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अखिल भारतीय समन्वित काजू अनुसंधान परियोजना

ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW

Annual Report
वार्षिक प्रतिवेदन
2020

काजू अनुसंधान निदेशालय
पुत्तूर - ५७४ २०२, दक्षिण कन्नड, कर्नाटक

ICAR - DIRECTORATE OF CASHEW RESEARCH
PUTTUR – 574 202, DAKSHINA KANNADA, KARNATAKA

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वार्षिक प्रतिवेदन
ANNUAL REPORT
2020

परियोजना समन्वयकर्ता
डा. अनीता करुण

PROJECT COORDINATOR
Dr. ANITHA KARUN

भाकृअनुप
ICAR

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CONTENTS

प्राक्कथन

यह, अखिल भारतीय समन्वित काजू अनुसंधान परियोजना की 37 वीं वार्षिक प्रतिवेदन है। यह प्रतिवेदन में जनवरी – 2020 से दिसम्बर - 2020 तक का शोध परिणाम और अन्य जानकारी को शामिल किया गया है।

परियोजना के अंतर्गत 14 केंद्र हैं, जैसे, भारत के पूर्वी तट में चार; बापट्ला (आंध्र प्रदेश), भुवनेश्वर (उड़ीसा), झारग्राम (प.बंगाल) और वृद्धाचलम् (तमिल नाडु); पश्चिम तट पर तीन केंद्र और एक उपकेंद्र जैसे, माडकत्तरा (केरळ), पिलिकोड उपकेंद्र (केरळ) तथा वेंगुर्ला केंद्र (महाराष्ट्र); नवसारी (गुजरात); मैदानी भाग में तीन केंद्र, एक चिंतामणि (कर्नाटका), दूसरा जगदलपुर (छत्तीसगड) तीसरा दारीसई (झारखण्ड) में स्थित हैं और इस परियोजना का अनुसंधान कार्यसूची को कार्यान्वयन करते हैं।

इस के अतिरिक्त 3 सहयोगी केंद्रों भी परियोजना के अंतर्गत कार्य कर रहे हैं। अरबावी (कर्नाटका), बारापानी (मेघालया) और गोवा में एक – एक केंद्र हैं।

विभिन्न अनुसंधान परियोजनाएँ, प्रमुख विषयानुसार जैसे जनन द्रव्य संग्रहण एवं फसल सुधार, फसल प्रबंधन और फसल संरक्षण जारी हैं। हर एक केन्द्र द्वारा दी गई परिणामों को संकलित कर यह प्रतिवेदन में प्रस्तुत किया गया है। इस प्रतिवेदन में दो प्रमुख अध्याय हैं, एक है, परियोजना और क्षेत्रीय तौर पर प्राप्त प्रायोगिक उपलब्धियों की तकनिकी जानकारी और दूसरा है इतिहास, कर्मचारियों की विवरा, वित्तीय प्रावधान, मौसम की आँकडें, शोध प्रकाशन से संबंधित संस्थानीय जानकारी।

स्थान : पुत्तूर
दिनांक : 1.3.2021

[अनीता करुण]
प्रभारी निदेशक एवं परियोजना समन्वयकर्ता

ABOUT THIS REPORT

This is the thirty seventh Annual Report of the All India Coordinated Research Project on Cashew. This report covers the research results and other information pertaining to the period from January 2020 to December 2020.

There are a total of fourteen centres ie., four in the East Coast of India, namely, Bapatla (Andhra Pradesh); Bhubaneshwar (Odisha); Jhargram (West Bengal) and Vridhachalam (Tamil Nadu), four centres in the West Coast, namely, Madakkathara (Kerala) and Pilicode (Kerala) (Sub centre); Vengurla (Maharashtra), Navsari (Gujarat) and one each in Plains Region, namely, Hogalagere (Karnataka), Jagdalpur (Chhattisgarh) and Darisai (Jharkhand) which are implementing the research programmes. Besides, 3 cooperating centres are also functioning under AICRP-Cashew one each in Arabhavi (Karnataka), Barapani (Meghalaya) and Goa.

There are various ongoing research projects under major theme areas such as Germplasm Conservation and Crop Improvement, Crop Management and Crop Protection. The results reported by each centre are compiled region-wise and theme-wise and presented in this report. This report consists of two major chapters ie., Technical consisting of project wise and region wise experimental results from different centres and Organisation consisting of history, staff, budgetary provisions, functioning, meteorological data and research publications.

Puttur
Dated : 01.03.2021

[ANITHA KARUN]
DIRECTOR & PROJECT COORDINATOR (ACTING)

INTRODUCTION

The All India Coordinated Spices and Cashewnut Improvement Project (AICS & CIP) was started during the fourth five year Plan in 1971. The AIC & CIP had five centres (four University Centres and one ICAR Institute based centres) identified for conducting research on cashew. These centres were located at Bapatla (Andhra Pradesh), Vridhachalam (Tamil Nadu), Anakkayam (Kerala) (Later shifted to Madakkathara), Vengurla (Maharashtra) and CPCRI, Regional Station, Vittal (Karnataka). During the fifth Plan period, one centre at Bhubaneswar (Orissa) and in sixth plan period two centres one at Jhargram (West Bengal) and another at Chintamani (Karnataka) were added. During VIII Plan period one centre at Jagdalpur (Chattisgarh) and a sub Centre at Pilicode (Kerala) was started. During the period of XI plan, two new centres were added – one in Paria in Gujarat in 2009 and another in Darisai in Jharkhand in 2010. Further three co-operating centres are also functioning under AICRP-Cashew at Arabhavi, Barapani and Goa since 2009.

The Headquarters of the project was located at Central Plantation Crops Research Institute, Kasaragod. During the Seventh Plan period, the project was bifurcated into:

1. All India Coordinated Cashew Improvement Project and
2. All India Coordinated Spices Improvement Project.

The headquarters of the independent cashew project was shifted to National Research Centre for Cashew, Puttur in 1986. Presently, there are ten coordinating Centres and one sub Centre, four in the East Coast viz., Bapatla. Bhubaneswar, Jhargram, Vridhachalam, four in the West Coast viz., Pilicode, Madakkathara, Vengurla, Paria and three centres, one each in the plains region at Hogalagere in Karnataka, at Jagdalpur in Chhattisgarh and at Darisai in Jharkhand and three co-operating centres.

The objective of the Project is to increase production and productivity through:

1. Evolving high yielding varieties with good kernel quality and tolerance to biotic and abiotic stresses.
2. Standardizing agro techniques for the crop under different agro-climatic conditions;
3. Evolving cost effective and efficient pest and disease management practices.

CHAPTER 1
TECHNICAL

परियोजना समन्वयकर्ता की रिपोर्ट

वर्तमान में काजू के अखिल भारतीय समन्वयीत अनुसंधान परियोजना के चौदह केंद्र हैं, जो देश के बारह काजू उगानेवाले विभिन्न राज्यों में स्थीत हैं। इन सभी केंद्रों पर विभिन्न राज्य कृषि विश्वविद्यालयों और आईसीएआर के संस्थानों का प्रशासनीक नियंत्रण होता है। परियोजना का वर्ष 2020 का मूल बजट आबंटन रु. 513.10 लाख (भा.कृ.अ.प. का शेयर) था और कुल व्यय रु. 494.71 लाख (भा.कृ.अ.प. का शेयर) था।

निम्नलिखित विधियों से काजू की उत्पाद और उत्पादन क्षमता बढाना इस परियोजना का लक्ष्य है:

1. उच्च उत्पादन के साथ रोग एवं कीट सह्य/ निरोधी, अच्छे गिरी गुणवत्ता वाले और जैविक और अजैविक तनाव को सहने वाले किस्मों का विकास।
2. विभिन्न कृषि – मौसमी परिस्थितियों में काजू फसल के लिए कृषि प्रौद्योगिकी का मानकीकरण।
3. लागत प्रभावी, दक्ष पीडक एवं रोग प्रबंधन विधियों का विकास।

इन लक्ष्यों को पुरा करने के लिए प्रारंभित विविध परियोजनाओं से प्रतिवेदन अवधि मे प्राप्त मुख्य परिणामों को विविध विभागों में प्रस्तुत किया गया है।

फसल सुधार

कुल 1594 जनन द्रव्य किस्मों को विभिन्न केंद्रों में संरक्षण किया गया है। इस साल में 17 नवीन किस्मों को अलग अलग केन्द्रों द्वारा संग्रह किया गया है। जहाँ तक इन किस्मों का मूल्यांकन का सवाल है, इस वर्ष, अलग अलग केन्द्रों द्वारा, उपज और उपज केलिए कारण गुणों के आधार पर 95 किस्मों का चरित्र वर्णन किया गया है। वेंगुर्ला क्षेत्र में, जहाँ नरम कच्चा बीजों का माँग, खाना बनाने में ज्यादा है, CNSL फ्री किस्मों का एक नया प्रयोग आरंभ किया गया है। विमोचित किस्मों का प्रदर्शन का अध्ययन में बापट्ला में BPP-4, दरिसाई में BPP-8 सबसे अच्छा पाया गया।

हाइब्रिडाइजेशन और चयन के एक अध्ययन में, बापट्ला में 49, भुवनेश्वर में 48, झारग्राम में 7 नई संयोजन, वेंगुर्ला में 18 और होगलगेरे में 6 हाइब्रिडों का मूल्यांकन किया गया। कुल मिला के 12 नयें संयोजनों का अध्ययन जगदलपुर में आरंभ किया गया और कई अच्छे अच्छे हाइब्रिड प्रोजनीयों को पहचान किया गया। और, रापिड क्लोनल हाइब्रिड मूल्यांकन अध्ययन, जो आशाजनक हाइब्रिडों से वांछित गुणों को बाहर लाने में कोशिश करता है, भुवनेश्वर, मडक्कतरा, वृधाचलम और वेंगुर्ला केन्द्र में प्रगति पर है।

फसल प्रबंधन

उच्चतम उपज पाने केलिए आयोजित पोषक प्रबंधन अध्ययन में, शिफरिश की गई मात्रा में उर्वरक देना, लघु और मुख्य पोषकांशों को पत्तियों पर चिडकाँव करना, भुवनेश्वर एवं होगलगेरे में अत्युत्तम परिणाम दिया। बूँद बूँद सींचाई ट्राइल में, 80% कुम्युलेटिव पान इवोपोरेशन में करना घनत्व रोपण पर्यवेक्षण अध्ययन में यह देखने में आया कि उच्च घनत्व रोपण में (4मी. x 4मी.) बी सी रेशियों समय के साथ कम होते जा रही थी और वही रेशियो सामान्य घनत्व रोपण में समय के साथ सीधा विरुध्द दिशा में बडा रही थी (8मी. x 8मी.)।

अंतर फसल प्रबंधन अध्ययन में, अंतर फसल मेरिगोल्ड बापट्ला में, टोमेटो दारिसाई में, हल्दी झारग्राम में, क्राइसेंतिमंम कनबर्गि में, हरि मिर्चि मडक्कतरा में, कोरिएंडर परिया में और यार्डलोंगबीन वेंगुर्ला में अत्यंत ज्यादा निव्वल लाभ दिया। जैविक काजू खेती प्रबंधन अध्ययन में, वर्मिकाँपोस्ट और बायोफर्टिलाइसर द्वारा शतप्रतिशत नाइट्रोजन देने से बापट्ला केन्द्र में सर्वाधिक गिरी उपज पाया गया। जब कि सिफारिश की गई मात्रा 10 किलो FYM का उपचार वृधाचलम, वेंगुर्ला और होगलगेरे में उच्चतम बेनिफिट रेशियो दिखाया। और अल्ट्रा हाइडेन्सिटि अध्ययन बापट्ला, भुवनेश्वर, झारग्राम, मडक्कतरा एवं वेंगुर्ला में जारी है।

