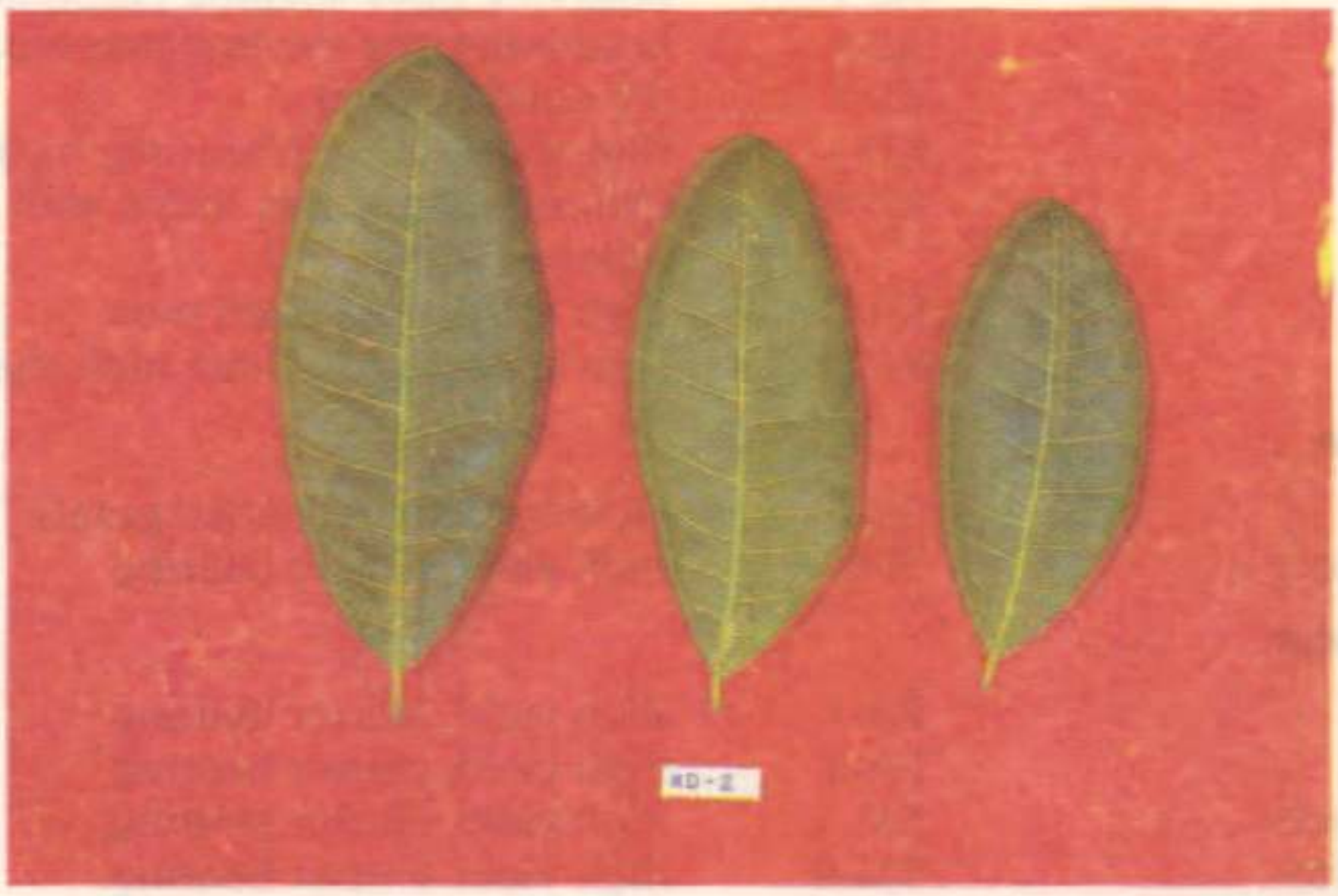
Table 1: Cashew germplasm identified from KCDC plantations during 1996

Name of the plantation	Collection number	Distinctive feature
Puttur Division		
Halaneranki - 1961	HN-1	High yield, cluster bearing
Koila - 1960	KO-1	High yield, cluster bearing
Halaneranki - 1975	HN-2	High yield, early and short duration
Suvarmale - 1972	SM-1	Long apple
Aranthakallu - 1967	AR-1	High yield, cluster bearing and high shelling percentage
Belal - 1969	BE-1	High yield, bold nuts, high shelling percentate
	BE-2	High yield, cluster bearing
	BE-3	Semi dwarf plants
	BE-4	High yield, cluster bearing, early and short duration, low apple to nut ratio
Alike - 1964	AL-1	Bold nut, poor shelling percentage
	AL-2	Bold nut, poor shelling percentage
Kodippady - 1961	KP-1	Big sized flowers
Kodimbady - 1984	KD-1	High yield, cluster bearing, high shelling percentage
	KD-2	Oblong-elliptic leaf shape with pointed apex and reflexed leaves
Kodiyala - 1969	KOD-1	High yield, bold sized nuts
Kidu (CPCRI) - 1969	KI-1	Low apple to nut ratio, high shelling percentage
Kundapur Division		
Sablady - 1957-60	SL-1	Flowers with expanded petals
Shirur paduvare-1965	SP-1	High yield, cluster bearing
Moodabidri Division		
Paranki-1971	PA-1	High yield, cluster bearing
	PA-2	High yield, cluster bearing
Konaje Marpady - 1966	KM-1	High yield, cluster bearing
Shirur paduvare - 1965	KM-2	High yield, cluster bearing
Daregudde Valpady - 1963	DV-1	High yield, cluster bearing
	DV-2	High yield, cluster bearing

Big sized flowers



Big sized male and female flowers



Oblong elliptic leaf with pointed apex

Sixteen samples of dwarf cashew types were also obtained from Brazil through Mozambique. The mean nut weight of these samples varied from 6.0 - 14.0g.

1.2 GERMPLASM EVALUATION

1.2.1 Screening of accessions against tea mosquito bug (TMB)

Out of the 320 accessions planted so far in NCGB, 56 accessions planted in 1986 were screened by field cage method. Tender shoots were inserted in cylindrical cages of galvanised iron wire and nymphs (2 nos./cage) were released into it. Nymphs were allowed to feed on tender shoots for 48 hr. Bags made out of mosquito net cloth were used to cover the cages to prevent insects from escaping.

Damage on tender shoots was scored one week after the release of nymphs. Accessions based on the damage scores, were classified as tolerant (0.0 - 1.0), moderately tolerant (1.1-2.0), moderately susceptible (2.1-3.0) and susceptible (3.1-4.0). All the 56 accessions screened were susceptible. Natural infestation of TMB on these accessions was also recorded in January 1996 after spraying them with monocrotophos and carbaryl in November and December 1995, respectivlely. Of these accessions, five were moderately tolerant and 12 were moderately susceptible (Table 2).

Table 2: Reaction of 56 accessions planted during 1986 to TMB under natural condition

Reaction	Number of accessions						
Moderately tolerant	5	(NRC 8, (1.8)*	23, (1.6)	26, (1.4)	54, (1.2)	55) (1.8)	
Moderately susceptible	12	(NRC 2, 34,	3, 35,	18, 42,	19, 47,	21, 50,	33, 52)
Susceptible	39						
Total	56						

Figures in parantheses indicate Damage score

Screening for TMB tolerance by field cage method

Table 3: Reaction of 264 accessions (planted in NCGB during 1987-1994) to TMB under natural infestation

Reaction	Number of accessions
Tolerant	16
Moderately tolerant	14
Moderately susceptible	15
Susceptible	219
Total	264

Damage due to natural infestation of TMB on the remaining 264 accessions (subjected to similar insecticide sprays) were also scored. Of these, 46 accessions showing tolerant to moderately susceptible reaction will be further screened under field cage method (Table 3).

1.3 CATALOGUING OF GERMPLASM

Based on three environmentally stable characters, namely, flowering season, duration of flowering and colour of apple, 56 accessions (planted in 1986) were grouped into 15 distinctive clusters (Table 4). Of the 15 clusters, five clusters consisted of single accession and the largest cluster had 15 accessions.

Table 4: Grouping of 56 accessions into clusters

Season of flowering	Flowering duration	Apple colour	Number of accessions	Accession number
Early	Medium	Yellow	3	1, 50, 56
Early	Long	Yellow	5	3, 20, 21, 46, 47
Early	Long	Red	2	38, 39
Early	Long	Mixed	2	6, 40
Mid	Medium	Yellow	7	5, 7, 13, 17, 42, 53, 55
Mid	Medium	Red	6	27, 29, 35, 36, 37, 41
Mid	Medium	Mixed	1	14
Mid	Long	Yellow	15	2, 4, 9, 10, 15, 16, 22, 31, 43, 44, 45, 48, 49, 52, 54
Mid	Long	Red	6	8, 11, 25, 28, 32, 51
Mid	Long	Mixed	3	12, 30, 34
Late	Medium	Yellow	1	26
Late	Medium	Red	1	18
Late	Medium	Orange	1	33
Late	Long	Yellow	2	23, 24
Late	Long	Red	1	19
Total			56	

Where:

Season of flowering: Early (Nov. - Dec); Mid (Dec. - Jan.); Late (Jan. - Feb)

Flowering duration: Short (< 60 days); Medium (60-90 days); Long (> 90 days)

1.4. VARIETAL IMPROVEMENT

Objectives of the breeding programme are genetic improvement of cashew for yield and other important characters such as nut weight (>7g), kernel weight (>2.0g), shelling percentage (>28%), resistance to tea mosquito bug and better quality (high protein and lysine) cashew kernels.

A total of 58 accessions (elite lines), three selfs and 50 hybrids were evaluated in seven trials. Details of the trials are as under :

1. Elite germplasm lines/accessions.
2. Evaluation of recommended varieties.
3. Evaluation of hybrids/selfs.
4. Evaluation of cashew hybrids for improvement of nut size.
5. Evaluation of high yielding and high sehlling types.
6. Evaluation of big apple and medium nut types.
7. Comparative study of the performance of grafts versus seedlings.

1.4.1. Yield evaluation of elite germplasm lines/accessions - Selections.

In a trial with 14 elite germplasm lines/selections, highest annual yield (2.56 kg/tree) and highest cumulative yield (3.93 kg/tree) were recorded in VTH 539/2 in the fifth harvest as against the annual yield of 1.53 kg/tree and cumulative yield of 2.46 kg/tree in control (M 44/3). Per cent increase in annual yield and cumulative yield over the control was 67 and 60 respectively.

1.4.2 Evaluation of recommended varieties

Two trails with recommended varieties planted in 1986 (12 varieties, Set-1) and 1991 (9 varieties, Set-2) had a common control of M 44/3.

Photosynthetic efficiency of 12 recommended varieties (Set-1) were studied at flushing, flowering and fruiting stages using Leaf Chamber Analyser in two plants from each of the varieties.

Photosynthetic efficiency at flushing stage ranged from 4.8 to 10.4 μ mol $CO_2/m^2/sec$ and the highest rate was recorded in H2/11. At flowering stage, photosynthetic efficiency ranged from 3.9 to 8.7 μ mol $CO_2/m^2/sec$ with BLA 39-4 exhibiting the highest rate. At fruiting stage, photosynthetic efficiency varied from 1.0 to 7.3 μ mol $CO_2/m^2/sec$ with Ullal-1 showing the highest rate. In H2/11 variety, there was gradual reduction of photosynthetic efficiency from flushing stage to flowering stage and then to fruiting stage (10.4, 7.9 and 5.1 μ mol $CO_2/m^2/sec$, respectively) while in Ullal-1 the efficiency remained almost constant at around 7.0 μ mol $CO_2/m^2/sec$ at all the three stages. Average Photon Flux Density (PFD) values were 1273, 1249 and 1323 μ mol/m^2/sec at flushing, flowering and fruiting stages, respectively.

Flowering pattern was studied in twenty varieties in the later part of the season (January to April 1996). Proportion of hermaphrodite flowers to total number of flowers and period of different flowering phases (male phase, hermaphrodite phase and mixed phase) were observed in each of the twenty varieties by counting the number of hermaphrodite and male flowers at regular intervals from tagged flower panicles. Proportion of the hermaphro-

Table 5: Yield of recommended varieties in seventh harvest (Kg/tree).

Variety	Yield	Cum. yield
M 44/3	2.32	7.09
EPM 9/8	2.29	5.55
T. No. 1 (BPP 5)	2.22	5.54
H2/12	1.89	4.56
T. No. 56 (BPP 6)	1.70	4.42
Ullal - 1	1.56	4.27
M 10/4	1.55	5.40
BLA 139-1	1.36	3.74
BLA 39-4	1.33	5.80
H 2/11	1.05	3.28
H 3-17	0.79	2.61
H 3-13	0.10	1.55
CD 5%	0.804	1.695
CD 1%	1.092	2.304

dite flowers ranged from 0.93 per cent to 34.69 per cent among different varieties, the lowest being in H2/12 (BPP-2) and the highest being in H 3-17. Varieties with more than 20 per cent hermaphrodite flowers were H 3-17 (34.69%), H 2/11 (BPP 1) (32.09%), BLA 39-4 (29.32%) and T.No.56 (BPP 6) (24.02%).

Among the 20 varieties studied, mixed phase was observed in the early period in H2/11 T.No.1 (BPP 5), EPM 9/8 (BPP 4), M 44/3 (VRI-2), BPP 3 and BLA 39-4 (Madakkathara-1) while mixed phase existed in the middle period in H 3-17. In T.No.56 mixed phase persisted throughout the flowering period. Male phase predominated throughout the flowering period in Ullal-1, Ullal-2, M 10/4 (VRI-1), H2/12 (BPP 2), NDR 2-1 (Madakkathara-2), Vengurla-1, Vengurla-4, NRCC Selection-1, NRCC Selection-2 and K 22-1 based on the preliminary observations on flowering pattern.

In the first set, yield differences among 12 varieties were significant. Highest annual yield (2.32 kg/tree) and highest cumulative yield (7.09 kg/tree) for seventh harvest were recorded in control (M 44/3) (Table 5).

BLA 39-4, EPM 9/8, T.No.1 and M 10/4 had cumulative yield ranging from 5.40 to 5.80 kg/tree as against the cumulative yield of 7.09 kg/tree of M 44/3.