फसल संरक्षण

जगदलपुर और वृधाचलम में टी एम बी, शूट टिप क्याटर पिल्लर, एपल और नट् बोरर और लीफ मैनर के खिलाफ लामडा-साइलोत्रिन (0.6 मिलि/ली.) अन्य कीटनाशकों से भी ज्यादा प्रभावी पाया गया; मडक्कतरा में थियोमिथोक्साम (0.1ग्रां/ली.) प्रभावी रहा। जब कि, होगलगेरे एवं वेंगुर्ला में थियोमिथोक्साम (0.2 ग्रां/ली.) ज्यादा प्रभावी पाया गया और परिया में ब्युप्रोफेजिन प्रभावी पाया गया। जहाँ तक काजू कांड और जड छेदक का सवाल है (CSRB) क्लोरोपेरीफोस (10 मिलि/ली.) मडक्कतरा, वृधाचलम एवं जगदलपुर में प्रभावी रहा। मगर, इमिडाक्लोरोफिड (2 मिलि/ली.) बापट्ला केन्द्र में प्रभावी रहा। होगलगेरे ओर वेंगुर्ला केन्द्र में फिप्रोनिल सबसे ज्यादा अच्छा प्रदर्शन दिखाया।

क्षेत्रीय वनस्पतीयों पर आधरित टीएमबी प्रबंधन के एक अध्ययन में कोई भी केंन्द्र में वनस्पती आधारित प्रबंधन रासायनिक कीटनाशकों से ज्यादा प्रभावी न दिखा। जब कि, दतुरा बीज का अर्क (5%) वेंगुर्ला में प्रभावी दिखा, दतुरा अर्क (3%) जगदलपुर एवं कासरगोड में प्रभावी रहा। पिलिकोड में गो मूत्र (10%) और वृधाचलम में अडतोडा, दतुरा, विटेक्स, केलोट्रोपिस और नीम के पत्तियों से निकाला अर्क, आरंभिक दिनों में अच्छा फलितांश दिया।

तकनिकी हस्तांतरण

वर्ष 2020 में, AICRP काजू केन्द्रों ने 5.28 लाख से ज्यादा काजू कलमों को उत्पादन किए हैं। उन्हें किसानों को, सरकारी संघटनों को, गैर सरकारी संस्थानों को वितरण किया गया है। नवीन उत्पादन प्रौद्योगिकियों को, तकनिकी मार्गदर्शन के साथ प्रसार करने के लिए अलग अलग केन्द्रों द्वारा "प्रदर्शन खेती" आरंभ किया गया है।

PROJECT CO-ORDINATOR'S REPORT

The AICRP on Cashew has presently fourteen centers, which are located in 12 cashew-growing states of the country and are under the administrative control of different State Agricultural Universities/ ICAR Institutes. The original budget allocation of the project for the year 2020 was Rs. 513.10 lakhs (ICAR Share) and the expenditure was Rs. 494.71 lakhs (ICAR Share).

The mandate of the project is to increase production and productivity of cashew through:

1. Evolving high yielding varieties with good kernel quality and tolerance to biotic and abiotic stresses.
2. Standardizing agro techniques for the crop under different agro-climatic conditions and
3. Evolving cost effective and efficient pest and disease management practices.

The salient findings during the period under report, in different projects are presented here.

CROP IMPROVEMENT

The total germplasm accessions conserved at various centers is 1594. A total of 17 new germplasm accessions have been collected by different centers during the year. As for as evaluation of germplasm accessions are concerned, during the year, 95 accessions for yield and yield attributing characters have been evaluated by different centers. A new trial on CNSL free accessions was fully initiated at Vengurle where tender cashewnuts are in demand for culinary purposes. In the trial on performance of released varieties, BPP-4 at Bapatla, BPP-8 at Darisai were found to be superior.

In the trial on hybridization and selection, 49 hybrids at Bapatla, 48 at Bhubaneshwar, 7 new combinations at Jhargram, 18 at Vengurle and 6 hybrid combinations at Hogalagere were evaluated. A total of 12 new combinations have been tried at Jagdalpur to generate hybrid progenies and many promising progenies have been identified. Further, rapid clonal hybrid evaluation trial which aims at bringing desirable characters from promising germplasm accessions is under progress at Bhubaneshwar, Madakkathara, Vridhachalam and Vengurle centers.

CROP MANAGEMENT

In the trial on nutrient management for yield maximization in cashew, recommended dose of fertilizers with FYM and foliar spray of major and minor nutrients gave best results in Bhubhaneshwar and Hogalagere. In drip irrigation trial, irrigation at 80% cumulative pan evaporation was found to be the best in Hogalagere center. In the high density planting – observation trial, it was found that BC ratio goes on decreasing as the years advance in high density (4m x 4 m) and the reverse is true in case of normal planting (8 m x 8m) .

The marigold at Bapatla, Tomato at Darisai, Turmeric at Jhargram, Chrysanthemum at Kanabargi, Chilli at Madakkathara, Coriander at Paria, Yardlong bean at Vengurle centers gave highest net returns in the intercropping experiment. In organic management trial, 100% N as vermicompost and biofertilizers gave highest nut yield in Bapatla center. Whereas recommended dose of fertilizer with 10 kg FYM gave highest benefit ratio in Vridhachalam, Vengurle and Hogalagere. Further, the trial on ultra high density planting is under progress in Bapatla, Bhubaneshwar, Jhargram, Madakkathara and Vengurle centers.

CROP PROTECTION

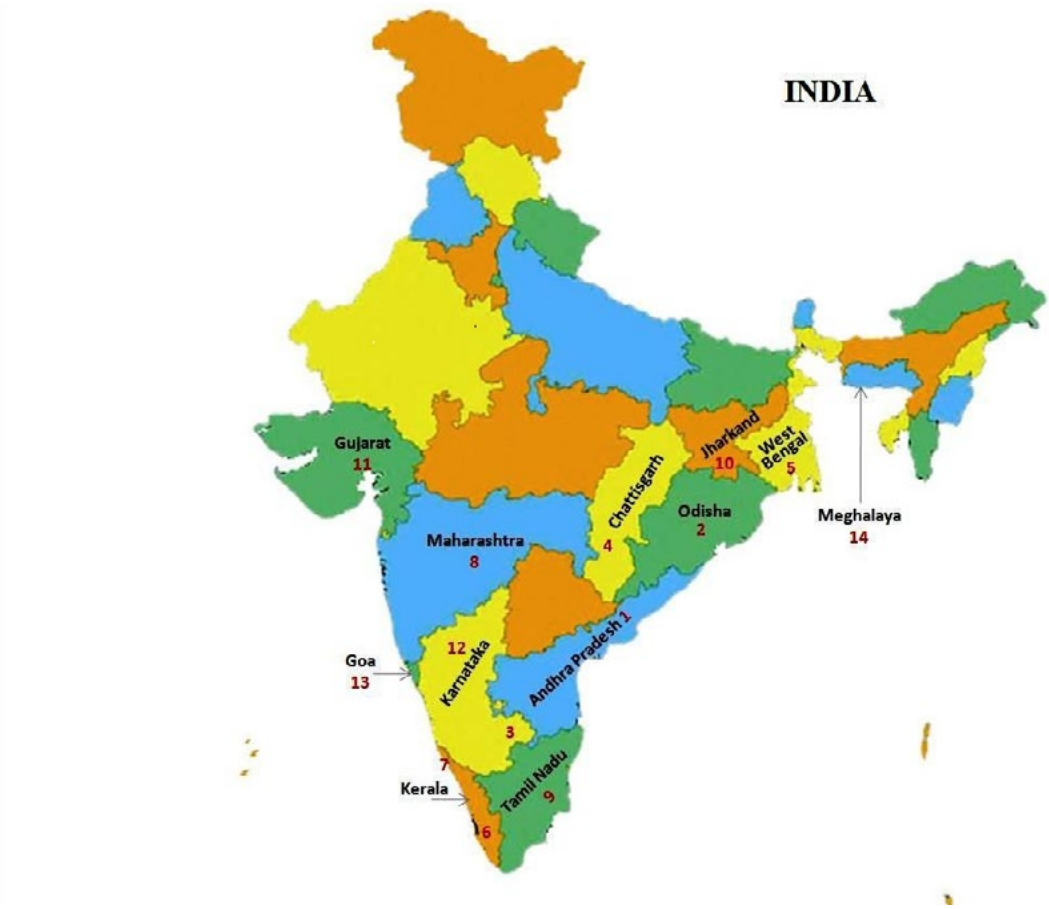
L-Cyhalothrin (0.6 ml/litre) found to be more effective compared to other insecticides against TMB, Shoot tip caterpillar, Apple and nut borer, leaf miner in Jagdalpur and Vridhachalam and Thiomethoxom (0.1 g/l) in Madakkathara. However, Thiomethoxam (0.2g/l) was found to be effective in Hogalagere and Vengurle centers and Buprofezin in Paria center. As for as CSRB is concerned, Chloropyriphos (10ml/l) was found to be effective in Madakkathara, Vridhachalam and Jagdalpur. However, Imidachloprid (2ml/l) was effective in Bapatla

center. In Hogalagere, and Vengurle centers, Fipronil gave the best results. In the trial on management of TMB through regional botanicals, no botanical formuation in any center performed better than the chemical control. However, Datura seed extract @5 % gave good results at Vengurle, Datura decoction @ 3% at Jagdalpur and Kasaragod, cow urine spray (10%) at Pilicode and leaf extracts of Adathoda, Datura, Vitex, Calotripis and neem at Vridhachalam gave good results initially.

TRANSFER OF TECHNOLOGY

During the year 2020, the AICRP-Cashew Centres have produced more than 5.28 lakh cashew grafts during 2020 which were distributed to cashew farmers, government and non-government organizations. Frontline demonstration plots have been laid out by different centres to disseminate the recent production techniques with backup of necessary technical guidance.

CENTRES OF ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW



HEADQUARTERS OF AICRP ON CASHEW

▲ ICAR - Directorate of Cashew Research, Puttur 574 202, Dakshina Kannada, Karnataka

AICRP on cashew Centres:

1. Cashew Research Station, (Dr. YSRHU), Bapatla-522 101, Guntur District, Andhra Pradesh.
2. Cashew Research Station, (OUAT), Bhubaneswar-751 003, Odisha.
3. Horticultural Research Station, (UHS), Hogalagere-563 138, Srinivasapura, Kolar Dist., Karnataka.
4. SG College of Agricultural and Research Station, (IGAU), Jagdalpur-494 005, Chattisgarh.
5. Regional Research Station, (BCKV), Jhargram - 721 507, Midnapore West District, West Bengal.
6. Cashew Research Station, (KAU), Madakkathara - 680 651, Thrissur Dist., Kerala.
7. Regional Agricultural Research Station, (KAU), Pilicode - 671 353, Kasaragod District, Kerala.
8. Regional Fruit Research Station, (Dr. BSKKV), Vengurla - 416 516, Sindhudurg Dist., Maharashtra.
9. Regional Research Station, (TNAU), Vridhachalam-606 001, Cuddalore District, Tamil Nadu.
10. Zonal Research Station, (BAU), Darisai-832 304, Barakhursi, East Singhbhum Dist., Jharkhand.
11. Agricultural Experimental Station (NAU), Paria-396 145, Valsad District, Gujarat.
12. Horticultural Research Station, (UHS), Kanabargi – 590 016, Belagavi Dist., Karnataka.
13. ICAR - Central Coastal Agricultural Research Institute, Ela, Old Goa, Goa – 403 402.
14. ICAR Research Complex for North Eastern Hilly Regions, Tura-794 005, West Garo Hills Meghalaya.

EXECUTIVE SUMMARY

- The total germplasm accessions conserved at various centers is 1594. A total of 17 new germplasm accessions have been collected by different centers during the year.
- A new trial on CNSL free accessions was initiated at Vengurle where tender cashewnuts are in demand for culinary purposes.
- In the high density planting – observation trial, it was found that BC ratio goes on decreasing as the years advance in high density (4m x 4 m) and the reverse is true in case of normal planting (8 m x 8m). In the trial on nutrient management for yield maximization in cashew, recommended dose of fertilizers with FYM and foliar spray of major and minor nutrients gave best results in Bhubhaneshwar and Hogalagere. In drip irrigation trial, irrigation at 80% cumulative pan evaporation was found to be the best in Hogalagere center.
- The intercrop marigold at Bapatla, Tomato at Darisai, Turmeric at Jhargram, Chrysanthemum at Kanabargi, Chilli at Madakkathara, Coriander at Paria, Yardlong bean at Vengurle centers gave highest net returns. In organic management trial, 100% N as vermicompost and biofertilizers gave highest nut yield in Bapatla center. Whereas recommended dose of fertilizer with 10 kg FYM gave highest benefit ratio in Vridhachalam Vengurle and Hogalagere.
- L-Cyhalothrin (0.6 ml/litre) found to be more effective compared to other insecticides against TMB, Shoot tip caterpillar, Apple and nut borer, leaf miner in Jagdalpur and Vridhachalam and Thiomethoxom (0.1 g/l) in Madakkathara. However, Thiomethoxam (0.2g/l) was found to be effective in Hogalagere and Vengurle centers and Buprofezin in Paria center.
- For CSRB, Chloropyriphos (10ml/l) was found to be effective in Madakkathara, Vridhachalam and Jagdalpur. However, Imidachloprid (2ml/l) was effective in Bapatla center. In Hogalagere, and Vengurle centers, Fipronil gave the best results.
- In the trial on management of TMB through regional botanicals, no botanical formuation performed better than the chemical control. However, Datura seed extract @5% gave good results at Vengurle, Datura decoction @ 3% at Jagdalpur, Kasargod cow urine spray 10% at Pilicode and leaf extracts of Adathoda, Datura, Vitex, Calotripis and neem at Vridhachalam gave good results initially.
- 93 training programmes on different aspect of cashew cultivation and management practices have been conducted by different centers in which around 5724 farmers have participated.

Production of Planting Material :

A total of 528673 grafts were produced during 2020 and distributed to several government and non-government organizations as well as to cashew farmers. The centre wise production of cashew grafts is given below :

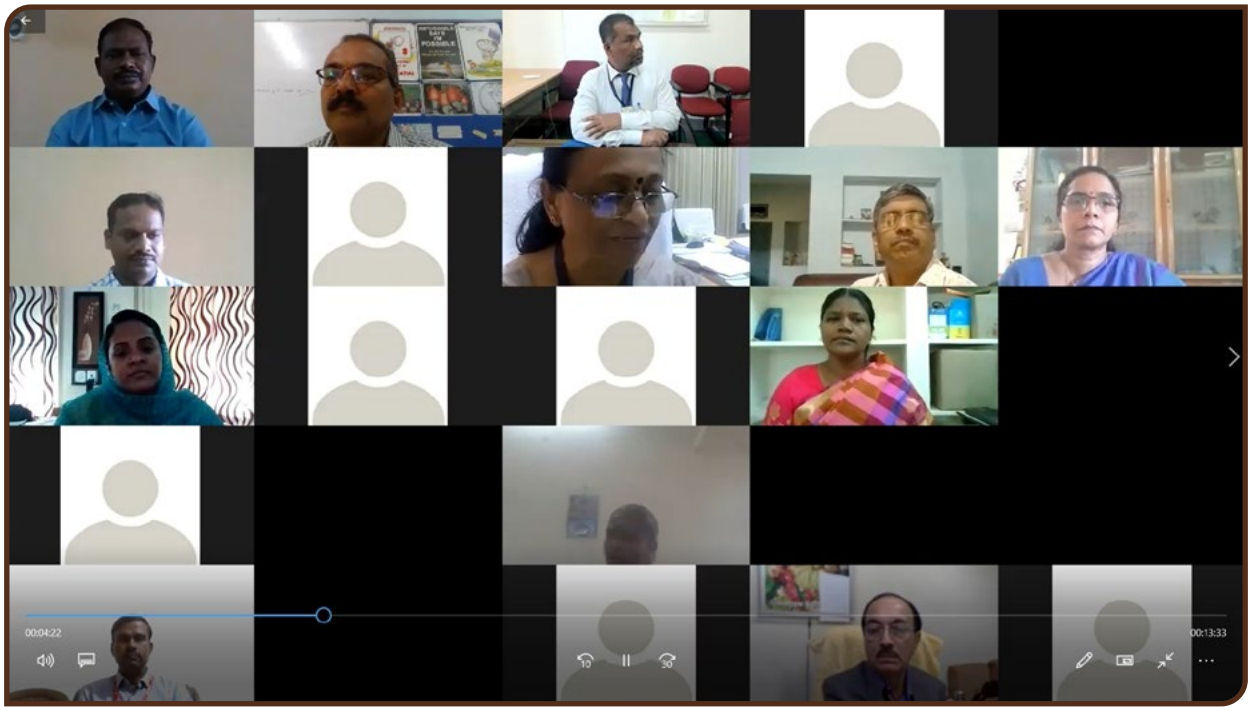
Centre	No. of grafts produced
Bapatla	60000
Bhubaneswar	20000
Hogalagere	3000
Jagdalpur	9500
Jhargram	5000
Kanabargi	15000
Madakkathara	91348
Paria	600
Pilicode	7500
Vengurle	166725
Vridhachalam	150000
TOTAL	**528673**

REPORT OF THE ANNUAL GROUP MEETING OF SCIENTISTS OF ALL INDIA COORDINATED RESEARCH PROJECT ON CASHEW - 2020

The Annual Group Meeting (AGM) of Scientists of AICRP on Cashew was organized on a virtual platform during 18th to 19th December 2020. Dr. Anitha Karun, Director (Acting) presented the project coordinator's report and welcomed all the delegates. The Inaugural address was delivered by Dr. B.K. Pandey, ADG (Hort-II.), ICAR, New Delhi wherein he expressed his concern about increasing the production and productivity of cashew in the country for doubling the income of the farmers.

The scientists from different AICRP centers presented their research findings in different technical sessions. The technical session on 'Crop Improvement' was chaired by Dr. Niral V., Principal Scientist, ICAR-CPCRI and co-chaired by Dr. M.S. Aneesa Rani, Professor, Dept. of Fruit Science, TNAU followed by 'Crop Management' session which was chaired by Dr. V.S. Korikanthimath, Former Director, ICAR-CCARI and co-chaired by Dr. J.D. Adiga, Principal Scientist, ICAR-DCR. The Crop Protection Session was held on 19th Dec. 2020 which was chaired by Dr. Kesavan Subaharan, Principal Scientist (Ento.), NBAIR and co-chaired by Dr. Joseph Rajkumar A, Principal Scientist, ICAR-CPCRI which was followed by Interactive Session chaired by Dr. Venkatesh Hubballi, Director, DCCD, Kochi wherein farmers, scientists, processors and officials from other development departments had participated. During the session the problems and suggestions of farmers regarding cashew was also discussed at length.

The session on variety release proposal was chaired by Dr. A. K. Singh, Deputy Director General (Horticulture), ICAR, New Delhi. He reiterated the importance of cashew research and called for improving the productivity. Further he suggested the formation of FPOs in cashew. During the session, Dr. M. G. Nayak, Principal Scientist (Horticulture) presented the proposal on a new dwarf variety NRC-492 and after thorough discussion, it was approved for release. The AGM was concluded with vote of thanks by Dr. Mohana G.S. Principal Scientist and Scientist-in-charge, PC Cell, ICAR-DCR, Puttur.



EXPERIMENTAL RESULTS

I. CROP IMPROVEMENT

I. CROP IMPROVEMENT

Gen 1: Germplasm collection, conservation, evaluation, characterization and cataloguing

Centres: East Coast : Bapatla, Bhubaneshwar, Jhargram and Vridhachalam

West Coast : Paria, Pilicode, Madakkathara and Vengurle

Plains / others: Darisai, Hogalagere, Jagdalpur, Kanabargi and Tura

The objectives of the project are:

(a) To evaluate the existing germplasm of cashew in different centres

(b) To collect local germplasm material with desirable characters such as high yield, cluster bearing habit, bold sized nuts, duration of flowering, off season flowering types from different cashew growing regions and,

(c) To establish clonal germplasm conservation blocks in different centres

During the current year, 17 germplasm accessions have been collected by different centers of AICRP on Cashew and are planted in the respective Regional Cashew Field Gene Banks (RCFGBs). The total number of accessions conserved so far is 1594 (Table. 1.1).

Table 1.1 :Cashew germplasm holding in different centers

Centre	No. of accessions		
	Earlier existing	Collected during 2019-20	Existing
East Coast			
Bapatla	111	--	111
Bhubaneshwar	112	2	114
Jhargram	168	--	168
Vridhachalam	208	--	208
West Coast			
Goa	104	--	104
Madakkathara	142	6	148
Paria	7	--	7
Pilicode	101	2	103
Vengurla	358	2	360
Plains tract/others			
Darisai	24	1	25
Hogalagere	104	--	104
Jagdalpur	76	--	76
Kanabargi	3	4	7
Tura	59	--	59
Total	**1577**	**17**	**1594**

Fig. A high yielding pruning responsive semi dwarf germplasm at RRS, Jhargram

DARISAI

Among the evaluated germplasm, two accessions DSI-107 (5.41 Kg nut /plant) and DSI-103 (5.04 Kg nut / plant) were identified for higher nut yield. It was observed that flowering in different germplasm ranged from 2nd week of November to 2nd week of April with maximum mean flowering duration of 147 days, in accession DSI-107 & minimum of 89 days in accession DSI-105. Mean nut weight was recorded maximum in accession DSI-107 (8.86 gm), followed by accession DSI-114 (8.69 gm) and DSI-111 (8.65 gm). The cumulative yield was maximum in accession DSI-107 (19.63 Kg/ plant) followed by accession DSI-103 (18.50 Kg/ plant) considering four harvests.

Table 1.2 : Yield parameters of promising cashew germplasm at ZRS Center during the year 2019-20

Accession	Year of planting	Duration of flowering (days)	No. of flowering laterals /m²	Nut wt. (g)	Apple wt. (g)	Nut yield 5th Year (kg/tree)	Cumulative Yield (kg/plant) of five harvests
DSI 101	2012	103.26	18.22	8.17	86.24	4.65	16.87
DSI 102	2012	106.75	24.96	7.55	71.96	4.43	17.12
DSI 103	2012	141.44	18.04	6.46	56.39	5.04	18.50
DSI 105	2012	89.29	28.93	7.52	60.49	4.83	17.64
DSI 106	2012	94.82	36.27	8.51	72.75	4.49	16.75
DSI 107	2012	147.56	38.35	8.86	40.83	5.41	19.63
DSI 109	2013	108.89	29.09	8.48	61.06	5.17	18.22
DSI 111	2014	103.16	26.78	8.65	94.45	4.35	14.65
DSI 112	2014	121.93	19.81	8.05	44.26	4.79	17.35
DSI 113	2015	102.85	16.49	8.49	70.37	4.31	16.66
DSI 114	2015	110.28	9.95	8.69	59.94	4.39	15.79

HOGALAGERE

Reproductive yield parameters of accessions planted in 2014, revealed that weight of nuts ranged from 4.5 to 10.3 (g) and that of the nut yield from 1.9 to 4.8 (kg/tree). The highest nut weight recorded was in HREC-11 (10.3g) and highest nut yield recorded was in HREC-10 (4.8 kg/tree) (Table 1.3).

For accessions planted in 2016 the weight of nuts ranged from 4.4 to 9.4 (g) and that of the nut yield from 1.5 to 2.8 (kg/tree). HREC-53 recorded highest nut weight of 9.4g whereas HREC-54 recorded the highest nut yield of 2.8 kg/tree (Table 1.4).