High photosynthetic efficiency of 10.4 μ mol $CO_2/m^2/sec$ in case of H 2/11 in flushing stage did not reflect in the yield as the yield levels were low (annual yield : 1.05 kg/tree and cumulative yield : 3.28/kg/tree). In spite of low photosynthetic efficiency in case of M 44/3 at all the three stages, yield levels were relatively higher. However, in case of BLA 39-4 higher photosynthetic efficiency in flushing and flowering stage (9.1 and 8.7 μ mol $CO_2/m^2/sec$ respectively) reflected on better cumulative yield (5.80 kg/tree).

T.No.56 (BPP 6) had better photosynthetic efficiency at flowering stage (8.4 μ mol $CO_2/m^2/sec$), higher proportion of hermaphrodite flowers (24.02%), longest mixed phase period. But these parameters did not reflect on the yield as this variety had relatively low cumulative yield of 4.42 kg/tree.

Trees in the second set of recommended varieties trial are in the early stages of bearing (planted in 1991).

1.4.3: Evaluation of hybrids/selfs

There are three sets of experiments under the evaluation of hybrids/selfs. In the first

set, 33 hybrids planted in 1987, were evaluated while in the second set (planted in 1992) six hybrids and one selfed line and in the third set (planted in 1994) five hybrids and two selfed lines were evaluated in replicated trials along with NRCC Sel-1, NRCC Sel-2, VRI-2 and VTH 174.

In the first set, among the 33 hybrids, VTH 12 (M 44/3) x VTH 11 (M 10/4) performed better with a yield of 4.55 kg/tree in the sixth harvest followed by VTH 59 (13/5 Kodur) x VTH 16 (M 16/3) (4.05 kg/tree) compared to yield of 1.43 kg/tree in the case of M 44/3. Per cent increase in yield of these hybrids over M 44/3 was 218 and 183, respectively (Table 6). Further, highest cumulative yield (10.35 kg/tree) was also recorded in VTH 12 (M 44/3) x VTH 11 (M 10/4) for six years as compared to 4.73 kg/tree in M 44/3 (Control) for the same period. Increase in cumulative yield over the control was 119 per cent.

Hybrids/selfs the second and third set of are in the initial stage of plantation.

1.4.4. Improvement of nut size in released varieties

In order to combine the high yielding character with bold nut and kernel characters, crosses were made between released varieties (M 44/3, BLA 139-1, Vengurla 5 and Vengurla 2) and bold nut types (VTH 711/4 Brazilian and VTH 40/1) since 1990. Over 650 hybrid plants have been planted since 1991. Details of the field plantings of hybrid seedlings done during the year are given below.

Entry	No. of Plants
BLA 139-1 x VTH 711/4	92
VTH 711/4 x BLA 139-1 (Reciprocal cross)	5
V-2 x VTH 711/4	46
VTH 711/4 (OP)	9
TOTAL	152

Nut weight of 11.0g was recorded in H 1200 (VRI-2 x VTH 711/4) which gave a yield of 0.8 kg/tree in the first harvest. Frequency distribution for nut weight in hybrid progenies is presented in Table 7.

In crosses where bold nut genotype VTH 711/4 was used, proportion of the hybrid plants having more than 7.0g nut weight was higher as compared to the crosses where medium nut size genotype VTH 40/1 was used (Table 7).

Table 6: Yield of five promising hybrids in sixth harvest (Kg/tree)

Name of the Cross	Yield	Cumulative yield
VTH 12 (M 44/3) x VTH 11 (M 10/4)	4.55	10.35
VTH 59 (13/5 Kodur) x VTH 16 (M 16/3)	4.05	6.68
VTH 30 (A 18/4) x VTH 11 (M 10/4)	3.65	7.78
VTH 36 (T. No. 56) x VTH 30 (A 18/4)	2.46	8.32
VTH 12 (M 44/3) x VTH 30 (A 18/4)	2.96	8.03
VTH 12 (M 44/3) Control	1.43	4.73

Table 7: Frequency distribution for nut weight in hybrids progenies

Cross/Genotype	Nut wt. of mother parent	Number of trees with nut wt(g)				
		≤ 5.0	5.1-7.0	7.1-9.0	≥ 9.1	Total
M 44/3 x VTH 40/1	5.0	7	19	5	1	32
BLA 139-1 x VTH 711/4	6.0	3	7	10	2	22
V-5 x VTH 711/4	4.5	9	27	17	1	54
BLA 139-1 x VTH 40/1	6.0	4	13	5	-	22
M 44/3 x VTH 711/4	5.0	9	10	13	1	33
V-5 Self	4.5	-	-	1	-	1
V-5 x VTH 40/1	4.5	30	44	5	-	79
V-5 x *A. pumilum*	4.5	4	-	-	-	4
ISH x V-5	-	3	-	-	-	3
ISH x VTH 40/1	-	2	1	-	-	3
Total	-	71	121	56	5	253

During the year, released varieties (BLA 139-1, M 44/3 and Ullal-2) were crossed with another set of bold nut types selected from National Cashew Gene Bank such as Kankadi, Vetore I, Vetore II, Bhedasi, Sirtal, Humbarmal and also genotypes with medium nut types (13/5 Kodur and A 18/4).

1.4.5 Other trials

Trials on high shelling types, big apple types and comparative trial on grafts versus seedlings planted in 1990 are in the initial stage of plantation. In the grafts versus seedling trial, grafts and seedlings originating from same source did not differ much for morphological characters in most of the genotypes.

1.5 MICROPROPAGATION

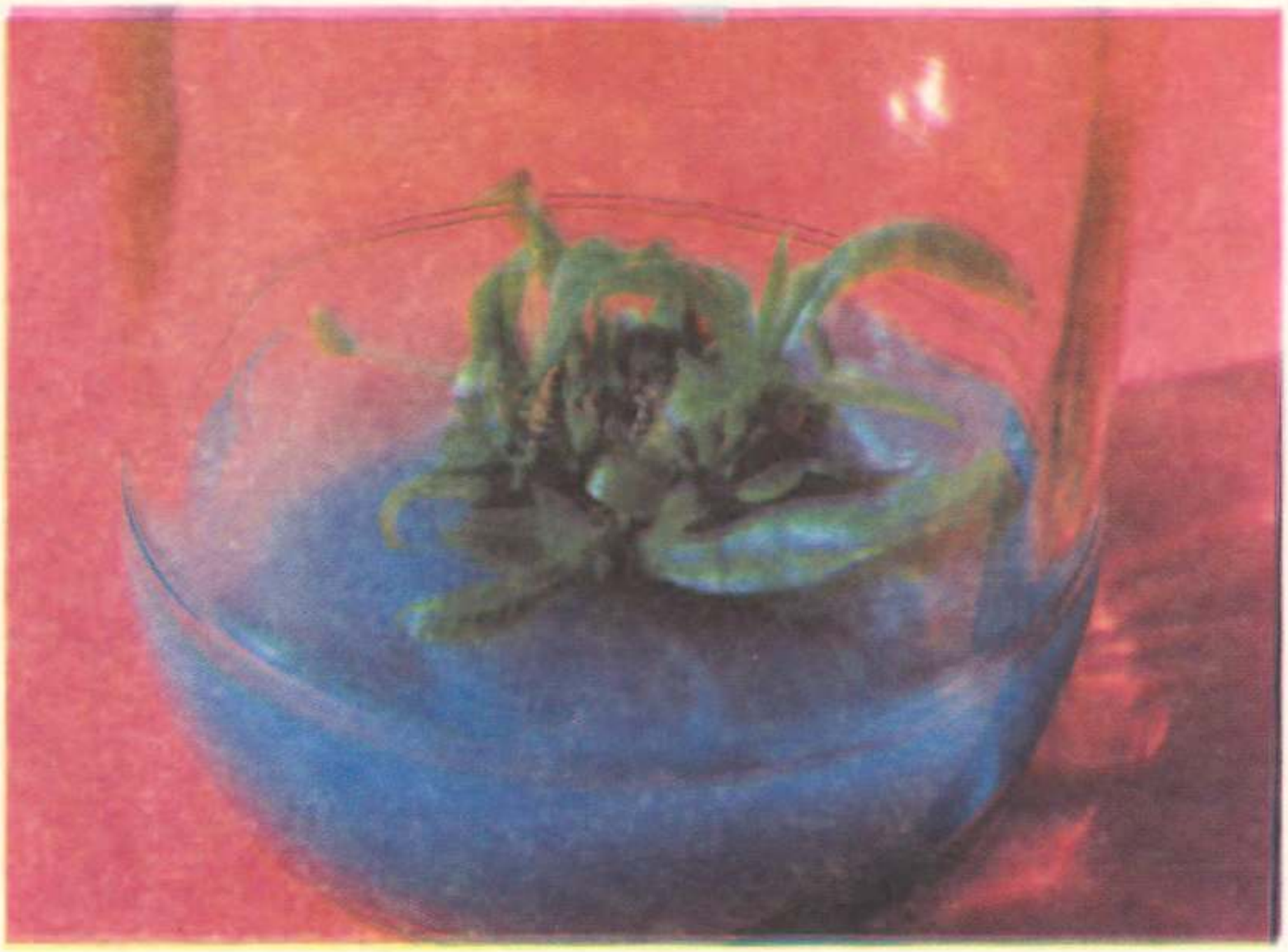
The project was initiated in 1989 with an objective of standardising micropro pagation technique to multiply elite lines of cashew.

1.5.1 Induction of multiple shoots

Experiments with cytokinins tried earlier at various levels did not induce multiple shoots from nodal cultures. Nodal cuttings and shoot tips from in vitro raised seedlings of VTH-174 were cultured in three fourths MS medium supplemented with thidiazuron (TDZ) (0.1 mg/l) alone and with BA, NAA and IBA in 21 different combinations for induction of multiple shoots. Within 3-4 weeks, explants showed shoot bud proliferation (1-13 buds/explant). Among the treatments, difference was not significant. However, combination of TDZ and NAA at 0.1 mg/l each gave better response with an average of 5.4 buds/explants.

1.5.2 Shoot bud elongation

Among the two semi-solid media namely, modified MS medium containing sucrose (5%), maltose (5g/l), BA (1mg/l) and coconut water (10%) and Raj Bhansali (1990)



Multiple shoot induction in TDZ medium

medium tried for shoot bud elongation, better response was observed with 68 per cent of the shoots showing elongation in Raj Bhansali (1990) medium.

1.5.3 Rooting of microshoots and acclimatisation

Microshoots from nodal cultures and shoots harvested from cotyledonary nodes were used for rooting experiments. Micro-shoots were cultured on half-strength MS medium supplemented with NAA, IBA and IBA alone (2.5, 5.0 mg/l) and in combination of two (2.5 mg/l each). Maximum rooting (75%) was observed in media containing 5.0 mg/l of NAA.

Eighteen in vitro rooted plantlets were acclimatised in vitro on liquid half MS me-dium. Hardened plants (15 Nos) were transferred to plastic pots containing the mixture of sand, soilrite and coir pith (2:1:1). Potted plants covered with polythene bags were further acclimatised in laboratory. Polythene bags were gradually removed over a period of time in the process of acclimatisation. Four plants have been successfully established in green house.

1.5.4 Establishment of nodal cultures (mature tree)

Different pretreatments and sterilisation treatments were followed for control of contamination in field explants. Stock plants were given periodic sprays with carbendazim, mancozeb streptomycin suplhate. Later, explants were sterilized with chlorine tablets (Millipore) alone and in combination with mercuric chloride. Sterilization with chlorine tablet (2.5% Cl2) for 30 min. with 0.05 per cent HgCl2 for 10 min. or 0.1 per cent HgCl2 for 2 min. showed least contamination (70%). However, explants of young cashew grafts when maintained in protective environment had lower contamination (10-40%). Seasonal variation was observed with least contamina-tion in November and December.

CROP MANAGEMENT

2 CROP MANAGEMENT

2.1 PROPAGATION AND REJUVENATION STUDIES

Studies on propagation were initiated with the idea of carrying out grafting successfully during off season (flushing/flowering/fruiting season). Rejuvenation studies aim at standardising top working technique for improving the production of old and unthrifty cashew plantations.

2.1.1 Off season grafting

Grafts prepared in February, March and April were kept under low cost humidity chamber and were compared with the grafts (with polythene caps on scion) kept under thatched sheds (normal method). Initial success under both the conditions were similar (Table 8). This is in conformity with earlier results.

2.1.2 Root stock studies

Earlier studies have indicated that morphological and anatomical characters such as height of the seedling, Number of leaves, internodal length, girth at collar region, bark percentage of root and shoot, stomatal numbers, total phenols etc, could not be used as indicators for identifying dwarfing root stock at nursery stage. Therefore, air layers of 'semi dwarf' trees identified at CPCRI (RS) Vittal (S-11/1, S-11/2, VTH 762/4, VTH 712, VTH 713 and NRCC Selection 1) were prepared for laying out a field trial to study their dwarfing effects.

Table 8: Graft success (%) under low-cost humidity chamber and under normal method (1996)

Month of grafting	Low cost humidity chamber	Normal method
Feb.	85.00	84.00
Mar.	83.00	87.00
Apr.	82.00	81.00
Mean	83.00	84.00

2.1.3 Topworking

Topworking trial on cashew was initiated with an objective of comparing the economics of topworking with fresh planting of grafts in old and unthrifty cashew plantations.

Thirty cashew trees of 14 years age were topworked during the year 1990 at NRCC and in the adjacent plot 30 trees were completely uprooted and grafts of VTH 30/4 were planted. Out of 30 topworked trees, 19 trees survived (63.3%) and the rest died due to stem and root borer infestation inspite of regular prophylactic measure like swabbing of trunk with carbaryl (0.2%). Out of thirtyfive trees top worked earlier at CPCRI (RS), Vittal in 1994, 19 trees survived (54.3%).

Growth parameters such as height of the plant/topworked shoot, girth and canopy spread were recorded. Mean canopy spread of topworked trees was 28.5 m^2 while it was 14.75 m^2 in the replanted plot (Table 9). At NRCC, cost of establishment and maintenance of surviving top worked tree was Rs. 265.80/tree for six years, while it was Rs. 140.50/tree in replanted plot. At Vittal,

Table 9: Growth parameters of top worked and replanted plants at NRCC

Plot		Plant height/shoot length (m)	Trunk/ shoot girth (cm)	Primary branches cut (No)	Canopy spread (m^2)
Top	Min.	2.67	22.70	1	9.62
Worked	Max.	5.50	42.00	4	56.75
	Mean	3.49	31.19	3	28.50
Replanted	Min.	2.20	18.50	-	1.76
	Max.	4.10	49.00	-	28.27
	Mean	3.36	32.30	-	14.75

cost of establishment and maintenance for surviving topworked tree was Rs. 241.80/ tree for two years. Cost of establishment, maintenance and yield of topworked and replanted plots since 1990-91 is presented in Table 10. Top worked plot gave a yield of 27.86 kg/plot as against 17.29 kg/plot in re-planted plot during the year under report.

2.2 PIANTING SYSTEMS AND SPACING

2.2.1 Hedge and square systems

In an attempt to study the effect of planting systems, spacing and pruning on growth and yield of cashew, trials were laid out in 1990. Different spacings under square and hedge systems were as follows :

Square system	Hedge system
5.0 m x 5.0 m	5.0 m x 4.0 m
6.5 m x 6.5 m	6.5 m x 4.0 m
8.0 m x 8.0 m	8.0 m x 4.0 m

Effect of pruning is being studied in both the systems of planting. All the plants were trained to central modified leader system of training in pruned plots. During the year, criss cross branches, intermingling branches with neighbouring trees, dry twigs etc. were

Table 10: Yield and establishment and maintenance cost of topwoked and replanted plots (0.2 ha each) during last 6 years

Year	Amount spent (Rs)		Yield (Kg/ha)	
	Topworked	Replanted	Topwokred	Replanted
1990-91	1241.00	620.00	-	-
	845.00	530.00	-	-

Table 11: Growth of cashew in different systems of planting and spacing under pruned and unpruned conditions (1995-96)

Spacing (m)	Plant Population/ ha	Plant height (m)		Trunk Girth (cm)		Canopy spread (m^2)		Ground coverage (%)	
		P	UP	P	UP	P	UP	P	UP
Square									
5.0 x 5.0	400	2.76	2.86	34.26	32.86	11.09	13.32	44.36	53.28
6.5 x 6.5	236	2.73	2.16	27.80	26.40	9.84	23.22	23.22	23.28
8.0x 8.0	156	2.69	2.52	27.28	28.40	8.78	20.93	13.69	27.05
Hedge									
5.0 x 4.0	500	3.14	2.95	31.60	33.73	11.22	12.36	56.10	61.80
6.5 x 4.0	384	2.71	2.59	30.86	31.41	11.75	13.98	45.36	53.82
8.0 x 4.0	312	2.59	2.44	31.20	29.20	9.77	9.26	30.58	28.98
		NS	NS	NS	NS	NS	NS	CD = 15.72	

P - Pruned ; UP - Unpruned

pruned off in the sub plot treatments. Among various spacings under hedge and square systems, maximum ground coverage was recorded in 5 m x 4 m spacing both under pruned ($56.1m^2$) and unpruned ($61.8m^2$) condition followed by ground coverage ($53.8m^2$) in 6.5 m x 4.0 m spacing under unpruned conditions (Table 11). Maximum yield/ha was obtained from hedge system with 5 m x 4 m ospacing in both pruned (433 kg) and unpruned (342.5 kg) conditions. Cumulative yield/ha was also maximum in this system of planting in both pruned (877.32 kg) and unpruned (967.98 kg) conditions (Table 12).

Table 12: Yield of cashew in different planting systems (kg/ha)

Spacing (m)	Density No. /ha	Yield		Cumulative yield	
		Pruned	Unpruned	Pruned	Unpruned
Square					
5.0 x 5.0	400	359.86	312.40	821.55	890.65
6.5 x 6.5	236	139.02	90.86	347.86	341.57
8.0 x 8.0	156	58.96	53.05	183.73	203.08
Hedge					
5.0 x 4.0	500	443.16	342.50	877.32	967.98
6.5 x 4.0	384	219.00	164.86	596.25	542.01
8.0 x 4.0	312	162.18	117.00	479.59	441.45

CD (Spacing) : 261. 32 (5%)

CD (Pruning) : NS

2.2.2 High density planting

High density planting experiment was started in 1982 to assess the effect of different plant densities on growth and yield of cashew.

During the year (13th year after planting) the plot with a population of 555 trees/ha(originally 1111 trees/ha and thinned to 555 after seven years of planting) gave highest yield of 688.98 kg/ha.

Cumulative yield, however was more (5446.32 kg/ha) in the case of the plot with 312 tree/ha (originally 625 and thinned out to 312 after 10 years of planting) [Table 13]. Difference in yield/ha was significant among different densities of planting.

2.3 CANOPY MANAGEMENT STUDIES

Programme has been initiated to study the effect of pruning on plant growth parameters like flushing and flowering behaviour, branching habit canopy containment, dwarfing and yield of cashew.

A field trial with four cashew varieties viz., VRI-1 (intensive branching and early flowering type), Ullal-1 (intensive branching and late flowering type), VTH 30/4 (extensive branching and early flowering type) and NRCC Selection-1 (extensive branching and late flowering type) has been laid out.

All the plants have been trained to modify leader system of training. Pruning treatment have been imposed during the year. Details of the treatments are as follows :

Iep	Ilp	Eep	Elp
Ieap	Ilap	Eeap	Elap
Ieyp	Ilyp	Eeyp	Elyp
Iesp	Ilsp	Eesp	Elsp

E=Extensive branching ; e=early flowering ; p=no pruning

I=Intensive branching ; l=late flowering ; yp= yearly pruning

ap =alternate year pruning ; sp =shape pruning

Table 13: Yield of cashew under different plant densities (Kg/ha)

Plant population (No/ha)	Yield/ha	Cumulative yield (from 4 - 13 years after planting)
156	324.80	2599.80
278	610.86	3751.86
625 upto 10 years and 312 after thinning	499.20	5443.20
1111upto 7 years and 55 after thinning	685.97	5350.98
2500 upto 7 years and 625 after thinning	532.49	4880.50

CD = 42.66

2.4 NUTRITIONAL STUDIES

2.4.1 Slow release nitrogenous fertilizers

Different forms of slow release nitrogenous fertilizers are compared for their efficacy in a field experiment started in 1990. Treatments also included bio fertilizers like Azatobactor and Azospirillum.

There was no significant difference in soil N content among different treatments before and after the application of N fertilizer. Soil N content was maximum (0.14%) after the application of NP tablets once in year.

There was a significant difference in leaf N content during flushing, flowering and fruiting due to application of different forms of slow release N fertilizers. Neem coated urea (once in two years) resulted in highest N content in leaves during flushing (2.96%). During flowering, leaf N content was maximum (2.13%) in treatment with NP tablets once in two years. Application of Azospirillum resulted in highest N content in leaves (2.03%) during fruiting. Lowest N content was noticed in leaves at all the stages when urea was applied as single dose (Table 14).

In the third havest, highest yield (4.96 kg/plot) was recorded when NP tablets were applied once in two years while the lowest (2.05 kg/plot) was recorded when neem coated urea was applied once in two years. However, there was no significant difference in yield among different treatments.

2.4.2 Irrigation and graded doses of NPK

Effect of drip irrigation coupled with graded doses of NPK on the productivity of

Table 14: Leaf N Content (%) in different fertilizer treatments

Treatment	Flushing	Flowering	Fruiting
Urea split dose	2.34	2.08	1.44
Urea single dose	1.49	1.14	1.04
Urea in perfobag-once in a year	2.04	2.07	1.67
Urea in perfobag-once in two years	2.02	1.79	1.72
Urea formaldehyde-once in a year	2.25	1.70	1.59
Urea formaldehyde - once in two years	2.19	1.67	1.58
Neem coated urea-once in a year	1.96	2.09	1.71
Neem coated urea-once in two years	2.96	2.10	1.92
Azatobacter	2.10	1.75	1.68
Azopspirillum	2.61	1.67	2.03
NP tablets-once in a year	2.51	2.04	1.98
NP tablets-once in two years	2.40	2.13	1.95
CD at 1%	0.433	0.322	0.213
SEm	0.1088	0.0809	0.0688

cashew grafts is assessed in this programme which was started in 1989. Main plot treatments consist of drip irrigation at the rate of 20, 40, 60 and 80 l/tree once in four days during dry months, while sub plot treatments include 250 g N,62.5 g each of P_2O_5 and K2O/tree; 500g N,125g each of P_2O_5 and K_2O/tree and 750g N, 187.5g each of P_2O_5 and K_2O/tree.

Leaf water potential in control plot was -3.5 bars and it was around -2.5 bars in treatments receiving irrigation ranging from 20 to 80 l /tree (Fig.1). Leaf water potential during peak summer did not differ significantly among different irrigation treatments (20 to 80 l/ tree). There was, however, a significant difference between irrigated and control plot.

Annual yield of 2.26kg/tree was obtained from the plot receiving 80 l water/tree in the third harvest. Cumulative yield of this plot, however, was 7.38 kg/tree for 3 years.

In control plots, lowest annual yield (1.17kg/tree) and cumulative yield (4.16kg/tree) were recorded. There was no significant difference among irrigation treatments (Table 15).

Highest annual yield (2.09 kg/tree) was obtained in the third harvest from the plot receiving 750 g N,187.5 g each of P_2O_5 and K_2O. Cumulative yield for three years was also highest in the same plot (6.76 kg/tree). In the control plot, lowest annual yield

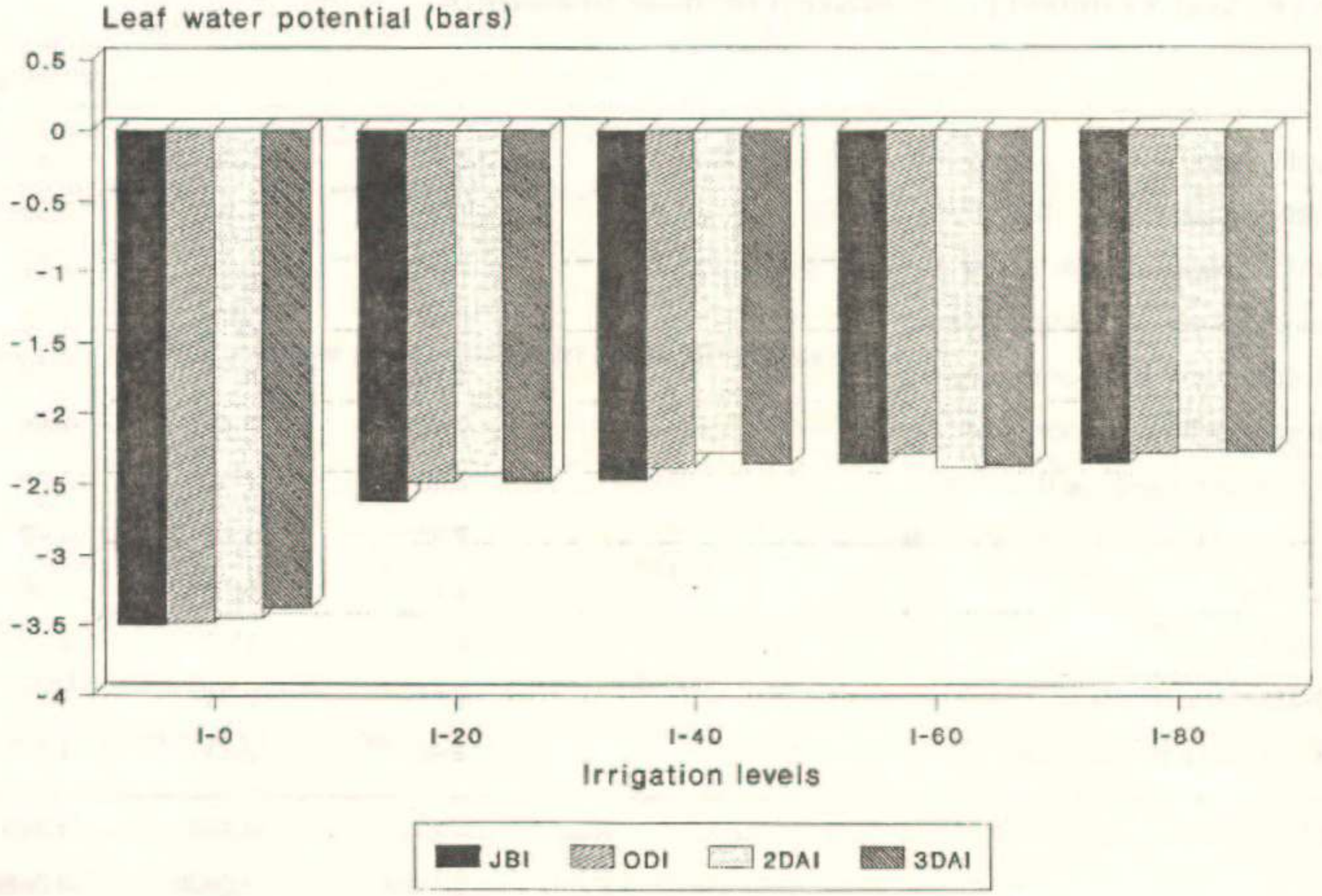


Fig. 1 Effect of irrigation on leaf water potential (BARS)

Table 15: Yield (Kg/tree) in different irrigation and fertilizer (NPK) treatments (4 to 6 years after planting)

Treatment	Harvest			Cumulative yield
	First	Second	Third	
Irrigation (l/tree)				
0	0.70	2.29	1.17	4.16
20	0.81	3.07	1.84	5.72
40	0.80	3.08	2.05	5.93
60	0.94	3.97	2.00	6.91
80	0.97	4.15	2.26	7.38
Mean		3.31		
Fertilizer (N:P:K)				
0 : 0 : 0	0.78	2.65	1.39	4.82
250 : 62. 5 : 62. 5	0.82	3.29	1.95	6.06
500:125 : 125	0.84	3.59	2.04	6.47
750 : 187. 5 : 187.5 : 187 .5	0.95	3.72	2.09	6.76

* Once in four days through drippers ;

CD for Mainplot (Irrigation) : 0.536
CD for Subplot (Fertilizer) : 0.262
SEm for Mainplot : 0.1761
SEm for Subplot : 0.0719

(1.39 kg/tree) and cumulative yield (4.82 kg/tree) were recorded. Differences among graded doses of fertilizer were not significant. Irrigation and graded doses of fertilizers influenced nut, apple and kernel weights. Highest nut weight (7.41 g) was observed in plot receiving 80 l water/tree. In control plot it was 6.93 g. Similarily, kernel weight in control plot was 1.83 g while it was 2.09 g in plot receiving 80 l water/tree. Apple weight however, was highest (55.54 g) in plot receiving 60 l water.