Table 1.3 : Yield parameters of cashew germplasm during 2020 (date of planting 25-09-2014) at Hogalagere

Sl. No.	Accession No.	Flowering duration (days)	No. of nuts /panicle (No.s)	Nut weight (g)	Yield/plant (Kg)
1	HREC-3	84	6.7	7.9	4.0
2	HREC-10	71	8.2	5.0	4.8
3	HREC-11	71	4.8	10.3	2.1
4	HREC-12	88	8.0	6.3	4.5
5	HREC-20	78	7.0	5.5	4.0
6	HREC-26	86	7.4	5.2	4.3
7	HREC-27	76	7.6	5.6	3.8
8	HREC-28	83	7.3	6.2	4.5
9	HREC-29	85	7.2	6.3	4.3
10	HREC-31	85	7.5	5.6	3.8
11	HREC-42	70	6.8	5.9	3.9
12	HREC-44	74	6.3	4.7	3.9
13	HREC-45	86	7.0	4.8	3.8

Table 1.4 : Yield parameters of cashew germplasm during 2020 (date of planting 05-12-2016)

Sl. No	Accession No.	Flowering duration (days)	No. of nuts /panicle (No.s)	Nut weight (g)	Yield/plant (Kg)
1	HREC-52	82	4.9	6.6	2.5
2	HREC-53	72	7.1	9.4	2.5
3	HREC-54	80	6.4	4.4	2.8
4	HREC-57	76	7.2	5.1	2.4
5	HREC-61	76	7.2	7.6	2.1
6	HREC-65	73	5.1	4.6	2.3
7	HREC-69	78	6.8	5.3	2.1
8	HREC-70	70	8.1	5.9	2.1
9	HREC-73	74	6.6	5.9	2.1
10	HREC-75	85	5.8	5.5	2.3
11	HREC-80	71	6.0	5.5	2.1
12	HREC-83	58	6.4	6.8	2.1
13	HREC-86	82	5.5	5.1	2.2
14	HREC-92	91	5.8	5.1	2.1

JAGDALPUR

During the fruiting season 2019-20, the survey was conducted in forest plantations of Lohandiguda block of Bastar District. Five block plantations were surveyed for collection of unique germplasms, however none of the surveyed areas had any unique or desirable characters in the plantations. Hence no germplasm could be collected in the year 2019-20.

Gen 1. Expt 1. Evaluation of promising cashew germplasm of Bastar region

Experimental details

Experimental Site	:	Upland Research Station, Lamker
Number of germplasm	:	24
Number of plants/accession	:	4
Replication	:	Unreplicated
Year of planting	:	2018 and 2019

The trial has been initiated during August 2018 with 16 germplasm accession and rest of the accessions were planted during 2019. The data revealed that, maximum plant height was observed in genotype CARS-5 (2.36 m). The canopy spread in North-South as well as East-West directions were reported maximum in genotype CARS-13. The flowering was reported extra early in genotype CARS-17.

KANABARGI

During the current year 7 Germplasm of cashew KBG-1 to KBG-7 (KBG-4 to KBG-7 collected during 2020-21) were planted at HREC, Kanabargi.

MADAKKATHARA

During the year, a wild relative of cashew, *Semicarpus kurzii* from the Regional station of National Bureau of Plant Genetic Resources, Thrissur and four cashew varieties (Goa-1, Goa-2, Goa-3, Goa-4) from the ICAR Research Complex for Goa were collected and planted in the germplasm conservation block. With the addition of these six new accessions, the total number of germplasm collections increased to 148.

Among the hybrids conserved in the germplasm block, 12 hybrid plants were identified as bold nut types with an average nut weight of >10g and kernel weight of >2.5g. The salient features of these hybrids are presented as Table 1.5.

Table 1.5 : Salient features of hybrids evaluated at Cashew Research Station, Madakkathara during 2020

Sl. No.	Hybrid No.	Parentage	Apple colour	Apple wt. (g)	Nut wt. (g)	Kernel wt. (g)
1	H03-95/4	M26/2 X H1591	Yellow Red	59.4	11.2	2.74
2	H03-95/3		Yellow Red	46.2	10.9	3.10
3	H04-3/6	SULABHA X PRIYANKA	Yellow Red	80.5	11.6	2.58
4	H03-103/15	P-10-1 X V5	Yellow Red	77.7	11.2	3.17
5	H03-18/17	H1600 X K-22-1	Yellow Red	198	15.2	2.87
6	H04-02/03	H-8-1 X V2	Yellow Red	75	13.3	3.01
7	H03-70/13	H1591 X M44/3	Yellow Red	153	11.0	3.19
8	H03-69/25	K-10-2 X M44/3	Yellow Red	80.1	10.8	2.75
9	H03-52/7	H1591 X M26/2	Yellow	77.4	10.3	2.61
10	H03-52/6		Yellow	88.3	10.8	2.69
11	H03-52/5		Yellow	154	10.6	2.51
12	H03-36/5	H1608 X BLA39/4	Yellow Red	81.2	11.7	2.56

PILICODE

New trial with newer set of germplasm has been initiated in 2017. The promising variety from the earlier trial, PLD 4 was also included in the new trial.The germplasms showed significant differences in height, spread in both NS and EW directions and canopy area. Girth of the plants did not show any difference.

TURA

During 2019-20, characterization of two early bearing (Baramashi 1 and 2) and one bold seeded cashew genotypes was undertaken. The suitable time of grafting was evaluated.

VENGURLE

Growth observations of all 20 types were recorded during the year 2019-20 and presented in Table 1.6. Among the 20 types, the maximum height (5.30 m), stem girth of 60.33 cm, EW canopy spread (5.73 m), NS canopy spread (6.22 m) and canopy area (28.07 m^2) was recorded in RFRS 195.

Total 20 cashew accessions were planted during 2008-2018, out of which 16 cashew accessions planted during 2014 to 2018 are small and yet to start flowering and fruiting and only 4 accessions have started flowering and fruiting.

Among the 4 types, the maximum flowering duration (126.6 days), number of laterals/m^2 (28.6/m^2) and sex ratio (0.21) was recorded in RFRS 195. The highest number of nuts per sq. m. (19.5/m^2) and highest number of nuts per panicle (4.5) was observed in RFRS 197.

Yield attributing data of 4 cashew germplasm (Table 1.6) showed that RFRS 197 had the maximum nut weight of 7.80 g. Highest apple weight (68.50 g) was recorded in RFRS 196 and highest shelling percentage (31.0%) was recorded in RFRS 195. The maximum annual nut yield (8.395 kg/tree) and cumulative nut yield at 7 harvests (25.635 kg/tree) was observed in RFRS 195 for the year 2019-20.

Table 1.6 : Yield parameters of promising cashew germplasm at Vengurla centre during the year 2019-20

Accession No.	Nut wt (g)	Apple wt. (g)	Shelling (%)	Annual nut yield (kg/tree)	Cum. yield (kg/tree)
RFRS 195	6.10	47.50	**31.00**	**8.395**	**25.635***
RFRS 196	7.15	**68.50**	28.75	0.350	1.250**
RFRS 197	**7.80**	67.00	28.25	0.310	1.250**
RFRS 198	7.65	46.50	30.25	0.202	0.807**

*Cum. yield for 7 harvests and ** Cum. yield for 4 harvests

CONCLUDED REPORT

CENTRE : RFRS, VENGURLE

Year of planting : 2005

Concluding year : 2019 (after 8 harvests)

Results:

The data during the period 2010-11 to 2017-18 (8 years) on various vegetative, flowering, fruiting and yield attributes of 10 cashew types planted in 2005 at AICRP-Cashew, Vengurle centre under Gen.1 trial was recorded. The 65 characters of these 10 types were recorded as per the Proforma CI-3 "Characterization and Evaluation of Cashew Germplasm". The performances of 10 cashew germplasm accessions tested under Gen-1 trial are as follows.

1. **Performance of cashew germplasm with respect to vegetative growth parameters**

Among the 10 various types, the maximum mean height (6.59 m) was recorded in RFRS 188 while the minimum height (4.00 m) was found in RFRS 191 (4.00m). The maximum mean girth (70.56cm) was recorded in RFRS 189. The higher EW canopy spread (7.51m) was recorded in RFRS-190, while the maximum NS canopy spread (7.19m) was noted under RFRS-188. Whereas, the lowest EW spread (4.19m) and NS spread (3.64m) and mean canopy spread (3.89m) was recorded in RFRS-193. The maximum mean canopy spread (6.94m) was observed in RFRS-188.

2. **Performance of 10 cashew types with respect to flowering and fruiting attributes**

Among the 10 types, the maximum flowering panicles per m^2 was recorded in RFRS-193 (15.06/m^2) followed by RFRS-192 and RFRS-194 (15.00/m^2) while, the minimum number of flowering panicles per m^2 was observed in RFRS-186 (12.03/m^2). The minimum mean flowering duration (98.69 days) recorded in RFRS-190 while, the maximum mean flowering duration (102.69 days) was noted in RFRS-189. The highest mean fruit set/m^2 (16.87/m^2) obtained in RFRS-192 while, the lowest fruit set/m^2 (10.50/m^2) was noted in RFRS-191. Similarly, the maximum number of nuts/panicle (2.96) was recorded in RFRS-192 while, the minimum number of nuts/panicle (1.76) was observed in RFRS- 185.

3. **Performance of 10 cashew types with respect to yield attributes**

Out of 10 cashew germplasm accessions, RFRS-189 recorded the maximum mean nut weight (7.96 g) followed by RFRS-188 (7.55 g) and RFRS-186 (7.53 g) while, the minimum mean nut weight of 5.72 g was recorded in RFRS-191. The maximum apple weight (54.86 g) was recorded in RFRS-189 and the minimum apple weight (32.50 g) was observed in RFRS-192. The maximum mean yield of 1.28 kg/tree and cumulative yield for 8 harvests (7.70 kg/tree) was recorded in RFRS-192 while, the minimum mean nut yield of 0.39 kg/tree was recorded in RFRS-187 & RFRS-187. Data on shelling percentage revealed that the highest shelling per cent (30.30 %) was recorded in RFRS-190 while, the lowest shelling per cent was recorded in RFRS-189 with 27.90 per cent.

Conclusion:

Among the 10 cashew accessions, RFRS-192 recorded the maximum mean nut yield of 1.12 kg/tree and cumulative yield of 7.78 kg/tree. However, yield recorded by all cashew accessions under study was very low besides they had low nut weight and apple weight. So, none of cashew germplasm accessions under study were found promising and also not showed the specific or promising character/s which can be further utilized in future cashew breeding programmes.

Gen 1a : Evaluation of CNSL free germplasm accessions

Centres: East Coast :	Bapatla and Vridhachalam
West Coast :	Vengurla
Plains / others:	Hogalagere

Objective: To evaluate CNSL free accessions for yield and yield attributes

VENGURLE

The replicated trial of all six CNSL free types were initiated at Vengurla centre during July, 2018. The growth of all experimental grafts is satisfactory. There was no significant difference in vegetative parameters recorded among accessions.

VRIDHACHALAM

The scion sticks of five germplasm accessions from DCR, Puttur one type from Vengurla will be collected and planting will be done during June 2021.

Fig. CNSL free RFRS – 195 at Vengurle

Gen.3. Expt.1. Multi Location Trial – III

Centres: Plains / others: Hogalagere

The objective of the project is to evaluate promising hybrids identified and TMB tolerant accessions obtained from different sponsoring centres for their performance in different agro-ecological conditions.

HOGALAGERE

The growth parameters of varieties during 2019-20 showed tree height ranging from 1.9 to 2.5 m, trunk girth varied from 27 to 40 cm, the maximum plant height was noticed in H-675 and Chintamani-2 (2.5 m) and stem girth in Chintamani-2 (40 cm). The canopy spread of the varieties ranged from 4.1 to 9.1 m^2 with maximum in Chintamani-2 and flowering duration ranged from 72 to 97 days with maximum in Chintamani-2 (Table 1.7). Among the yield parameters, per cent flowering intensity per square meter ranged from 65 to 83 (max. H-11 and Chintamani-1), fruits per panicle ranged from 4.7 to 7.9 No.s (max. BH-85), nut weight 5.1 to 6.3 g (max. Chintamani-1), yield per plant ranged from 1.6 to 2.2 kg (Chintamani-1) (Table 1.7). The TMB incidence was medium in all the accessions.

Table 1.7 : Yield parameters of cashew genotypes in MLT-III, during 2020-21 (Date of planting 08-12-2016).

Sl. No.	Variety	Fl.Int./sq.m (%)	Fruits/Panicle (No.s)	Nut weight (g)	Yield /plant (kg)
01	BH 6	66	6.9	6.2	2.0
02	BH 85	70	7.9	5.1	1.6
03	H 1597	77	5.4	5.1	1.7
04	K 22-1	82	6.4	5.4	1.7
05	H 662	71	4.7	5.4	2.1
06	H 675	65	5.8	5.8	2.1
07	H 11	83	5.2	6.1	2.0
08	H 14	75	5.5	6.1	1.7
09	H 32/4	80	6.2	5.2	2.1
10	C-1	83	5.9	6.3	2.2
11	C-2	71	5.5	5.5	1.8
	SEm ±	1.95	0.37	0.28	0.09
	CD at 5%	5.77	1.10	0.82	0.27
	CV %	4.53	10.89	8.49	8.30

CONCLUDED REPORT

CENTRE : RFRS, VENGURLE

Replications : 3

Treatments : 11 - Types/ hybrids

1.	B.H.6	(Bhubaneshwar)	Promising hybrids
2.	B.H.85		
3.	H-1593	(Madakkathara)	
4.	H-662	(Vengurle)	
5.	H-675		
6.	H-32/14	(NRCC, Puttur)	TMB tolerant types
7.	K-22-1	(Madakkathara)	
8.	H-11	(Vridhachalam)	
9.	H-14		
10.	Goa 11/6	(NRCC, Puttur)	
11.	Local check i.e. V-7		

Year of Planting : Re-planted during December, 2008

Concluding Year : 2019 (after 7 harvests)

Overall, H-662 appeared as a best and performed well yielding highest (5.40 kg/tree, 1.05 t/ha) and cumulative yield (37.82 kg/tree) for 7 harvests as compared to rest of the genotypes and also having the medium bold size nut of 8.49g. However, the mean pooled yield recorded by H-662 is very low (5.40 kg/tree) and not found promising and hence not recommended for release.

Expt.2. Performance of Released Varieties

(Multi Location Trial – V)

Centres: East Coast : Bapatla and Vridhachalam

Plains / others: Darisai, Hogalagere and Jagdalpur

The objective of this experiment is to evaluate the performance of released cashew varieties from various centers for their suitability to different agro-climatic regions.

BAPATLA

The trial has been planted during the year September 2014 with the following released varieties of different centers.

Year of Planting : September, 2014
Design : RBD
No of Replications : 3
No of Plants per replication : 4

State	No.	Released varieties
Andhra Pradesh	3	BPP-4, BPP-6 and BPP-8
Maharashtra	4	Vengurle-1, Vengurle-4, Vengurle-6 and Vengurle-7
Karnataka	5	Chintamani-1, Ullal-1, Ullal-3, Ullal-4, UN-50
Kerala	7	Madakkathara-1, Madakkathara-2, Priyanka, Dhana, Kanaka, Amrutha and K-22-1.
West Bengal	1	Jhargram-1
Orissa	1	Bhubaneswar-1
NRCC Puttur	1	NRCC sel-2, Bhaskara
Tamilnadu	1	VRI-3
Goa	2	Goa-1
Total	**25**	

Fig. Trial on MLT-V at CRS, Bapatla

The 25 released varieties of different centers were evaluated and among the genotypes there was no significant difference observed with respect to mean plant height, canopy height and stem girth.

Among the 25 genotypes studied, the duration of flowering ranged from 84.0 days to 107.0 days. The shortest flowering duration was recorded in Chintamani-1 (84.0 days) and followed by UN-50 (87.0 days) and BPP-8 (89.0 days). With respect to flowering intensity, mean number of flower panicles per square meter and mean number of nuts per panicle was found to be significant. The flowering intensity per square meter was highest in NRCC Sel-2 (17.10) followed by Kanaka (16.40) and Madakkathara - 1 (16.52). The mean no. of nuts per square meter was found highest in Madakkathara-1 (33.40) followed by BPP-4 (33.10) and Madakkathara - 2 (31.20). The mean no. of nuts per panicle was found maximum in BPP 4 (5.6) followed by BPP-8 (4.8) and Madakkathara-1 (4.40).

Table 1.8 : Yield parameters of cashew genotypes in MLT-V at Bapatla Centre

Sl. No.	Variety/ Genotype	Nut weight (g)	Apple weight (g)	Shelling (%)	Nut Yield /tree (kg) (Harvest No.3) 2020	Cum.nut yield (kg/tree) (for 3 Harvests) 2018-20
1.	BPP 4	5.50	35.70	28.56	**5.54**	**11.18**
2.	BPP 6	6.63	43.5	28.20	2.80	5.87
3.	**BPP 8**	8.03	67.0	28.90	**4.96**	**11.21**
4.	BBSR -1	5.30	46.0	**31.10**	2.83	5.93
5.	Chintamani-1	5.40	34.0	30.76	1.99	5.49
6.	Jhargram-1	5.44	45.1	30.07	2.20	5.61
7.	Madakathara-1	6.73	48.1	**30.36**	2.75	6.24
8.	Madakathara-2	6.80	43.0	29.07	4.5	8.74
9.	K-22-1	7.30	51.0	29.10	4.5	8.34
10.	Dhana	8.10	50.0	27.10	3.10	7.17
11.	Kanaka	6.20	**70.1**	27.35	3.43	8.17
12.	Priyanka	**9.30**	**71.20**	29.77	3.50	6.24
13.	Amrutha	7.40	64.50	30.34	2.20	5.35
14.	Vengurla -1	5.80	62.6	31.07	3.36	7.12
15.	Vengurla -4	8.20	51.0	30.02	2.85	6.61
16.	Vengurla -6	**8.43**	54.20	29.13	1.95	5.13
17.	Vengurla -7	**8.50**	56.30	29.18	**2.50**	**6.53**
18.	VRI-3	6.96	48.38	30.10	3.20	7.55
19.	NRCC Sel 2	7.40	63.10	29.60	3.0	6.67
20.	Ullal 1	4.70	30.09	28.20	4.20	8.62
21.	Ullal 3	6.90	47.0	30.50	2.50	6.23
22.	Ullal 4	5.80	39.0	29.50	1.75	4.38
23.	UN 50	7.70	61.0	29.67	2.20	5.47
24.	Goa 1	6.70	66.0	**31.27**	2.45	6.18
25.	Bhaskara	6.70	48.0	25.27	3.20	6.45
	CD@5%	0.82	4.37	NS	0.93	
	SEm ±	0.28	1.53	1.36	0.33	

With respect to mean nut weight, mean apple weight, shelling percentage and mean annual nut yield per tree was found to be significant.

Among the 25 released varieties, the mean nut weight was found maximum in Priyanka (9.30g) followed by Vengurla 6 (8.50g) and Vengurla -7 (8.43g). The maximum mean annual nut yield per tree during the year was recorded in BPP-4 (5.54 kg) followed by BPP 8 (4.96kg) and Madakkathara-2 (4.50kg). With regard to the mean apple weight, the highest was recorded in Priyanka (71.20g) followed by Kanaka (70.10g). The highest shelling percentage was recorded in Goa-1 (31.20) followed by BBSR -1 (31.10).

DARISAI

The cumulative yield of variety BPP-8 (20.66 Kg/ plant) on the basis of five harvests recorded maximum yield, which was statistically on par with BPP-6 (19.72Kg/plant) and VRI-3 (19.16 Kg/plant). Duration of flowering ranged from 145.56 days in K22-1 to 93.09 days in VRI-3. Mean apple weight recorded (122.36 gm) in K22-1 to 43.79 gm in BPP-4. Mean nut weight was highest in Priyanka (11.55 gm) followed by Kanaka (9.86 gm).

Table 1.9 : Yield parameters of cashew genotypes in MLT-V at ZRS, Darisai Centre during the year 2020

Accession	Nut wt. (g)	Apple wt(g)	No. of laterals /m²	Duration of Flowering Days	Mean Yield (kg/ tree) 5th Harvest	Cumulative Yield (Five Harvests)
BH6	7.49	81.25	25.56	109.91	4.48	17.18
BH85	7.30	67.05	17.88	122.70	4.09	14.07
H1597	7.64	71.18	27.16	104.11	4.71	17.79
H662	7.14	81.83	21.79	102.32	4.13	15.77
H675	4.85	72.95	15.29	111.81	4.69	15.92
H11	5.58	80.56	19.32	138.22	4.82	17.5
H14	4.96	71.74	15.96	101.31	5.38	17.29
H32/4	6.75	68.95	17.89	95.43	4.31	15.76
GOA 11/6	6.12	83.32	13.24	128.30	2.95	11.98
BPP-4	6.64	43.79	22.17	100.24	3.66	15.17
BPP-6	6.12	46.81	28.93	106.36	5.18	**19.72**
BPP-8	8.07	79.14	39.67	125.28	5.67	**20.66**
Dhana	8.38	76.14	34.51	124.17	3.16	15.69
Madakkathra-1	7.68	46.39	12.17	98.63	2.42	9.06
Madakkathra-2	7.46	54.44	14.15	121.69	1.96	9.4
Kanaka	9.86	63.47	20.89	126.29	3.63	14.65
Vengurla-1	8.49	68.59	18.53	104.88	3.05	13.19
Priyanka	11.55	89.22	30.42	99.15	3.36	15.43
Ullal-1	7.46	48.79	16.51	142.33	1.65	10.06
Goa-1	7.33	57.36	15.06	126.91	3.29	12.07
Bhaskar	8.28	55.45	16.18	136.08	3.26	12.78
VRI-3	6.35	67.28	39.23	93.09	4.87	**19.16**
K22-1	8.34	122.36	15.19	145.56	2.55	10.85
Jhargram-2	5.71	52.78	16.57	105.51	3.21	11.78
SEm±	1.41	14.93	2.76	5.43	0.41	0.63
CD (5%)	3.91	43.26	8.08	16.37	1.15	1.78
CV (%)	14.17	16.38	14.49	15.31	13.87	14.57

HOGALAGERE

The growth parameters of varieties during 2020-21 showed tree height ranging from 2.1 to 3.2 m, trunk girth varied from 22 to 60 cm. The maximum plant height was noticed in UN-50 and Bhaskara (3.2 m) and stem girth in Goa-1 (60.0 cm). The canopy spread of the varieties ranged from 6.4m² to 14.4m² with maximum in BPP-6 and flowering duration ranged from 54 to 98 days with maximum in Jhargram-1, ullal-1 and Vri-3. Among the yield parameters, per cent flowering intensity per Square meter ranged from 71 to 86 (max. Madakkathara-2), fruits per panicle ranged from 4.1 to 8.4 No.s (max. Vengurla-1), nut weight from 4.9 to 7.9 g (max. Vengurla-7, Priyanka and NRCC-sel-2), yield per plant ranged from 2.2 to 4.8 kg (Ullal-3) (Table 1.10).