Similar trend was observed among different fertilizer treatments. Nut weight of plants receiving 750 g N, 187.5 g each of P_2O_5 and K_2O was 7.38 g compared to 7.05 g in control. Highest kernel weight (2.0 g) was also observed in the same treatment (Fig 2).

2.5 CROPPING SYSTEMS

2.5.1 Inter and mixed cropping

This programme aims at finding out suitable crops that could be grown profitably during initial years of cashew orchard. Casuarina, subabul and acacia which were grown as intercrops previously (1987 planted) were removed five year after planting as they affected yield of cashew. Pineapple was planted a year later across the slope in trenches. Two years after planting pineapple, yield of cashew increased considerably. In the acacia plot, yield increased from 2.15 kg/plot to 10.32 kg/plot during subsequent year. Yield, however, declined to 5.63 kg/

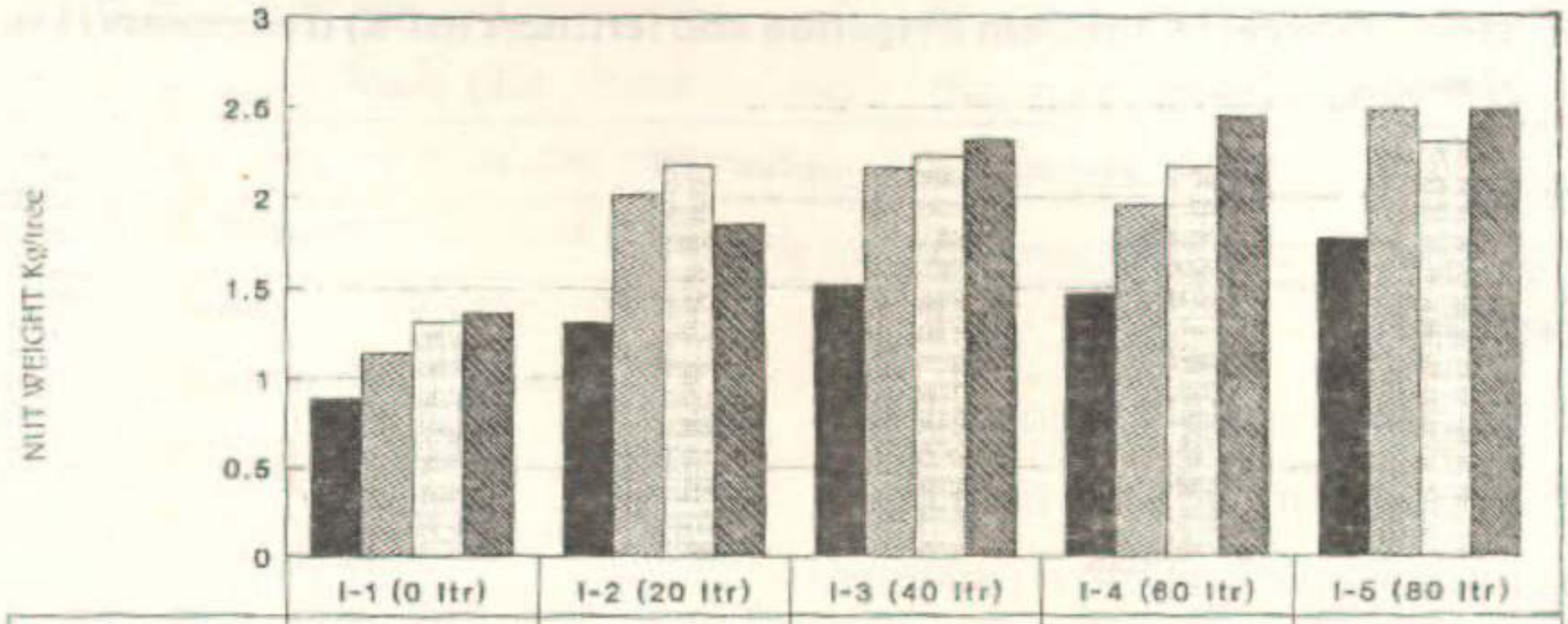
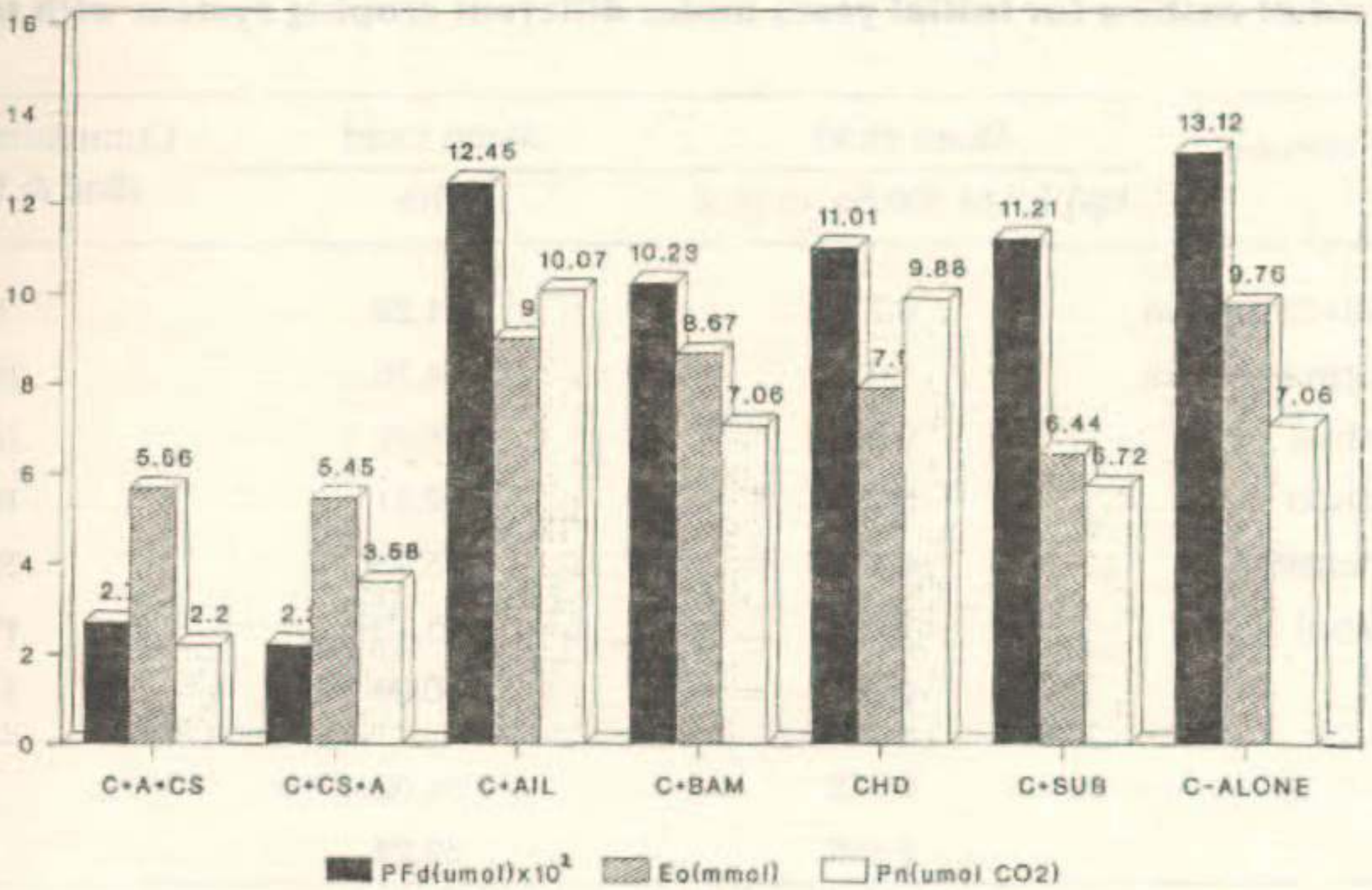


Fig. 2 Effect of irrigation and graded dose of NPK on yield

plot in the next season. Similar trend was observed in the plots where subabul and casuarina were planted. Cumulative yield (55kg/plot) realised from the plot intercropped with pineapple was higher than the rest of the treatments (Table 16).

Table 16: Yield of cashew after removal of tree species and cumulative yield (kg/plot of 384 m²)

Cropping system	6 years after planting and 1 year after the removal of intercrop	7 years after planting and 2 years after the removal of intercrop	8 years after planting and 3 years after the removal of intercrop	Cumulative yield for the last 3 years
Cashew alone	7.78	14.42	9.37	31.57
Cashew + pineapple initially planted in the 1st year and replanted in the 5th year.		14.37	28.34	12.2955.00
Cashew + guava	5.94	13.55	9.79	29.28
Cashew + acacia upto 5 years and pineapple after that.	2.15	10.32	5.63	28.10
Cashew + subabul upto 5 years and pine-apple after that.	5.44	13.15	11.83	30.44
Cashew + casuarina upto 5 years and pine-apple after that.	6.73	12.12	8.23	27.08
Cashew + *Mucuna bracteata*(covercrop)	8.43	15.32	14.31	38.06
F test	Significatnt	Significant	NS	
CD	3.27	7.07	-	



Note : C-Cashew, A-Acacia, CS-Casuarina, AIL-Ailanthus
BAM-Bamboo, CHD-Cashew High Density

Fig. 3 Physiological parameters in cashew based cropping system

There was a significant difference in yield of cashew among different treatments during sixth and seventh year. However, it was not significant in the eighth year.

Yield of the intercrop (pineapple) was maximum (502 kg/plot) where subabul was retained as intercrop for the first five years (Table 17).

Table 17: Yield of intercrops (pineapple and guava)

Treatment	Kg/plot (384 sq.m)	Kg/ha
Cashew + pineapple	168.0	4368
Cashew + casuarina upto 5 years followed by pineapple	189.0	4914
Cashew + subabul upto 5 years and pineapple after that	502.0	13052
Cashew + acacia upto 5 years followed by pineapple	310.0	8060
Cashew + gauva	53.8	1398

Photon flux density (PFd or PAR), transpiration (Eo) and photosynthetic rate (per m^2/sec) reduced significantly when acacia and casuarina were grown in different combinations with cashew (Fig. 3). Similar observation has been made in another field experiment laid out with forest species in 1990. Tree species like bamboo, subabul, ailanthus did not affect photonflux density, transpiration and photosynthesis in cashew.

Cashew yield in the fifth year (24.22 kg/ha) was affected when grown with casuarina and acacia. Maximum yield, however, was obtained from high density plot (5m x 5m) (204 kg/ha). Yield in control plot was 80 kg/ha where the spacing adopted was 10 m x 5m (200 trees/ha) (Table 18).

Table 18: Yield of cashew for initial years under different croping system with tree species

Cropping system	Mean yield kg/plot of 300 Sq. m plot	Mean yield kg/ha	Cumulative yield kg/ha (2nd & 3rd harvest)
Cashew+acacia+casuarina	0.73	24.22	84.88
Cashew+casuarina+acacia	1.65	54.76	124.08
Cashew+ailanthus	2.65	88.22	164.87
Cashew + bamboo	3.06	102.21	165.87
Cashew high density	6.11	203.53	328.51
Cashew + subabul	3.17	105.70	173.02
Cashew alone	2.80	80.29	174.28
SEm	0.652	21.60	
CD 1%	2.692	89.24	

CROP PROTECTION

3 CROP PROTECTION

Efforts are underway to standardise various pest management components for developing suitable Integrated Pest Management schedules for the two major pests of cashew viz., cashew stem and root borers (CSRB) *Plocaederus* spp, and tea mosquito bug (TMB) *Helopeltis antonii*. Studies are also taken up for standardising rearing technique for CSRB. Attempts are being made for evolving efficient methods for multiplying bio-control agents.

3.1 REARING TECHNIQUES

3.1.1 Egg collection

Egg collection technique developed at this laboratory was found suitable for both species of CSRB. A total of 2215 eggs of *P. ferrugineus* and 1770 eggs of *P. obesus* were collected, which had hatching ranging from 26.6 to 81.0 percent (Table 19).

3.1.2 Rearing young grubs

In the rearing method followed earlier, freshly hatched grubs (6-8) were being released into a single bark piece of 5cm x 5cm. In this method, grub survival used to be lower because of cannibalism and due to drying of the bark. Hence, a new technique was developed for rearing young grubs. Individual nascent grubs were inserted into bark pieces of 2cm x 2cm size, which were compactly arranged in petridishes. Inner surface of the petridish was sprayed with water to retain moisture. Feed changing once in six days with daily water spraying resulted in highest survival of young grubs of both *P. ferrugineus* (96.7%) and *P. obesus (95%)*. This method also economised bark requirement.