Table 1.10 : Yield parameters of cashew genotypes in MLT-V, during 2020 (Date of planting 02-01-2015)

Sl. No.	Variety	Fl.Int./sq.m (%)	Fruits/ Panicle (No.s)	Nut weight (g)	Yield /plant (kg)
01	Chintamani-1	78	7.6	7.1	4.4
02	Madakkathara-1	76	6.0	7.0	2.6
03	Vengurla-1	80	8.4	7.0	3.3
04	Priyanka	75	6.3	7.9	4.4
05	Goa-1	76	5.7	6.2	2.2
06	Bhaskara	81	6.8	6.6	3.2
07	Ullal-3	79	6.1	6.3	4.8
08	BPP-6	80	6.0	4.9	3.8
09	Madakkathara-2	86	6.9	6.5	4.1
10	Vengurla-6	74	7.0	6.4	3.5
11	Vengurla-7	80	6.8	7.9	4.4
12	K-22-1	77	6.5	7.0	2.4
13	NRCC-sel-2	76	6.5	7.9	2.9
14	Ullal-1	74	4.4	6.7	4.0
15	Ullal-4	80	5.0	6.7	2.7
16	UN-50	79	5.6	6.4	2.9
17	Kanaka	81	4.1	5.9	3.4
18	Jhargram -1	85	4.9	4.9	2.8
19	Chintamani-2	77	6.3	5.6	3.2
20	Amrutha-10	78	5.8	6.0	2.7
21	VRI-3	71	5.9	5.6	3.5
22	BPP-4	73	6.0	6.1	3.1
23	Dhana	77	5.9	6.3	4.2
	SEm ±	2.45	0.36	0.36	0.18
	CD at 5%	6.98	1.04	1.02	0.51
	CV %	5.45	10.23	9.62	8.90

JAGDALPUR

The trial was laid out during 2018. There was no significant difference among the varieties for plant height and canopy spread during 2019-20. All varieties were found to be precocious except Bhubaneswar-1, Jhargram-1 and UN-50.

CONCLUDED REPORT

CENTRE : RRS, JHARGRAM

Considering the main four yield characters i.e. nut weight, shelling%, yield/tree and cumulative yield/tree for recommending varieties for the red and laterite zone of West Bengal, Vengurla – 7, Bhaskara, Ullal- 3, BPP- 8 and Madakkathara - II were found promising for this region.

Table : Pooled mean of yield attributing parameters of cashew during 2013 – 2019

Varieties	Flowering /m²	Nuts / m²	Nuts/ panicle	Nut weight (g)	Apple weight (g)	Yield/ tree (Kg)	Shell-ing%	Cumulative yield for 6 harvests (Kg/tree)
Bhaskara	8.90 d	21.21 b	6.63 b	6.64 bcdefg	60.94 a	5.81	32.27	34.85
Madakkathara II	12.28 abc	21.01 b	6.55 b	6.03 cdefgh	48.15 a	3.21	32.01	18.36
Bhubneswar -1	13.59 abc	47.84 a	13.47 a	4.91 h	37.77 b	5.56	32.85	24.72
K – 22 -1	12.58 abc	20.19 b	7.42 b	5.91 cdefgh	48.03 a	3.90	32.10	19.30
Chintamani - 1	11.03 abc	20.83 b	9.37 b	5.63 defgh	38.69 b	3.62	30.12	16.68
Ullal 4	11.06 abc	22.03 b	5.93 b	5.74 defgh	61.72 a	4.11	31.82	23.04
Vengurla - 7	10.98 abc	20.53 b	5.88 b	8.04 a	62.28 a	5.58	31.88	36.93
VRI - 3	13.98 abc	21.15 b	5.63 b	5.87 cdefgh	45.81 a	2.97	32.87	18.47
BPP - 6	8.70 d	15.50 c	6.46 b	5.03 h	49.64 a	2.74	30.09	15.88
Amrutha	12.29 abc	25.15 b	8.87 b	5.97 cdefgh	48.22 a	3.08	31.51	18.08
Vengurla - 4	9.15 d	31.00 b	8.37 b	6.05 cdefgh	50.44 a	4.72	29.99	23.14
Goa - 1	9.08 d	20.25 b	8.03 b	6.27 cdefgh	55.26 a	3.86	29.48	18.90
Madakkathara I	10.58 bc	16.05 b	4.91 b	5.27 h	39.76 b	2.20	30.99	14.22
Priyanka	11.30 abc	11.48 c	3.59 c	7.44 ab	66.24 a	3.13	27.38	17.68
BPP - 8	12.46 abc	21.32 b	6.08 b	6.89 bcde	65.93 a	4.44	29.90	23.66
Kanaka	12.00 abc	21.67 b	5.11 b	5.37 gh	55.72 a	3.24	32.16	22.06
Vengurla - 1	9.58 d	28.27 b	9.55 b	5.52 efgh	54.55 a	3.44	30.66	19.67
Vengurla - 6	11.68 abc	21.64 b	5.55 b	5.88 cdefgh	57.70 a	3.45	30.11	17.87
Ullal - 3	8.77 d	20.00 b	7.37 b	6.91 bcd	59.71 a	4.91	30.31	27.78
Dhana	8.68 d	15.58 c	6.50 b	6.75 bcdef	56.63 a	3.38	28.97	19.54
BPP - 4	10.57 bc	23.05 b	7.78 b	4.95 h	43.86 b	3.27	28.70	15.54
UN - 50	10.69 bc	18.71 b	6.79 b	7.14 bc	55.64 a	3.70	30.27	23.15
Jhargram - 1	15.08 a	24.81 b	7.13 b	5.32 gh	51.77 a	3.47	32.77	16.82
NRCC - Sel - 2	14.74 ab	23.68 b	6.28 b	6.11 cdefgh	51.98 a	3.96	35.01	17.84
S.Em ±	**0.86**	**2.74**	**0.85**	**0.24**	**3.74**	**0.50**	NS	
C.D. at 5%	**2.41**	**8.28**	**2.58**	**0.74**	**11.31**	**1.50**		
CV%	**20.33**	**32.61**	**31.94**	**10.63**	**18.74**	**34.30**		

**In 2017 Crop damaged due to hail storm

* Subject to DMRT

CENTRE : RARS, PILICODE

The experiment was laid out during 2007-08. Twenty five varieties have been allotted for the experiment and 20 released varieties with 10 plants each were planted during June 2008. The varieties differed among themselves for all the biometric characters studied. The pooled mean for various biometric characters are presented in the table A (Mean of data recoded from 2012-2019).

Highest annual nut yield was observed in Priyanka (13.72 Kg/Plant/year) and Kanaka (12.42 Kg/plant/year). Between the years wide variation in yield was observed which might be due to the influence of climatic factors. Yield was least in Vengurla 4 and NRCC Sel 2. Highest cumulative nut yield was observed in Priyanka and Kanaka, which was followed by Madakkathara 2.

Based on the results obtained, Priyanka, Kanaka and Ullal 4 can be recommended for the region. Priyanka and Kanaka had a compact growth habit, whereas, Ullal-4 was found to be vigorous in nature. The varieties like Vengurla 4, NRCC sel 2 and VRI 3 have performed poorly and hence cannot be recommended for commercial cultivation.

Table : Yield parameters of cashew genotypes in MLT-V at Pilicode centre during 2012-19 (2008 planted)

Accession No.	Mean nut wt. (g)	Mean apple wt. (g)	Shelling %	Mean annual nut yield (kg tree)	Cum. yield (kg/tree) (for 7 Harvests)
BPP-6	7.22	89.75	30.66	1.21	6.28
BPP-8	9.76	92.50	29.46	4.21	24.84
Bhubaneswar-1	5.52	73.80	27.14	4.84	42.13
Madakkathara-1	6.26	47.50	31.33	3.78	24.32
Madakkathara-2	7.26	62.80	28.11	6.36	55.11
K-22-1	7.21	52.00	26.48	2.46	15.38
Dhana	8.01	61.00	30.85	1.55	9.11
Kanaka	9.47	59.80	28.60	12.42	82.51
Priyanka	11.17	62.40	29.43	13.72	86.37
Amrutha	10.78	62.90	29.15	6.38	35.74
Vengurla-4	7.44	53.10	30.16	0.88	7.63
Vengurla-7	8.86	48.44	30.15	2.73	15.49
VRI-3	6.69	51.60	27.92	1.06	6.52
NRCC Sel-2	10.31	85.32	32.44	0.76	7.34
Ullal-1	6.29	49.92	34.77	5.00	27.26
Ullal-3	7.41	52.50	32.25	2.77	23.71
Ullal-4	7.91	54.00	31.52	8.63	44.72
UN-50	9.46	62.47	28.01	2.76	16.52
Goa-1	6.50	56.86	28.57	1.49	12.53
Bhaskara	8.10	54.00	30.50	1.70	19.54
CD at 5%	**1.09**	**6.24**	**1.78**	**5.40**	**6.57**
CV%	**10.70**	**8.04**	**4.73**	**101.16**	**11.15**

Gen.3. Special Multilocation Trial – (MLT – VI)

Centres: West Coast : Paria

Plains / others : Darisai, Kanabargi and Tura

The objective of this experiment is to evaluate selected released varieties in new centres started during XI Plan (2009).

DARISAI

The mean flowering duration ranged from 103.12 days to 128.68 days in varieties BPP-3/28 and NRCC Sel-2 respectively. The variety H-303 (125.35 days) and the variety H-255 (121.73 days) were significantly at par. The mean apple weight of variety H-367 (114.91 gram) was significantly superior to all other varieties tested. The mean nut weight of H-303 recorded the highest nut weight (8.36 gram) followed by BPP-3/28 (7.86 gram). The maximum nut yield was recorded in variety M-15/4 (4.91 kg/plant) followed by 4.56 kg in variety H-68 in the fifth harvest. The cumulative yield was also highest in M-15/4 (18.41 Kg/plant) followed by H-68 (17.66 Kg/plant) on the basis of five harvests.

Table 1.11 : Yield parameters of cashew genotypes in MLT-VI at ZRS, Darisai Centre during the year 2020

Accession	Flowering duration (Days)	Apple wt. (g)	Nut wt. (g)	Nut yield 5th Year (kg/tree)	Cumulative Nut Yield (kg/plant) of five harvests
NRCC sel-1	112.49	79.39	6.79	3.21	13.51
NRCC sel-2	128.68	73.42	7.62	4.08	16.68
M44/3	105.95	45.83	6.21	4.35	17.01
M15/4	119.59	90.59	7.73	4.91	18.41
BPP3/33	116.38	67.14	6.85	3.76	15.16
BPP10/19	111.05	60.95	6.50	3.28	13.38
BPP30/1	107.48	53.33	6.83	2.59	9.99
BPP3/28	103.12	80.12	7.86	4.01	14.51
H303	125.35	75.18	8.36	4.13	15.93
H255	121.73	80.46	6.05	4.32	17.22
H367	112.32	114.91	6.99	3.69	15.69
H68	114.81	78.73	5.31	4.56	17.66
SEm±	3.87	4.53	0.44	0.29	0.33
CD (5%)	10.56	13.27	1.24	0.83	0.85
CV (%)	15.37	16.36	15.21	14.42	14.28

KANABARGI

Year of planting : 2015

Design : RBD

Replication : Three

Spacing : 6 m X 6m

Number of plants per replication : 5

Varieties/No. of entries : 8

1. NRCC Sel-2
2. BPP-8
3. VRI-3
4. H 303
5. Bhaskara
6. Dhana
7. VRI (CW) H-1
8. Vengurla 4

This experiment was initiated during 2015. Vegetative growth parameters of 4th year are presented below.