Table 19: Egg collection and hatching details during 1995-96

	P. obesus		*P. ferrugineus*	
Fortnight	No. of eggs laid	% Hatch	No. of eggs laid	% Hatch
II Aug.	23	47.8	-	-
I Sept.	68	60.3	41	46.3
II Sept.	184	71.7	173	76.3
I Oct.	232	64.6	183	75.4
II Oct.	285	64.2	216	78.2
I Nov.	315	72.3	343	69.9
II Nov.	378	78.3	280	81.0
I Dec.	288	70.4	174	75.3
II Dec.	197	68.5	116	70.3
I Jan.	133	42.5	102	54.9
II Jan.	83	49.3	82	46.3
I Feb.	29	41.4	60	26.6

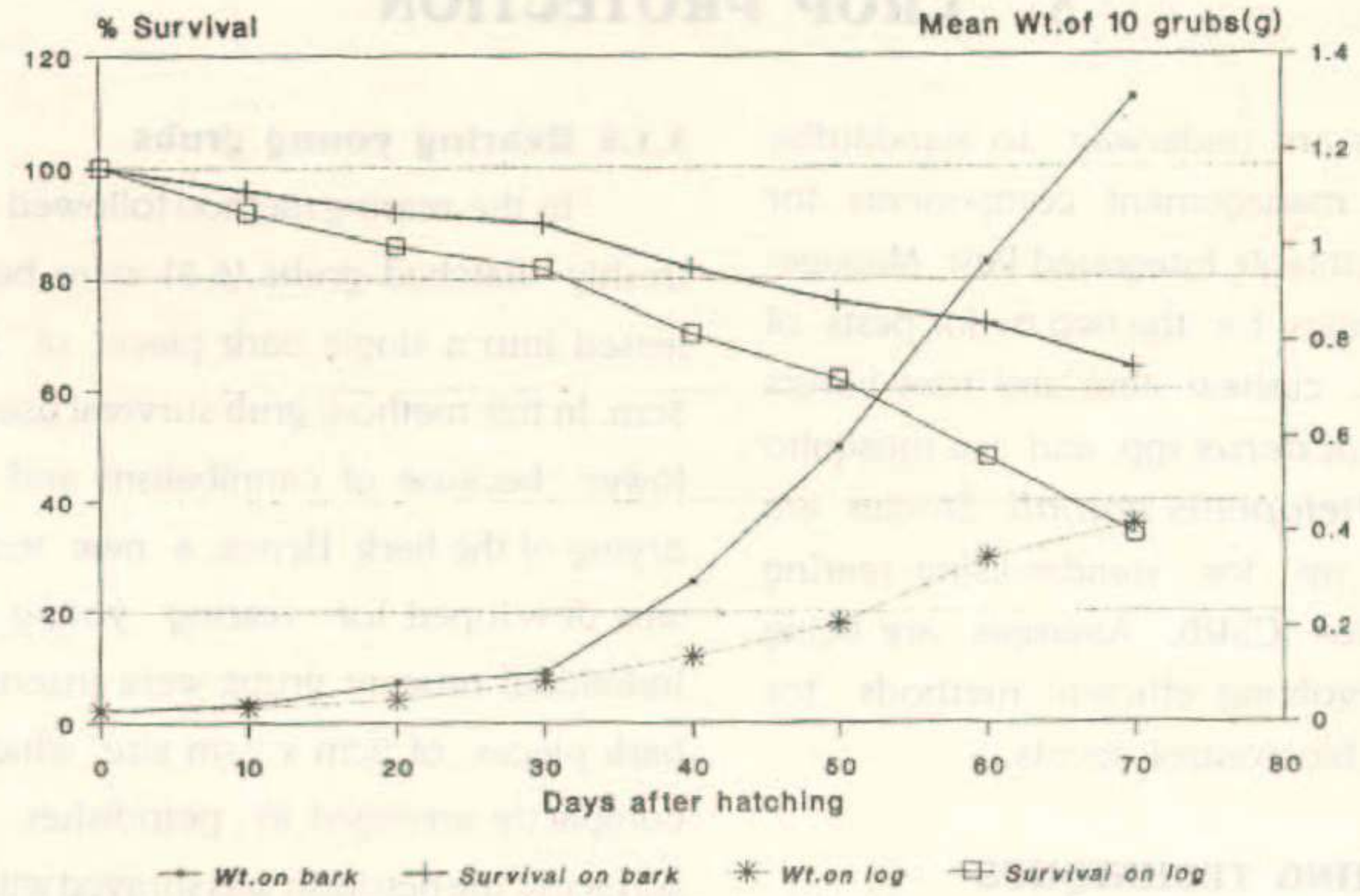


Fig. 4. Rearing of *P. Ferrugineus* on cashew bark and split log

Rearing of young CSRB grubs was also done on split cashew logs. Fresh logs of 10 cm diameter and 20-30 cm length were split and grubs of *P. ferrugineus* and *P. obesus* were allowed for feeding. This method was not suitable as weight gain of grubs was very low compared to rearing on cashew bark. Grub survival was also lower in this method (Figs. 4 and 5).

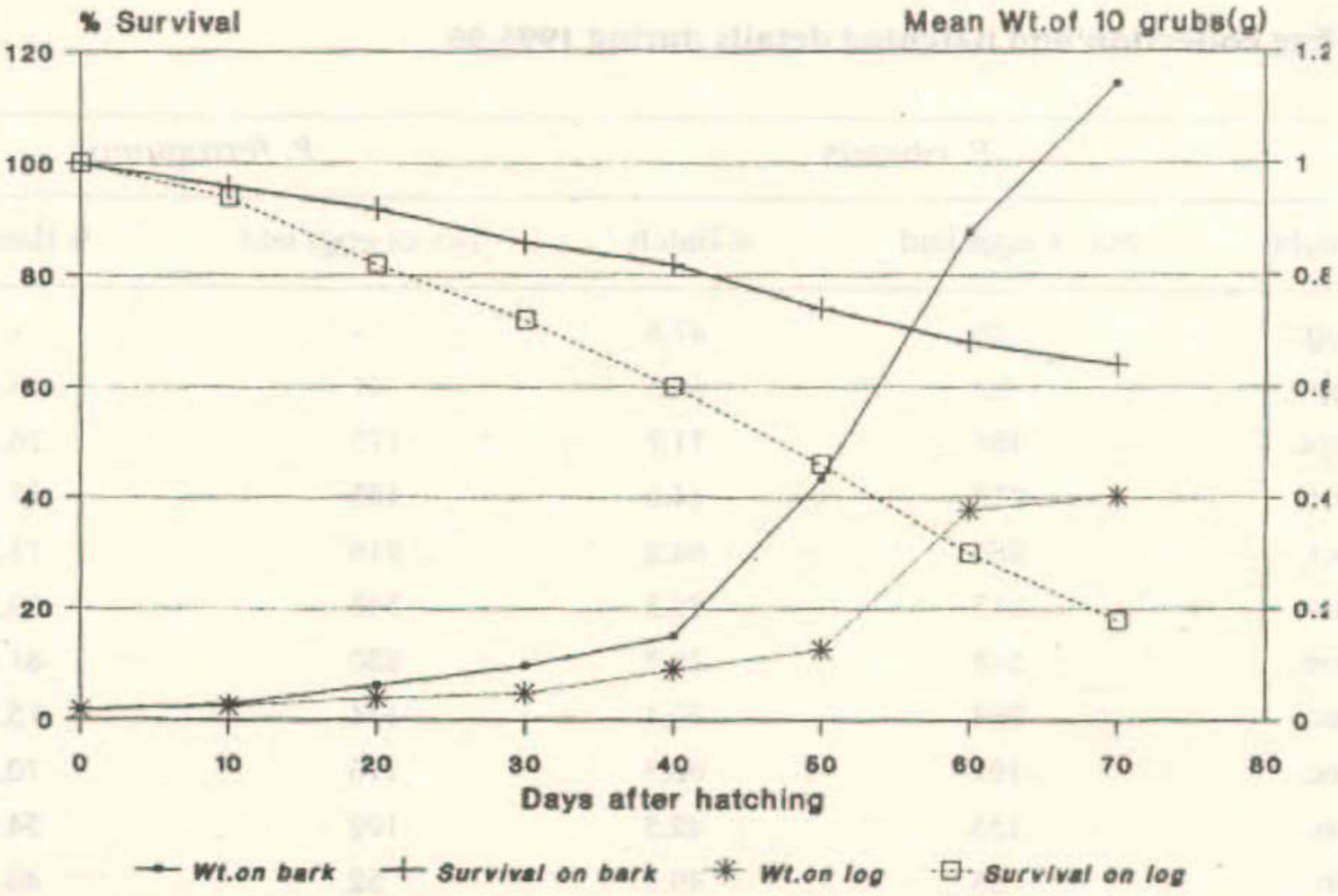


Fig. 5. Rearing of *P. Obesus* on cashew bark and split log

Multiplication of *B. bassiana* in autoclavable polyprophylene covers

3.2 BIOLOGICAL CONTROL

3.2.1 Fungal pathogens

Multiplication of *Beauveria bassiana* and *Metarhizium anisopliae* was attempted using autoclavable polyprophylene covers instead of glass flasks to enable safe transport and easy dislodging of spawn from covers.

The sporulated spawn of *B. bassiana* was added into mixture of sterilized soil and neem cake/FYM in 4:1 proportion to study its suvival. CSRB grubs were allowed to crawl on the soil samples drawn at regular intervals. Grub mortality of 71.4 per cent was noticed even in sample drawn after 180 days in soil mixed with neem cake. Mortality of the grubs was lower (57.1 per cent) in soil mixed with FYM after 180 days (Figs. 6 and 7).

As a prophylactic control measure, soil around the base of tree trunk was raked up using 250g spawn of B. bassiana mixed with 500g neem cake. Stem swabbing was also done with spore suspension. Upto three months, tree remained free from infestation. After the end of six months, however, one tree out of 25 trees was infested which was on par with recommended pesticide (carbaryl 0.2%) swabbing.

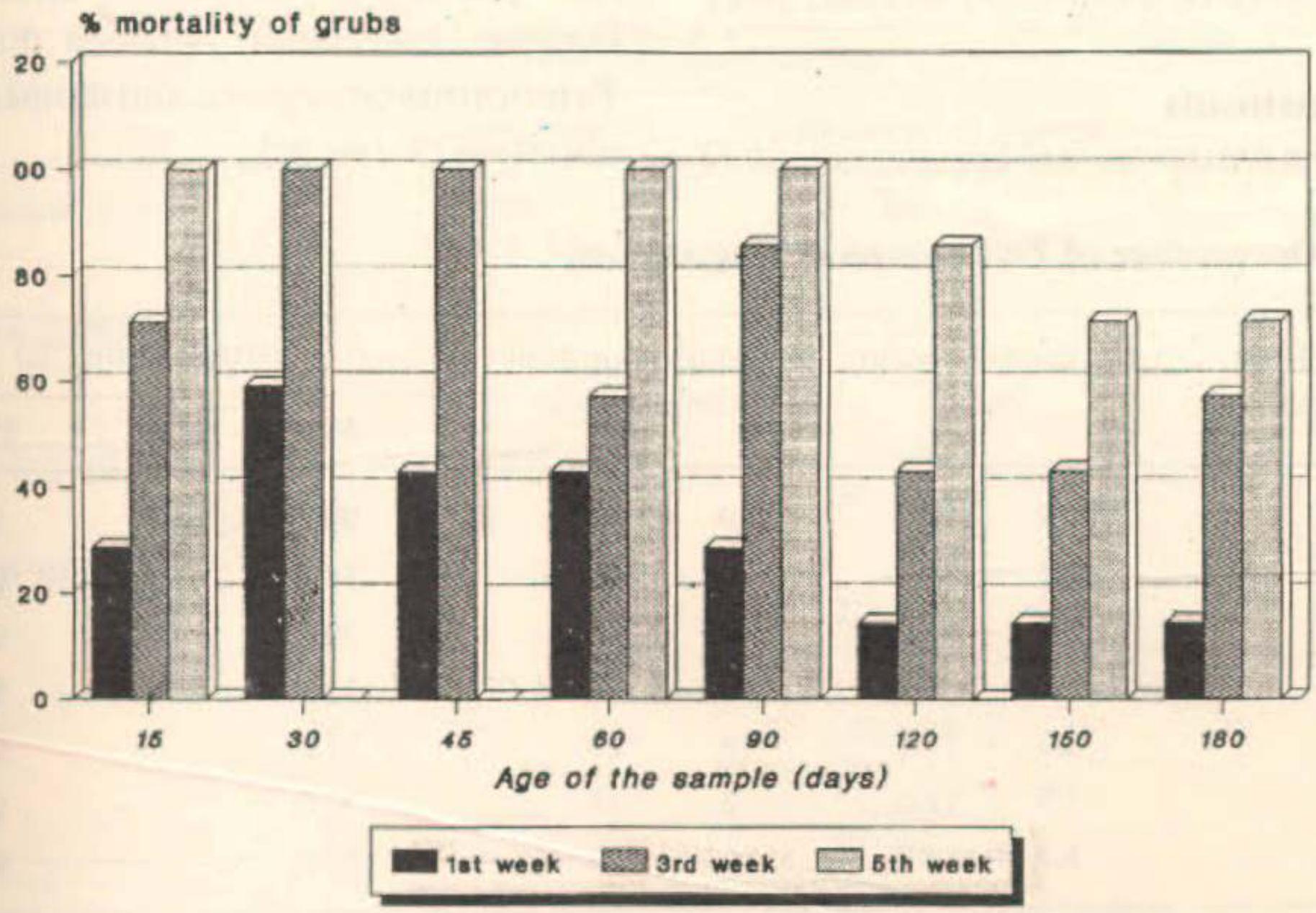


Fig. 6 Survival of *B. bassiana* in soil + neem cake (4:1)

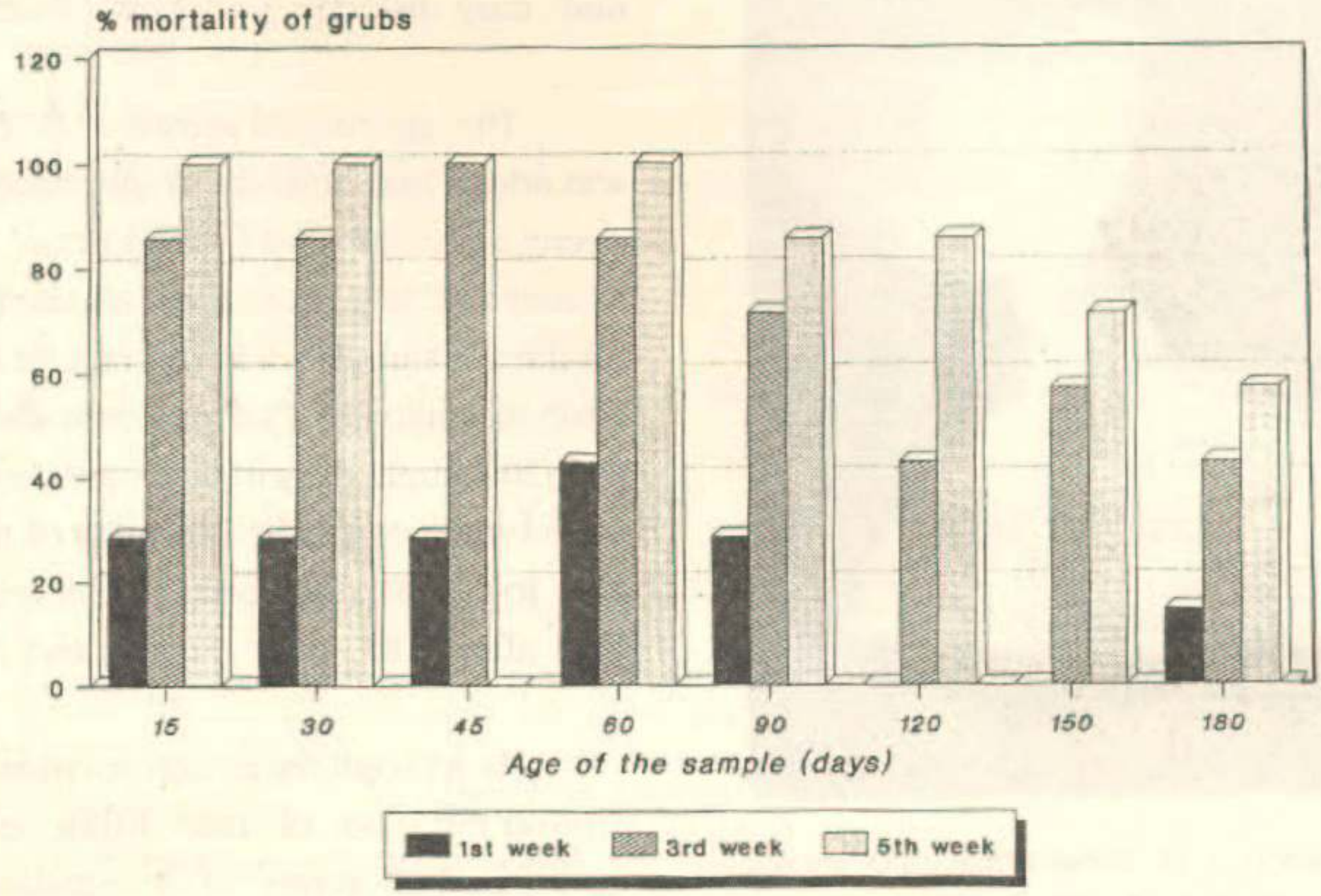


Fig. 7 Survival of *B. bassiana in* soil + FYM (4:1)

Grubs present in the trees with initial stages of infestation were mechanically removed and stem was swabbed with spore suspension of *B. bassiana*. Application of *B. bassiana* spawn (500g) mixed with neem cake (1000g) was also done which aided in the recovery of 9 out of 12 infested trees.

3.2.2 Parasitoids

Telenomus sp. an egg parasitoid of TMB was encountered only from August to February this year. Reasons for not encounring *Telenomus* through out the year as reported earlier are being looked into. This was also encountered from pesticide (monocrotophos and carbaryl) sprayed plots. Population of the parasitoid decreased after January. Positive correlation between duration for *Telenomus* emergence and temperature was observed (Table 20).

Table 20: Occurrence of *Telenomus* during 1995-96

Month of egg collection	Net parasitisation (%)	Maximum duration for emergence	Temperature (°C)	
			Max	Min
Aug	10.2 - 20.0	9 - 11	29.5	26.0
Sept	11.4 - 15.4	5 - 13	32.0	26.5
Oct	6.9 - 15.0	14 - 16	32.0	26.0
Nov	4.6 - 7.6	19 - 29	31.5	24.5
Dec	4.0 - 11.0	18 - 26	31.0	24.0
Jan	7.5 - 11.2	8 - 17	32.0	26.5
Feb	3.1 - 4.7	5 - 12	32.0	27.0

correlation coefficient r max. temp. : 0.436
correlattion coefficient r min. temp. : 0.617

Survival of *Telenomus* adults was tested for 48 hr. in different diets such as undiluted honey, honey solution (50%), sucrose solution (25%), honey solution (50%) with NaCl traces and water. Diets were provided as droplets on polythene strips placed in test tubes to aviod trapping of parasitoids in feed. Fifty per cent of adults survived in honey solution (50%) while the adult survival in sucrose (25%) and water was 42.9 and 40.0 per cent, respectively.

TMB eggs were collected on midrib and shoots of cashew seedlings. Midrib and shoots containing TMB eggs were cut and kept seperately in test tubes. Laboratory reared *Telenomus sp.* adults were released into the tubes. Parasitization was 14 and 10 per cent respectively in the case of eggs collected on midrib and shoots.

3.3 PLANT PRODUCTS

3.3.1 Neem formulations

Neem formulations were evaluated for their effectiveness as prophylactic treatments against CSRB. Treatments were given in May, August, November and February. Nimbecidine and neem oil treated trees were free from infestation upto three months after last round of treatment. Cumulative infestation of three years was least (only one tree out of 25 was infested) in case of Limanool treatment. Treatments differed significantly with control (Table 21). Four commercial neem formulations were evaluated for their insecticidal property against TMB under field condition along with neem oil and pongamia oil. Three sprays were given at monthly intervals starting with flushing. Data collected were subjected to co-variance analysis to eliminate the damage before imposing treatment. Damage percentage and score on shoot and

Table 21: Prophylactic control of cashew stem and root borers *Ploceaderus* spp. with neem formulations

Treatment	Per cent trees infested		Cost (Rs/tree)
	Current year	Cumulative of 3 years	
Nimbecidine (0.5%)	0.0	8.0 (16.95) a	2.75
Limanool (0.5%)	4.0	4.0 (12.25) a	2.72
Godrej Achook (0.5%)	4.0	12.0 (20.70) ab	2.50
Neem oil (6%)	0.0	8.0 (16.95) a	3.50
Control	4.0	24.0 (19.67) b	-
CD (5%)	-	12.36	-

Figures in the parentheses are angular transformed values.

Table 22: Efficacy of neem, pongamia and commerical formulations against tea mosquito bug

Treatment	Damage one month after III spray					
	Shoot			Panicle		
	%		Score	%		Score
Neem oil (2.5%)	22.69	bcd	0.76 abc	19.51	abc	0.77 bc
Pongamia oil (2.5%)	19.58	bc	0.75 abc	19.33	ab	0.63 ab
Godrej Achook (1%)	25.74	cd	0.86 bc	27.32	bc	0.81 bc
Limanool (1%)	19.55	bc	0.56 ab	16.30	a	0.55 ab
Nimbecidine (1%)	15.54	a	0.54 ab	13.38	a	0.35 ab
Carbaryl (0.1%)	11.09	a	0.37 a	11.56	a	0.22 a
Neem gold (0.1%)	17.54	ab	0.65 bc	17.31	a	0.65 ab
Control	28.74	d	0.97 c	28.93	c	1.16 c
CD 5%	6.81		0.26	8.11		0.50

Percentage and damage score values are transformed and adjusted means

Table 23: Knock down and feeding deterrence activity of certain leaf extracts against tea mosquito bug

	Damage score on (0-4 scale)			% Mortality
	Shoot	Mid rib	Lamina	
Vitex negundo (5%)	2.78 c	2.81 d	2.33 b	0.0
Adhatoda vasica (5%)	2.33 b	1.78 b	1.98 b	0.0
Thevetia neriifolia (5%)	2.78 c	2.33 c	2.07 b	0.0
Monocrotophos (0.05%)	0.22 a	0.26 a	0.26 a	100.0
Control	3.00 c	2.78 d	2.30 b	0.0
CD at 5%	0.27	0.30	0.36	

panicle after 30 days of final treatment is presented in Table 22. Among the plant products, lowest infestation was recorded with Nimbecidine followed by Limanool.

3.3.1 Laboratory evaluation of other plant products

Aqueous extracts of *Vitex negundo*, *Adhatoda vasica* and *Thevetia neriifolia* leaves were evaluated for insecticidal properties against TMB. These extracts were sprayed on cashew seedlings and TMB was allowed to feed on them for 48 hours. Damage rating was significantly lower in the case of *Adhatoda vasica* compared to control indicating the presence of feeding deterrence. Knock down action was not observed in any of the leaf extracts (Table 23).

Seed extracts (aqueous) of *Thevetia neriifolia* and oil of *Calophylum inophylum* were also evaluated similarly (Table 24). Seed extract of *T. neriifolia* had lower damage score on shoot and leaf compared to control.

Damage ratings due to TMB feeding on shoot and leaves were recorded after three and seven days of spraying plant products for studying residual action. Among leaf extracts, damage rating was less for *A. vasica*

Table 24: Knock down action and feeding deterrence activity of certain seed extracts and oil against tea mosquito bug

Treatment	Damage score on (0-4 scale)								
	Shoot		Mid rib		Lamina		% Mortality		
T. neriifolia seed (5%)	2.11	c	2.00	c	1.74	c	44	(41.6)	b
C. inophylum oil (5%)	2.73	d	2.41	d	2.32	d	0	(4.1)	a
Pongamia oil (5%)	0.81	b	0.82	b	0.92	b	72	(58.1)	c
Monocrotophos (0.05%)	0.31	a	0.32	a	0.31	a	100	(90.0)	d
Control	2.92	d	2.82	e	2.72	d	0	(4.1)	a
CD at 5%	0.26		0.26		0.45			(3.9)	

compared to other treatments both after three and seven days of spraying. Oil of *C. inophylum* was phytotoxic as black spots developed on leaves after three days of spraying (Table 24).

3.4 STUDIES ON ATTRACTANTS

3.4.1 Olfactometer trials

Various plant parts such as branch pieces, bark of healthy and infested trees, freshly collected frass and exuded cashew gum were screened using olfactometer for their ability to attract mated and unmated beetles of both sexes of *Plocaederus* spp. Bark of infested tree and freshly collected frass exhibited maximum response from virgin (20.0% and 22.5% respectively) and mated females (28.8% and 30.0% respectively) in the case of *P. ferrugineus*. Similar response was also noticed for *P. obesus*.

3.4.2 Free choice for oviposition

Mated female beetles of both *P. ferrugineus* and *P. obesus* were allowed freely for 48 hours in escape proof room in which different plant parts were kept. Maximum number of eggs were laid on infested bark, twigs wrapped with cotton tape and exuded gum in the case of both the species (Fig.8).

3.5 STUDIES ON PHEROMONES

Response of unmated and mated beetles to opposite sex was observed in preliminary trials with olfactometer. Orientation, and antennae and body raising and actual matings were recorded during the study. Response of unmated and mated males towards virgin females was observed.

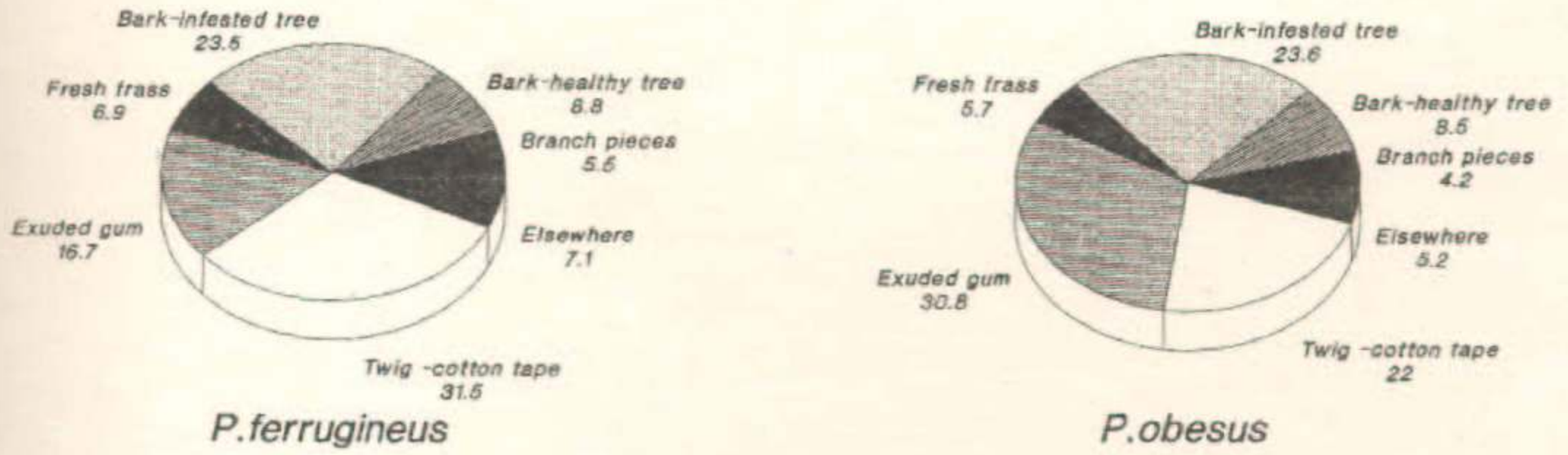


Fig. 8. Oviposition on various test materials

POST – HARVEST MANAGEMNT

4 POST – HARVEST MANAGEMENT

4.1 CAUSES OF KERNEL REJECTS

Studies were initiated to look into the causes for kernel rejects encountered during processing in collaboration with M/s. Achal Industries, Mangalore. Raw nuts obtained from Goa and Puttur (50 Kg each) were stored and at bimonthly intervals 2 kg each of these nuts were processed and assessed for both processing and biochemical quality to study the influence of storage on kernel rejects (Table 25). Storing raw nuts upto 8 months did not adversely affect shelling percentage, peeling outturn and per cent kernel rejection. Percent wholes recovered was not affected in Goa nuts whereas it decreased during storage in Puttur nuts. Kernel lipid peroxides and FFA increased while changes in sterols, sugars and starch were not uniform during storage upto 8 months.

Processing quality and biochemical quality were assessed in nuts processed with and without steam roasting (Table 26). Shelling percentage, peeling outturn and per cent kernel rejection did not differ between nuts processed with and without steam roasting. Per cent wholes recovered was considerably less in nuts processed without steam roasting compared to steam roasted nuts. Processing quality (shelling percentage, peeling outturn, per cent wholes recovered and per cent kernel rejection) and kernel composition (FFA, sterols, lipid peroxides, starch and sugars) did not differ much among different grades of rawnuts when they were processed seperately.