Table 1.12 : Performance of different varieties of cashew at HRES, Kanabargi

Sl. No.	Treatments	Plant height (m)	Trunk girth (cm)	Trunk height (m)	Canopy height (m)	Canopy diameter (m)	Nut yield (kg/tree) (2nd year yield)
1	H-303	3.07	47.60	0.51	2.57	3.77	3.20
2	VRI-H-1	3.09	40.20	0.77	2.32	3.01	2.72
3	NRCC-2	3.07	50.56	0.71	2.36	3.59	4.80
4	Vengurla-4	3.71	47.39	0.47	3.23	3.66	4.14
5	Bhaskara	3.77	58.28	0.51	3.27	3.97	4.09
6	VRI-3	3.69	58.83	0.47	3.22	3.89	3.79
7	Dhana	3.49	50.28	0.48	3.01	3.25	3.11
8	BPP-8	3.50	45.08	0.48	3.02	3.18	2.35
	SEm±	0.09	1.44	0.04	0.08	0.12	0.30
	CV	4.53	5.03	11.75	5.23	5.83	15.14
	CD (5%)	0.27	4.39	0.11	0.26	0.36	0.93

The significant difference with respect to plant height (3.77 m) canopy height (3.27 m) and canopy diameter (3.97 m) was highest in Bhaskara, Vengurla-4 and VRI-3 respectively. Least was recorded in VRI-H-1. While significant difference with respect to trunk girth was highest in VRI-3 (58.83 cm), followed by Bhaskara and least recorded in VRI-H-1. Significantly highest nut yield was recorded in NRCC-Sel-2 (4.80 kg) followed by V-4 (4.14 kg) least was in BPP-8 (2.35 kg) (Table 1.12).

TURA

Among the cashew genotypes (Table 1.13) highest plant height was recorded in Bhaskara (4.32 m) followed by Dhana (3.76 m) and VRI (CW)H-1 (3.74 m), while lowest was recorded in VRI-3 (2.76 m). Plant spread (NS x EW) was recorded highest in Dhana (4.77 m x 5.20 m), while lowest in H-303 (2.82 m x 3.68 m). The maximum plants survival was recorded in Dhana (50 per cent) followed by Bhaskara (33.3 per cent).

Gen.4. Hybridization and Selection

Centres: East Coast : Bapatla, Bhubaneshwar, Jhargram and Vridhachalam

West Coast : Vengurla

Plains / others: Hogalagere

The objective of this experiment is to utilize accessions with high yield and other desirable traits selected from the germplasm conserved at various AICRP centres as parents, to combine the desirable traits such as high yield, bold nut, cluster bearing habit, compact canopy, short flowering period, late synchronized flowering and high shelling percentage in single genotype.

BAPATLA

Table 1.14 : Yield parameters of different cashew hybrids at Bapatla Centre planted during 2010

Hybrid No.	Cross combination	Mean nut wt. (g)	Mean apple wt. (g)	Shelling (%)	Mean annual nut yield (kg/tree) 6th harvest (2020)	Cum. yield (kg/tree) (for six Harvests) 2015-2020
H504	T.No.30/1 x M15/4	7.02	47.1	25.65	6.8	28.31
H 512	M15/4xT.No.228	4.94	34.6	19.92	10.2	21.88
H 525	BPP-5X BPP-8	6.01	57.3	26.42	1.90	16.36
H 530	T.No. 30/1xPriyanka	9.68	92.6	20.5	3.20	35.70
H 532	T.No. 30/1xPriyanka	6.58	47.1	25.71	2.70	16.30
H 548	BPP-5 X H-320	6.66	74.1	29.49	4.2	17.10
H 554	BPP-3 X Priyanka	7.36	44	25.5	2.7	19.28
H 555	BPP-3 X Priyanka	3.96	39.1	31	1.0	17.33
H 581	VRI-3 x BPP-8	4.69	70.6	26.72	2.7	16.87
H 585	H-36x VRI-3	5.06	73.6	29.61	2.4	16.66

The mean nut weight was recorded highest in H-530 (9.68 g) followed by H-556 (8.86 g). The mean apple weight was found highest in H-587 (99.6 g) followed by H-534 (96.1 g). The shelling percentage was recorded maximum in H-540 (32.5) followed by H-523 (29.76). The mean annual nut yield was found highest in H-512 (10.20 kg/tree) followed by H-511 (8.60 kg/tree). The highest cumulative nut yield was recorded in H-530 (35.70kg/tree) followed by H-504 (28.31kg/tree) for 6 annual harvests.

Table 1.15 : Yield parameters of different cashew hybrids at Bapatla Centre planted during 2011

Hybrid No.	Cross combination	Mean nut wt. (g)	Mean apple wt. (g)	Shelling (%)	Mean annual nut yield (kg/tree) 5th harvest (2020)	Cum. yield (kg/tree) (for five Harvests) 2016-20)
H590	BPP-8 x Vengurla-2	4.91	43	25.38	4.6	16.21
H591	BPP-8 x Vengurla-2	4.86	59.5	24.57	1.3	15.98
H596	BPP-8 x BPP -9	3.43	45.5	34.25	6.2	23.26
H598	BPP-8 x BPP -9	4.96	40.5	29.57	2.3	12.08
H602	BPP-8 x BPP -9	5.16	92.5	29.67	5.8	7.20
H603	BPP-8 x BPP -9	3.55	70.5	20.16	5.8	11.0
H621	BPP-8 x Vengurla-5	6.79	40.5	21.3	4.3	19.75

Hybrid No.	Cross combination	Mean nut wt. (g)	Mean apple wt. (g)	Shelling (%)	Mean annual nut yield (kg/tree) 5th harvest (2020)	Cum. yield (kg/tree) (for five Harvests) 2016-20)
H622	BPP-8 x Vengurla-4	4.96	52	26.53	1.9	16.03
H623	BPP-8 x Vengurla-4	5.8	72.5	27.53	1.6	22.45
H630	BPP-8 x Vengurla-4	4.41	50.5	28.28	4.0	18.23
H636	BPP-8 x Hy94-T4	4.18	30.5	13.08	4.2	20.24
H641	BPP-8 x Hy94-T4	5.06	79.5	27.97	4.2	15.63
H642	BPP-8 x Hy94-T4	8.54	96	22.27	2.2	20.03
H643	BPP-8 x Hy94-T4	7.74	49.5	20.33	1.8	6.35

The highest mean nut weight was recorded in H-642 (8.54 g) followed by H-643 (7.74 g). The mean apple weight was found highest in H-642 (96.00g) followed by H-602 (92.50g). The maximum shelling percentage was recorded in H-596 (34.25) followed by H-598 (29.57). The mean annual nut yield was found highest in H-596 (6.20 kg/tree) followed by H-602 and H-603 (5.8 kg/tree). The highest cumulative nut yield recorded in H-596 (23.26 kg/tree) followed by H-623 (22.45 kg/tree) for five annual harvests.

Table 1.16 : Yield parameters of different cashew hybrids at Bapatla Centre planted during 2011

Hybrid No.	Cross combination	Nut wt. (g)	Apple wt. (g)	Shelling (%)	Annual nut yield (kg/tree) 4th harvest (2020)	Cum. yield (kg/tree) (for four Harvest) 2017-2020
H648	T.No.71 x T.No.273	7.69	47.85	28.5	3.7	4.33
H651	BPP-9 x T.No.2/22	5.15	27.05	27.1	7.8	12.05
H653	T.No.228 x BPP-9	3.89	41.05	28.1	3.1	14.2
H658	T.No.228 x F.No.3	4.15	82.55	21.45	1.6	8.13
H660	BPP-5 x T.No.2/22	7.75	51.55	26.7	6.2	14.4
H661	BPP-5 x T.No.2/22	7.68	45.05	27.72	1.4	9.58
H662	BPP-5 x T.No.2/22	8.58	53.05	28.9	2.9	8.3
H663	T.No.228 x Priyanka	5.85	41.05	27.8	2.6	13.05
H673	F.No.3 x T.No.228	4.7	68.05	27.14	1.05	3.04
H683	R.K.Bhai x T.No.40/1	3.91	43.3	23.7	7.5	11.40
H686	ABT-3 x T.No.40/1	5.45	46.05	22.5	4.2	11.50
H687	BPP-6 x Sel-2	5.69	46.85	22.42	1.6	9.85
H693	BPP-8 x T.No.228	4.19	43.7	25.4	2.6	9.83
H694	BPP-8 x T.No.228	4.21	46.53	25.18	2.7	11.75
H695	BPP-8 x Ullal-3	6.45	44.05	29.64	8.7	43.88

The mean nut weight was recorded highest in H-662 (8.58 g) followed by H-660 (7.75 g). The mean apple weight was found highest in H-658 (82.55g) followed by H-673 (68.05g). The shelling percentage was recorded maximum in H-695 (29.64) followed by H-648 (28.50). The mean annual nut yield was found highest in H-695 (8.70 kg) followed by H-651 (7.80 kg). The cumulative nut yield recorded highest in H-695 (43.88 kg) followed by H-653 (14.20 kg) for four annual harvests.

Table 1.17 : Yield parameters of different cashew hybrids at Bapatla Centre planted during 2012

Hybrid No.	Cross combination	Mean nut wt (g)	Mean apple wt. (g)	Shelling (%)	Mean annual nut yield (kg/tree) 4th harvest (2020)	Cum. yield (kg/tree) (for four Harvests) 2017-2020
H701	Kankady x BLA39/4	4.51	56.1	26.86	6.3	12.4
H705	Kankady x BLA39/4	6.59	70.6	26.94	7.2	9.8
H706	Kankady x BLA39/4	5.19	27.6	23	6.4	11.2
H711	T.No.10/19xKankady	5.25	53.1	29.8	2.9	4.4
H715	BPP-8 x Kankady	7.61	74	28.9	1.4	6.1
H716	BPP-8 x Kankady	7.43	42.6	21.59	3.2	11.05
H717	BPP-8 x Kankady	6.43	56.1	17.79	1.6	9.83
H718	BPP-8 x Kankady	5.59	54.85	25.04	1.5	9.05
H719	BPP-8 x Kankady	4.87	42.35	23.04	7.07	8.85
H721	BPP-8 x Kankady	7.4	77.1	26.94	1.25	2.90

The mean nut weight was recorded highest in H-715 (7.61 g) followed by H-716 (7.43 g). The mean apple weight was found highest in H-721 (77.1 g) followed by H-715 (74.0 g). The shelling percentage was recorded maximum in H-711 (29.8) followed by H-715 (28.9). The mean annual nut yield was found highest in H-705 (7.2 kg) followed by H-719 (7.07 kg). The cumulative nut yield recorded was highest in H-701 (12.40 kg) followed by H-706 (11.20 kg) for four annual harvests.

BHUBANESWAR

Hybridization programme was carried out with the objective to develop dwarf, bold nut, cluster bearing and high yielding F_1 progenies of cashew. A total of 1030 numbers of hermaphrodite flowers were pollinated in 11 different cross combinations. Fruit set ranged from minimum 10.85% to maximum 28.85%. 103 nuts were harvested and were sown in polybags for raising seedlings. Out of 103 seed nuts, 81 nuts were germinated. Germination of nuts varied from as low as 50% to as high as 100% in different cross combinations. Then the seedlings were subjected to screening based on phenotypic traits. As a result 48 numbers of F_1 progenies were selected and planted in the main field at a spacing of 5m x 5m on 29.09.2020 for further evaluation. The results of different cross combinations are presented in Table 1.18.