Table 25: Influence of storage period on processing and biochemical quality

Origin	Storage period (months)	Shelling %	% wholes recovered	Peeling out turn %	Moisture content %		Kernel rejection %	Lipid Peroxides	FFA	Sterols	Sugars	Starch
					Big	Small						
Goa	0	29.75	23.1	25.50	5.42	3.34	1.34	0.697	0.337	29.39	6.33	25.47
	2	29.75	24.3	25.60	4.36	3.19	1.34	1.070	1.636	22.45	5.33	29.16
	4	30.25	24.8	26.80	3.35	2.88	1.65	1.030	2.480	28.05	5.73	27.16
	6	29.00	23.7	26.10	3.63	2.72	0.34	1.070	1.440	22.29	6.02	25.24
	8	27.50	24.0	24.60	3.11	2.74	1.89	1.730	0.821	50.71	5.11	31.99
Puttur	0	29.85	23.1	24.80	4.06	1.87	1.84	0.714	0.337	37.09	5.92	28.84
	2	29.35	22.6	24.35	4.45	2.77	1.36	1.330	1.252	24.63	7.77	28.13
	4	29.60	22.3	24.07	4.27	3.81	1.85	0.683	4.603	19.19	5.42	24.05
	6	30.00	21.2	23.50	2.60	1.01	1.83	1.130	0.710	22.81	5.33	26.83
	8	29.60	19.0	24.00	1.84	2.40	2.53	1.530	0.491	25.18	4.87	26.67

Values of biochemical constituents are mean of three individual estimations
FFA - mg palmitic acid/g kernel flour
Sterols - µg/mg lipid
Starch and sugars - mg/100mg defatted flour
Lipid peroxides - n moles of MDA/100mg kernel flour

Table 26: Influence of roasting on processing and biochemical quality

Parameters	Goa				Puttur			
	With steam roasting		Without steam roasting		With steam roasting		Without seam roasting	
Shelling percentage	29.00		28.10		30.00		27.90	
Peeling outturn	26.10		23.50		23.50		23.00	
% Rejection of kernels	0.34		1.06		1.83		0.71	
% Wholes recovered	23.70		8.50		21.25		6.50	
Kernel lipids	43.70	(36.10)	39.40	(45.50)	48.80	(40.00)	37.50	(30.40)
Kernel FFA	1.44	(156.59)	1.23	(44.38)	0.71	(25.84)	0.86	(6.89)
Kernel sterols	22.29	(56.01)	32.37	(35.12)	22.81	(25.63)	26.49	(75.47)
Lipid peroxides	1.07	(5.58)	1.35	(1.37)	1.13	(1.29)	2.03	(3.13)
Starch	25.24	(18.63)	23.04	(29.69)	26.83	(20.23)	33.48	(16.35)
Sugars	6.02	(0.50)	4.44	(2.15)	5.33	(1.38)	4.51	(2.49)

Values for biochemcial constitutents are mean of three individual estimations.
Figures in parentheses are for kernel rejects, units are as in Table 25.

Immature nuts were processed to see whether they contribute for kernel rejection (Table 27). Shelling percentage (25.4) and peeling outturn (16.9%) and percent wholes recovered (14.2) were less while kernel rejection was high (10.6%). Kernel rejects from immature nuts had higher FFA, lower lipid peroxides, starch and sugars.

4.2 DATA BASE ON PROCESSING ASPECTS OF CASHEW INDUSTRIES

A pretested technical questionnaire

Table 27: Processing and biochemical quality of immature nuts.

Parameter	Value	
Shelling percentage	25.40	
Peeling outturn	16.90	
Weight/nut (g)	7.84	
Specific gravity	1.03	
Kernel rejection (%)	10.60	
Per cent wholes recovered	14.20	
Moisture content (%)	6.12	
	Wholes	Rejects
Total lipid	51.30	49.70
FFA	0.49	7.72
Lipid peroxides	1.28	0.32
Starch	15.62	12.20
Sugars	5.57	3.60

Values for biochemcial constitutents are mean of three individual estimations.
Units are as in Table 25.

consisting of Part-I with managers as target group and Part-II with processing supervisors as target group was sent to all the cashew processing industries of Kerala, Karnataka, Tamilnadu, Andhra Pradesh, Goa, Orissa and West Bengal. Part-I covered the aspects on (i) ownership pattern, (ii) location of the factory, (iii) category, (iv) procurement of raw cashewnut including source, quantity and method (v) employees in terms of strength, wages and facilities provided. Part-II was to collect information on (i) storage of raw cashewnuts, (ii) drying of nuts, (iii) conditioning/preliminary roasting, (iv) cooling, (v) shelling, (vi) roasting [Borma drying], (vii) peeling, (viii) grading and packing, (ix) CSNL extraction. Technical questionnaire Part-III (detailed) and socio-economic questionnaire Part-IV have been prepared and information will be collected during personal visit to cashew processing industries.

4.3 RAW CASHEWNUT GRADER

This project is formulated with an objective to design, develop and evaluate power operated raw cashewnut grader suitable for cashew processing industries. Preliminary studies on physical and mechanical properties of raw cashew nut pertaining to grading were determined. Physical parametes of raw cashew nuts (length, width, specific gravity and shell thickness) and mechanical properties (angle of repose and coefficient of internal friction) have been determined (Table 28). Based on these parameters the design is being worked out.

Table 28: Physical parameters of raw cashew nuts.

Parameters	Origin		Variety	
	Max	Min	Max	Min
Length (mm)	42.91 (Thurukavadi)	21.14 (Bellare)	43.34 (BLA-139-1)	25.81 (BLA-39-4)
Width (mm)	34.14 (Vietnam)	17.48 (Indonesia)	29.76 (Sel-2)	19.50 (V-1)
Mean Sp. gravity	1.265 (Puttur)	0.939 (Ratnagiri)	1.153 (Ullal-1)	0.972 (Sel-1)
Mean shell thickness (cm)	0.572 (Calicut)	0.250 (Nigeria)	4.14 (K-22-1)	3.069 (V-2)
Angle of repose	31.67° (Nigeria)	19.67° (Calicut)	26.67° (BLA-139-1)	20.33° (NDR-2-1)
Coeff. internal friction	0.94 * (DES)	0.27 (Ratnagiri)	0.40 (Sel-1)	0.15 (VRI-1)
Mean weight/nut (g)	7.57 (Ratnagiri)	4.50 (Tanzania)	8.84 (BLA-139-1)	5.20 (V-1)

* Dar-e-salam

TRANSER OF TECHNOLOGY

5 TRANSFER OF TECHNOLOGY

5.1 RESEARCH CUM DEMONSTRATION

Eight demonstrations were laid out during the year bringing the total number of demonstrations laid out since 1988 to 61. Demonstrations have been laid out on farmers fields in collaboration with Directorate of Cashewnut Development, Cochin, under Central Sector Scheme under which input support is provided to farmers during initial five years of establishment. Out of these, 41 plots completed five years period and remaining are in different phases of availing subsidy.

5.1.1 Communication behaviour

It consisted of information acquisition, processing, and dissemination behaviours. To analyse the communication behaviour of demonstration farmers, information was collected in structured questionnaire from 30 demonstration farmers who had completed five years and more under the scheme.

Regarding information sources consulted, all the 30 farmers consulted NRC for Cashew, for information on cashew. Other sources of information for demonstration farmers included relatives (40%), other cashew demonstration farmers (33%), cashew farmers (33%) and others (27%) such as Sevanirathas in Sribshetra Dharmastala Rural Development Project in Belthangadi taluk where eight farmers were interviewed (Table 29).

On receiving new information about cashew cultivation, demonstration farmers evaluated it with their past experience (87%), examined their economic feasibility (63%), observed other farmers (40%) discussed with their family members (37%), thought about its suitability to their farm (33%), discussed with other demonstration farmers (27%) and discussed with scientists (20%) (Table 30). Of the 30 demonstration farmers, 11 farmers continued to apply partial dose of fertilizers, two applied only organic fertilizers and 17 discontinued application of fertilizers. Reasons as reported by them for partial application of fertilizers were ; difficulty in getting *all the required straight fertilizers (urea, rock phosphate and muriate of potash) at the time of fertilizer application, difficulty in mixing the fertilizers in required proportion and

Table 29: Information sources consulted

Information source	Frequency	Per cent
NRC for Cashew	30	100
Relatives	12	40
Other demonstration farmers	09	33
Other cashew farmers	09	33
Others	08	27

Table 30: Information processing behaviour

Information processing behaviour	Frequency	Per cent
Evaluate with past experience	26	87
Examine economic feasibility	19	63
Observe other farmers	12	40
Discuss with family members	11	37
Think suitability	10	33
Discuss with demonstration farmers	08	27
Discuss with scientists	06	20

Table 31: Nature of information communicated

Information processing behaviour	Frequency	Per cent
Grafts as planting material	14	100.00
Varieties of cashew	09	64.29
Fertilizers	05	35.71
Plant protection	05	35.71
Intercropping	01	7.14
Soil and water conservation	01	7.14

too much of flushing due to application of higher N and thereby attracting more pests etc. At the same time applying complex fertilzer was felt as handy, less labour intensive and easy for application despite being costly. Farmers who had discontinued fertilizers, however, had no convincing justification for not applying fertilizers. Those who had switched over for organics felt that cashew grown organically has better market.

As a result of this, mean yield in demonstration plots was low in the first (55 kg/ha), second (152.6 kg/ha), third (225.8 kg/ha) and fourth harvests (287.8 kg/ha).

Among 30 demonstration farmers, 14 (46.67%) communicated information on cashew to others while the remaining (53.33%) did not communicate it to others. All the fourteen communicated information on grafts as planting material while varieties of cashew was communicated by nine of them. Five of them communicated on fertilizers and plant protection (Table 31).

ADDITIONAL INFORMATION ON EXTENSION ACTIVITIES

I Production and distribution of soft-wood grafts of cashew

During the year, around 40,000 soft wood grafts of cashew were distributed to farmers and Govt. agencies.

II Technical advice

During the year, 75 enquiries were received seeking technical advice. These were received from Andhra Pradesh (6), Assam (01), Goa (02), Haryana (01), Karnataka (15), Kerala (10), Madhya Pradesh (01), Maharashtra (09), New Delhi (03), Orissa (01), Rajasthan (01), Tamil Nadu (18), Uttar Pradesh (01) and West Bengal (04), apart from Sri Lanka (02). Details of different aspects on which advice was sought from major cashew growing states are given in Table 32.

III Training

During the year three training courses, one on Cashew Production Technology and two on Vegetative Propagation of Cashew were conducted. The former was for middle level managers while the latter one was for grafters/malis of development departments. A total of 49 persons were trained. Details of statewise participation in training courses is given in Table 33.

Table 32: Aspects of technical enquiries made by major cashew growing states

Aspects	Andhra Pradesh	Goa	Karnataka	Kerala	Maharashtra	Tamil Nadu	West Bengal	Other States
Varities	1	-	1	1	1	5	-	-
Cultivation practices	1	-	1	6	3	4	1	-
Economics of cashew cultivation	1	-	2	1	1	3	-	-
Processing	1	2	-	1	2	1	1	-
Miscellanceous	2	-	11	1	2	5	2	11
Total	6	2	15	10	9	18	4	11

Table 33: Statewise participation in training courses (1995-96)

State	Vegetative Propagation of Cashew	Cashew Production Technology	Total
Andhra Pradesh	-	02	02
Karnataka	19	06	25
Kerala	03	03	06
Maharashtra	-	02	02
Orissa	02	03	05
Tamil Nadu	05	01	06
West Bengal	02	01	03
Total	31	18	49

GENERAL INFORMATION

STAFF OF THE INSTITUTE

MANAGERIAL

Director	Dr. M.K. Nair, Director CPCRI, Kasaragod (Additional charge till 28.05.95)
Act. Director	Dr. EVV Bhaskara Rao (from 29.05.1995)

SCIENTIFIC

Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
Agricultural Engineering (ASPE)	D.Balasubramanian	-	-	1
Agricultural Entomology	P.Shivarama Bhat (SS) TN Raviprasad	D.Sundararaju(SG) -	-	3
Agricultural Extension	Sreenath Dixit	-	-	1
Biochemistry (Pl. Science)	-	KV Nagaraja (Sr.S)	-	1
Biotechnology	-	Thimmappaiah (SG) (Gen. & Cytogen.)	-	1
Computer Application	Vacant	-	-	1
Genetics and Cytogenetics	Shirly Raichal Samuel	-	-	1
Horticulture	M.Gangadhara Nayak	M.G. Bhat (Sr. S) (Plant Breeding) KRM Swamy (Sr.S)	Vacant	4

Plant Physiology	Vacant	-	-	1
Soil Science	N.Yadukumar (SG)* (Agronomy)	-	-	1
Soil and Water Conservation Engineering	Vacant	-	-	1
TOTAL				16

S- Scientist, SS- Senior Scale, SG- Selection Grade, SR. S- Senior Scientist

*- Promotion through assessment.

TECHNICAL

Sri B Nagaraja	Farm Superintendent (T-7)	
Sri K Lakshminarayana	Farm Superintendent (T-6)	
Dr Uma Jayaraman	Tech. Inf. Officer (T-6)	
Sri John Geroge	Tech. Asst. (T-4)	
Sri R Arulmony	Sr. Lib. Asst. (T-4)	
Sri A Padmanabha Hebbar	Ele. Cum. Pump Operator (T-4)	
Sri N Manikandan	Tech. Asst.(T-4)	Promoted w.e.f 01-07-95
Sri R Muthuraju	Computer (T-II-3)	
Sri K Seetharama	Farm Asst. (T-II-3)	
Sri M Prashanth	Farm Asst. (T-II-3)	
Sri Prakash V Ambekar	Art. Cum. Photographer. (T-II-3)	From 17-04-95
Sri Lakshmipathi	Tech. Asst. (T-II-3)	From 24-08-95
Sri R Lakmisha	Tech. Asst. (T-II-3)	From 15-09-95
Sri KV Ramesh Babu	Tech. Asst. (T-II-3)	From 21-09-95
Sri KR Padmanabhan Nair	Jr. Tech. Asst. (T-I-3)	
Sri A Poovappa Gowda	Jr. Tech. Asst. (T-I-3)	
Sri K Babu Poojary	Jr. Tech. Asst. (T-1)	From 20-07-95
Sri Ravishankar Prasad	Jr. Tech. Asst. (T-1)	From 28-07-95

ADMINISTRATIVE

Sri Ajit Kumar Bolur	Asst. Admn. Officer

Sri A Keshava Shabaraya	Asst. Fin. & Acc.OFFICER	
Sri K Sanjeeva	Superintedent	
Sri V Ahamed Bava	Sr. Stenographer	
Smt B Jayashree	Stenographer	
Sri OG Varghese	Stenographer	
Sri KM Jayarama Naik	Assistant	
Sri MS Sathyanarayana	Sr. Clerk	
Sri KM Lingaraju	Sr. Clerk	From 08-09-95
Smt M Ratna Ranjani	Jr. Clerk	
Miss Winnie Lobo	Jr. Clerk	
Sri Rasario Mascarenhas	Jr. Clerk	From 14-11-95
Miss M Leela	Jr. Clerk	From 16-11-95
Sri Uma Shankar	Jr. Clerk	

AUXILIARY

Sri Bejmi Veigus	Tractor Driver	
Sri KK Madhavan	Driver	
Sri K Umanath	Driver	
Sri K Balappa Gowda	Gestetner Operator	From 20-07-95

SUPPORTING STAFF

Sri D Guruva Mera	Watchman (SS-GR-IV)	
Sri B Devappa Naik	Watchman (SS.GR.IV)	
Sri K Krishnappa Naik	Mali (SS.GR.III)	Promoted w.e.f. 20-03-95
Sri K Narayanna Naik	Mali (SS.GR.III)	
Sri Krishnappa Gowda	(SS-GR-III)	
Sri P Vasantha Kumar	(SS-GR-II)	
Sri P Subraya Gowda	(SS-GR-II)	
Sri Venkappa Naik	(SS-GR-II)	
Sri K Narnappa Gowda	(SS-GR-II)	
Sri K Monappa Poojary	(SS-GR-II)	
Sri S Babu	(SS-GR-II)	
Sri Deranna Gowda	(SS-GR-II)	
Sri S Ammu Gowda	(SS-GR-II)	
Sri Krishnappa	(SS-GR-II)	Promoted w.e.f. 29-07-95
Sri N Narayana Naik	(SS-GR-II)	Promoted w.e.f. 20-03-96
Sri B Chennnappa Poojary	(SS-GR-II)	

Sri K Shiva	(SS-GR-II)	
Sri P Krishnappa Poojary	(SS-GR-II)	Promoted w.e.f. 21-03-96
Sri H Veerappa Gowda	(SS-GR-II)	Promoted w.e.f. 20-03-96
Sri Venkappa Gowda	(SS-GR-II)	Promoted w.e.f. 20-03-96
Sri Rama	(SS-GR-II)	Promoted w.e.f. 20-03-96
Sri P Honappa Gowda	(SS-GR-I)	
Sri S Krishnappa	(SS-GR-I)	
Sri PS Shekara	(SS-GR-I)	
Smt Janaki	(SS-GR-I)	
Sri Lingappa Gowda	(SS-GR-I)	
Sri P Honappa Naik	(SS-GR-I)	
Sri Vijaya Achary	(SS-GR-I)	
Sri Veerappa	(SS-GR-I)	
Sri Krishnappa Naik	(SR-GR-I)	
Sri V Sundara	(SS-GR-I)	
Sri K Annu	(SS-GR-I)	
Sri Hariya Naik	(SS-GR-I)	
Sri Umanath Shetty	(SS-GR-I) Messenger	From 05-02-96
Sri Surendra Kumar Indra	(Tea/Coffee Maker)	

INSTITUTE MANAGEMENT COMMITTEE (1994-97)

1.	Director NRCC Puttur	Chairman
2.	Director of Horticulture Govt. of Karnataka Bangalore, Karnataka	Member
3.	Additional Director Agriculture (Planning) Directorate of Agriculture Trivandrum, Kerala	Member
4.	Prof. MM Khan Professor of Horticulture Division of Horticulture University of Agricultural Sciences GKVK Campus, Bangalore	Member
5.	Shri Baldev Khosa Ex-MLA, Mumbai, Maharashtra	Non Official Member
6.	Shri Sudhir Jagtap Amroti, Maharashtra	Non Official Member
7.	Asstt. Director General (PC) ICAR, Krishi Bhavan New Delhi - 110 001	Member
8.	Dr. KRM Swamy Sr. Scientist, NRCC	Member
9.	Dr. MG Bhat Sr. Scientist, NRCC	Member
10.	Mr. D Sundararaju Scientist (SG), NRCC	Member

11.	Sr. Finance & Accounts Officer CPCRI Kasaragod	Member
12.	Dr. KV Nagaraja Sr. Scientist, NRCC	Member-Secretary

Management Committee of the Research Centre was constituted by ICAR with effect from 3rd May 1994. The committee met thrice during the year and deliberated on various aspects like QRT recommendations, reporting and reviewing officers of the staff, reappropriation of budget, purchase of equipments and ratification of reinstatement of casual mazdoors as per CAT judgement and ICAR's directives and accorded its concurrence. Proceedings of the second, third and fourth meetings have been approved by the Council.

Management committee meeting in progress

STAFF RESEARCH COUNCIL (SRC)

The SRC of the Centre is constituted by ICAR with Director as Chairman and the following as experts and members as per ICAR approval F.No.13-4/95-IA V dated 31st Jan.1995.

Dr.M.C.Nambiar Ex-Project Co-ordinator (AICRP cashew)	Expert
Dr.C.C.Abraham Assoc. Dean, KAU, Thrissur	Expert
Dr.M.M.Khan Professor of Horticulture UAS, Bangalore	Expert
All Scientists of NRCC	Members
M Gangadhara Nayak	Secretary

Eighth SRC meeting of the Centre was held on 5th and 6th June 1995 and technical programmes for 1995-96 were finalised. Mid year SRC meeting was held on 14th December 1995 to review the progress made in programmes approved in the eighth SRC meeting.

INSTITUTE JOINT COUNCIL (IJC)

Third IJC was constitued on 8th October, 1995 for a term of three years with the following as office bearers.

OFFICIAL SIDE

Dr. EVV Bhaskara Rao	Chairman
Dr. KRM Swamy	Member
Sri B Nagaraja	Member
Sri AK Shabaraya	Member
Sri AK Bolur	Member
Smt Shirly Raichal Samuel	Secretary

STAFF SIDE

Sri Prakash V. Ambekar	Member, CJSC
Sri R.Muthuraju	Member
Sri MS.Sathyanarayana	Member
Sri B.Chennappa Poojary	Member
Sri H.Veerappa Gowda	Member
Sri KM.Jayarama Naik	Secretary

The IJC met twice during the year to discuss staff welfare activities. The second meeting held on 14th February, 1996 was addressed by Dr.R.N.Pal, ADG(PC), ICAR, New Delhi.

राजभाषा कार्यान्वयन समिति

केन्द्र में इस वर्ष दि. 31-07-94 को राजभाषा कार्यान्वयन समिति की प्रथम बैठक का आयोजन किया गया तथा इस बैठक में समिति का गठन कर राजभाषा के कार्यान्वयन हेतु विविध महत्वपूर्ण बातों पर चर्चा की गई। इसीप्रकार राजभाषा नीति के कार्यान्वयन के लिए आवश्यक सभी कदम उठाने संबंधी निर्देश दिये गये। डॉ ई. वी. वी. भास्कर राव के अध्यक्षता में गठीत की गयी समिति के सदस्य हैं,

1.	डॉ. श्रीनाथ दीक्षित	सदस्य
2.	डॉ. टी एन रविप्रसाद	सदस्य
3.	डॉ. उमा जयरामन	सदस्य
4.	श्री. प्रकाश व आंबेकर	सदस्य
5.	श्री. अजित कुमार बोलूर	सचिव/संयोजक

केन्द्र में राजभाषा कार्यान्वयन समिति की इस वर्ष तीन बैठकें आयोजित की गयी। दि. 19 सितम्बर से दि. 5 अक्तूबर तक केन्द्र में 'हिन्दी पखवाड़ा' मनाया गया, तथा पखवाड़े के दरम्यान क्विज़ स्पर्धा, तथा निबंध स्पर्धा का आयोजन किया गया। दि. 22 मार्च और 23 मार्च 96 को प्रशासनिक कर्मचारियों हेतु दो दिवसीय हिन्दी कार्यशाला का भी आयोजन किया गया।

DEPUTATION ABROAD

1.	Short term training on plant tissue culture under NARP II Basic Research Subproject on Horticultural Crop Biotechnology - Department of Biology, Colorado State University, Fort Collins, USA	Thimmappaiah	12 July 1995 to 30 Sept 1995

PARTICIPATION IN SYMPOSIA/SEMINAR/TRAINING

1.	26th Short term course on Use of Computers in Agricultural Research, IASRI, New Delhi	D Balasubramanian	18-30 Sept 1995
2.	Annual General Body meeting and Meeting of Committee of Administration of Cashew Export Promotion Council of India, Cochin (Kerala)	EVV Bhaskara Rao	22 Sept. 1995
3.	XII Biennial Workshop of AICRP on Cashew, CPCRI Kasaragod	EVV Bhaskara Rao MG Bhat KV Nagaraja KRM Swamy N Yadukumar PS Bhat MG Nayak Sreenath Dixit TN Raviprasad Uma Jayaraman	14-16 Oct. 1995
4.	Review Meeting of Basic Sub-Project on Horticultural Crop Biotechnology, Indian Institute of Horticultural Research, Hessarghatta, Bangalore	EVV Bhaskara Rao	11-12 Dec. 1995
5.	XII Biennial Workshop of All India Coordinated Rese-Dec.arch Project on Palms, 1995 CPCRI, Kasaragod	EVV Bhaskara Rao	21-23 Dec. 1995

6.	Seminar on Crop Breeding in Kerala, University of Kerala, Kariyavattom, Trivandrum.	EVV Bhaskara Rao	25th Jan. 1996
7.	Regional Nursery Meeting for East Coast States, Visakhapatnam	KRM Swamy	18th Jan. 1996
8.	Meeting of Sub - Working Group on Diversification, Value Addition and Exoport Orientation for IX Plan proposals, New Delhi	EVV Bhaskara Rao	7th March 1996

RESEARCH/POPULAR PUBLICATIONS

Bhaskara Rao, EVV and Bhat, MG, 1996. Cashew Breeding - Achievements and **Priorities. Proceedings of Seminar on Crop Breeding in Kerala**. Jan 1996, Dept. of Botany, Univ. Kerala, Trivandrum, pp 47-53.

Dixit Sreenath, 1995. NRC-Cashew - A brief introduction, **Suddi Bidugade** (Kannada) Spl.No. pp 4-6.

Gangadhara Nayak, M Swamy, KRM and Palanisamy, K. 1995. Studies on screening of cashew types for dwarfing character. **The Cashew** 9 (4) : 18-24.

Swamy, KRM 1995. Top working of cashew (*Anacardium occidentale* L.) in Goa and Maharashtra States - A case study. **The Cashew** 9 (2) : 12 - 17.

PAPERS PRESENTED IN SYMPOSIA/WORKSHOP/SEMINAR

EVV Bhaskara Rao and MG Bhat (1996). Cashew Breeding- Achieve ments and Priorities. Presented in "Seminar on Crop Breeding in Kerala" held on 25.1.1996 at Department of Botany, University of Kerala, Kariavattom, Trivandrum.

TECHNICAL REPORTS/BULLETINS/COMPENDIA

All India Coordinated Research Project on Cashew, Annual Report 1994-95. (compiled and edited by Uma Jayaraman and EVV Bhaskara Rao) 120 p August 1995.

NRCC Annual Report 1994-95, (compiled and edited by EVV Bhaskara Rao, KV Nagaraja and Sreenath Dixit) 82 p, August 1995.

Swamy, KRM, Nayak, MG and Nagaraja, B. 1995. Soft wood grafting and nursery management in cashew. NRCC Tech. Bull. No.6 Sept. 1995.

Summary Report of XII Biennial Workshop of AICRP on Cashew 1993- 95, (Edited, by Uma Jayaraman) 95 p, October 1995.

Proceedings of XII Biennial Workshop on AICRP on Cashew. 107p November 1995.

Cashew Production Technology (compendium of lectures-compiled and edited by Sreenath Dixit). Lecture notes series 9, 51 p, Jan. 1996.

NRCC Research Highlights 1994-95 (compiled and edited by KV Nagaraja and Sreenath Dixit) 12 p, March 1996.

RADIO TALKS/INTERVIEWS
(Broadcast from AIR, Mangalore)

1.	Advantages of tissue culture technique	Thimmappaiah	13 May 1995
2.	Control of stem borer in cashew	PS Bhat	31 May 1995
3.	Top working of cashew plantations	KRM Swamy	19 July 1995
4.	Cashew varieties suitable for different agro - climatic regions	M.G.Nayak	22 July 1995
5.	Management of insect pests infesting cashew plantations	TN Raviprasad	8 Aug 1995
6.	Pests of cashew nursery	PS Bhat	15 Feb 1996
7.	Importance of pesticide residues in crop production	TN Raviprasad	2 Mar 1996

BOOKS/CHAPTERS

Ratnambal, MJ, Nair, MK, Muralidharan, K, Kumaran, PM, Bhaskara Rao, EVV and Pillai, RV, 1995. **Coconut Descriptor Part I,** 198p.

IMPORTANT VISITORS

30.5.1995	Dr. EV Nybe, Associate Professor & Head College of Horticulture Vellanikkara Thrissur, Kerala
06.7.1995	Dr. P Rethinam Asst. Director General (Plantation Crops) Indian Council of Agricultural Research Krishi Bhavan New Delhi
	Prof. MM Khan Prof. & Head, Dept. of Horticulture UAS, Bangalore
	Sri Sudhir Jagtap Member, Management Committee of NRC-Cashew Nagpur
16.10.1995	Dr. G L Kaul Horticulture Commissioner Govt. of India Ministry of Agriculture New Delhi
	Dr. KVA Bavappa FAO Expert

	Dr. R N Pal Asst. Director General (Plantation Crops) Indian Council of Agricultural Research Krishi Bhavan New Delhi
	Prof. MM Khan Prof. & Head, Dept. of Horticulture UAS, Bangalore
17.10.95	Sri Sudhir Jagtap Member, Management Committee of NRC-Cashew Nagpur
	Dr. R N Pal Asstt. Director General (Plantation Crops) Indian Council of Agricultural Research Krishi Bhavan New Delhi
14.12.95	Dr. MC Nambiar Retd. Project Co-ordinator (Cashew) Kasaragod
	Prof. MM Khan Prof. & Head, Dept. of Horticulture UAS, Bangalore
	Dr. CC Abraham Associate Dean, KAU, Vellanikkara

WEATHER DATA 1995-96

Month	Temp. (°C) Min	Humidity FN (%)	Humidity AN (%)	Rain fall (mm)	Rainy days	Sunshine (mrs)	Evaporation (mm)
Apr	23.9	87	55	121.2	7	9.4	6.3
May	23.7	93	69	311.6	13	6.5	4.5
Jun	23.6	96	69	639.6	23	2.6	2.8
Jul	22.3	97	90	1269.7	35	1.0	1.7
Aug	23.0	96	80	540.1	24	3.9	2.4
Sep	22.2	93	74	174.8	13	3.9	2.7
Oct	22.5	95	73	255.6	19	6.7	3.3
Nov	21.2	95	64	134.6	5	9.0	3.5
Dec	17.1	82	46	0.0	0	10.9	4.7
Jan	18.1	91	45	0.0	0	10.2	4.8
Feb	19.5	92	53	0.0	0	10.5	5.8
Mar	22.5	91	53	0.0	0	10.3	5.8
				3447.2			

*Maximum temperature was not recorded due to non availability of thermometer.