Table 1.18 : Details of hybridization programme at Bhubaneswar Centre, 2019-2020

Sl. No.	Cross combinations	# of flowers pollinated	# of nuts harvested	% fruit set	No. of seeds germinated	% germination	# of plants in the main field
1	Bhubaneswar-1 x KGN-1	162	25	15.43	21	84.0	9
2	Bhaskara x KGN-1	96	12	12.50	10	83.3	6
3	Dhana x KGN-1	125	3	11.20	3	100.0	3
4	BH-85 x KGN-1	47	2	21.28	2	100.0	2
5	BH-6 x KGN-1	52	2	28.85	2	100.0	2
6	Bhubaneswar-1 x VTH711/4	85	18	21.18	11	61.1	5
7	Dhana x VTH711/4	129	14	10.85	12	85.7	9
8	V-4 x VTH-711/4	64	10	15.63	8	80.0	4
9	VRI-3 xVTH-711/4	89	6	22.47	5	83.3	2
10	Bhaskara x VTH-711/4	95	5	26.32	4	80.0	3
11	Bhubaneswar 'C'-1 x VTH-711/4	67	6	23.88	3	50.0	3
	Total	**1030**	**103**		**81**	-	**48**

Evaluation of promising F_1 progenies of cashew (Year of planting 2014)

Experimental details:

No. of genotypes : 15 Replication : 2
Design : RBD Spacing : 7m x 7m
Year of planting : 2014

Result data presented in Table 1.19 revealed that nut weight was recorded maximum in genotype, VTH-711/4 (13.22 g) while apple weight was maximum in genotype, Kankadi (101.5 g). Genotype, Bhubaneswar-1 recorded maximum shelling (32.22%) among the tested genotypes. Mean annual nut yield was recorded significantly maximum in genotype, C2-6 (8.25kg plant^{-1}) at 4th harvest. Similarly, cumulative nut yield was also recorded maximum for the genotype, C2-6 (18.45 kg plant^{-1}) for 4 harvests during the fruiting season.

Table 1.19 : Yield parameters of F_1 progenies of cashew at Bhubaneswar Centre, 2019-2020

Hybrid No.	Nut wt. (g)	Apple wt. (g)	Shelling %	Annual nut yield (kg tree^{-1}) (at 4th harvest)	Cum. yield (kg tree^{-1}) (for 4 harvests)
B-27	8.13	51.50	29.38	5.30	10.48
C-30	6.80	42.50	30.78	6.23	12.92
D-19	8.31	44.50	30.35	7.45	16.48
C2-6	8.05	50.00	31.07	8.25	18.45
BH-105	7.75	47.00	29.14	5.75	12.81
BBSR-1	6.01	41.00	32.22	5.40	12.36
RP-1	5.22	29.50	30.53	5.20	11.8
RP-2	5.17	36.00	32.05	6.20	13.41
M-44/3	5.62	33.50	28.52	3.28	10.33
Kankadi	11.96	101.50	23.50	1.37	2.18
VTH-711/4	13.22	92.00	30.50	3.25	4.24
NRCC Sel.-2	7.41	51.50	30.06	5.20	10.22
H-320	7.30	41.50	28.75	2.40	6.03
Dhana	7.50	29.00	29.45	6.30	14.35
BPP-8	7.67	54.15	28.67	6.24	13.87
Mean	**7.74**	**49.67**	**29.66**	**5.19**	-

Evaluation of F_1 progenies (Year of planting 2017 and 2018)

Among the evaluated F_1 progenies, A1/17, G-6/18, L-2/18 and L-4/18 were found to be promising with respect to nut weight, shelling % and mean annual nut yield (kg plant^{-1}) at 1st harvest.

Table 1.20 : Yield attributing parameters and nut yield of promising F_1 progenies-2019-2020

Hybrid No.	Year of first fruiting	Nuts panicle^{-1}	Nut weight (g)	Apple weight (g)	Annual nut yield (kg plant^{1})	Shelling %
Year of planting 2017 : 1st harvest						
A1/17	2018	5	9.2	57.6	0.8	27.17
Year of planting 2018 : 1st harvest						
G-6/18	2018	10	7.8	50.3	1.16	30.61

Hybrid No.	Year of first fruiting	Nuts panicle^{-1}	Nut weight (g)	Apple weight (g)	Annual nut yield (kg plant^{1})	Shelling %
L-2/18	2018	10	7.8	45.6	1.15	30.35
L-4/18	2018	8	8.0	49.1	0.78	27.53

HOGALAGERE

In this experiment, six promising hybrids from ARS, Chintamani have been collected and planted at HREC, Hogalagere. Among the yield parameters, per cent flowering intensity per square meter ranged from 78 to 88 (max. H-151), fruits per panicle ranged from 5.4 to 8.6 No.s (max. H-191), nut weight ranged from 6.2 to 9.9 g (max. H-191), yield per plant ranged from 1.8 to 2.2 kg (H-191) (Table 1.21).

Table 1.21 : Yield parameters of of selected cashew F_1-Hybrids during 2020-21 (Date of planting 06-12-2016)

Sl. No.	Variety	Fl.Int./sq.m (%)	Fruits/ Panicle (No.s)	Nut weight (g)	Yield /plant (kg)
01	H-01	84	6.7	9.3	1.83
02	H-81	78	7.0	8.8	2.02
03	H-151	88	5.5	6.2	1.93
04	H-188	84	5.4	6.5	2.05
05	H-191	85	8.6	9.9	2.22
06	H-216	78	6.3	7.6	1.96

JAGDALPUR

Experimental details

Number of cross combinations : 12
Bold nut parents : CARS-8
VTH 711/4
Cluster bearing parents : Vengurle-4
CARS-7
Compact canopy parents : VRI-3
VRI-1
NRCC Selection 2
H-303

New crosses between jumbo/bold nut, cluster bearing and compact canopy genotypes were attempted. Total 12 cross combinations were used to obtain desirable crosses. The cross combinations made and nuts obtained is given in Table 1.22.

Table 1.22 : Success among the different crosses of cashew

S. No.	Parents	No. of flowers pollinated	No. of nuts obtained	% success
a) Breeding for improvement of nut size in cluster bearing genotypes				
1	V-4 X VTH 711/4	56	4	7.14
2	VTH 711/4 X H-303	61	4	6.55
3	H-303 X CARS-8	49	3	6.12
4	CARS-8 X H-303	50	4	5.13
5	VRI-1 X VTH 711/4	19	2	10.52

S. No.	Parents	No. of flowers pollinated	No. of nuts obtained	% success
6	CARS-7 X VTH 711/4	52	5	9.61
7	H-303 X VTH 711/4	134	23	17.16
b) Breeding for compact canopy/ semi tallness/ semi dwarfness in high yielding genotypes				
8	NRCC Sel. 2 X V-4	18	1	5.55
9	V-4 X H-303	52	4	7.69
10	NRCC Sel. 2 X CARS-8	31	1	3.22
11	VRI-3 X V-4	29	3	10.34
12	VRI-1 X V-4	105	6	5.71
13	**Total**	**656**	**60**	

*Low fruit set is attributed to hail storm during the crossing period and fruit set at pea stage

JHARGRAM

Statistical analysis reveals that the hybrids are significantly different from the control (BPP- 8) with respect to the growth characters like tree height, stem girth, canopy spread and canopy area. But the hybrids are on par among themselves with respect to the growth characters.

However, there were significant differences recorded among the hybrids with respect to nut weight and apple weight. The highest nut weight was recorded in the hybrid H-113 and H-139 both having nut weight more than 8 g followed by H-121 (7.4g). The hybrids had bolder nut than BPP-8 (check variety). In case of apple weight heaviest apples were produced by the hybrid H-139 (94.68g) followed by H-121 (64.70g). Smallest apple was produced by H – 37 (25.25g). The hybrids were at par with respect to the characters like yield and shelling %. Cumulative yield of 3 harvests revealed that H-113 was the highest yielder (10.77 kg/tree) followed by H-33 (10.05 kg/tree) and H-132 (8.66 kg/tree). H-121 was found to be a promising hybrid with respect to the yield attributes like nut weight, yield and shelling percentage.

Table 1.23 : Yield parameters of different cashew hybrids at Jhargram Centre during the year 2019 – 20 (Year of Planting : 2015)

Hybrid No.	Cross combination	Nut wt (g)	Apple wt. (g)	Shelling %	Nut yield (kg/tree)	Cum. yield (kg/tree) (for 3 Harvests)
H-121	H- 2/15x Red Hazari	7.40	64.70	33.33	5.36	7.94
H-132	H- 2/15x Red Hazari	6.06	40.78	32.58	5.18	8.66
H-139	KGN – 1 x BLA -39-4	8.40	94.68	29.95	1.76	3.08
H- 33	Local x 2/9 Dicherla	6.66	50.73	33.02	7.90	10.05
H- 113	H- 2/15x Red Hazari	8.43	50.93	30.86	9.45	10.77
H- 35	Local x 2/9 Dicherla	5.15	51.28	29.74	4.49	6.39
H- 126	H- 2/15x Red Hazari	5.25	44.74	31.82	4.52	6.87
H- 37	Local x 2/9 Dicherla	4.65	25.25	33.35	5.42	8.19
H- 41	Local x 2/9 Dicherla	6.35	45.50	35.06	4.63	6.79
BPP - 8		7.03	53.05	30.81	3.48	5.19
S.Em ±		0.08	0.88	1.09	0.88	
C.D. at 5%		0.25	2.55	3.16	2.57	
CV %		2.59	3.37	6.80	33.88	

The height of hybrids varied between 1.4 m to 2.55 m. Though the parents were same but variations was observed among the hybrids and the tallest was H-195 and H-199 and H-200 had minimum height. The range of girth was between 14 – 27 cm. H - 195 had maximum canopy spread while minimum was in H-200. Therefore the canopy area was maximum in H - 195 (13.79 m^2) followed by H- 192 (13.02 m^2).

Table 1.24 : Yield parameters of different cashew hybrids at Jhargram Centre during the year 2019 - 20 (Year of Planting : 2018)

Sl. No.	Hybrid No.	Cross combination	Nut wt. (g)	Apple wt. (g)	Shelling %	Cashew Apple colour	Cashew Apple shape	Annual nut yield (kg/tree)
1	H -182	JGM - 282 x JGM - 216	8.17	66.7	28.57	Red	Obovate	0.42
2	H - 183	JGM - 282 x JGM - 216	5.00	60.0	20.0	Red	Obovate	0.53
3	H -185	JGM - 282 x JGM - 216	4.20	50.0	41.7	Red	Cylindrical	0.33
4	H -186	JGM - 282 x JGM - 216	5.00	25.0	25.0	Red	Cylindrical	0.07
5	H -187	JGM - 282 x JGM - 216	5.22	56.7	33.5	Pink	Cylindrical	0.66
6	H -189	JGM - 282 x JGM - 216	7.30	66.7	31.9	Pink	Obovate	1.18
7	H -190	JGM - 282 x JGM - 216	6.33	66.7	26.3	Pink	Obovate	0.70
8	H -192	JGM - 282 x JGM - 216	5.75	50.0	34.8	Pink	Cylindrical	1.46
9	H -193	JGM - 282 x JGM - 216	5.75	35.0	30.4	Pink	Cylindrical	2.26
10	H -195	JGM - 282 x JGM - 216	7.33	37.5	36.4	Pink	Cylindrical	2.05
11	H -196	JGM - 282 x JGM - 216	6.00	25.0	25.0	Red	Obovate	0.98
12	H -197	JGM - 282 x JGM - 216	6.20	41.7	31.2	Red	Obovate	0.85
13	H -198	JGM - 282 x JGM - 216	6.00	50.0	29.2	Pink	Cylindrical	0.47
14	H -201	JGM - 282 x JGM - 216	6.29	50.0	31.8	Red	Cylindrical	0.61

The number of inflorescence per square meter was recorded maximum in H-188 (13.75) followed by H-182 (12), H-193 (11) and H-197 (10.25). Though the number of inflorescence per square meter was recorded less in H-189 but highest number of nuts per square meter (40.5) and nuts per panicle (15) was recorded in this hybrid. Therefore, it is clear that H-189 had either more number of hermaphrodite flowers or the nut set was more due to proper pollination or some other factors. Similar result was recorded in H-190. H-193 and H-187 had also higher number of nuts /m^2. Table 1.24 represents the yield parameters of different cashew F_1 hybrids planted at Jhargram Centre in 2018 under un-replicated trial.

Among the 21 F_1 hybrids planted in 2018, 14 hybrids produced countable yield in second year. The promising hybrids those yielded quite high in the second year of planting were H-195 (2.05 kg/tree) with 6.25 nuts per panicle, 7.33g nut weight and 32.7 % shelling, H-189 (1.46 kg/tree yield) with 15 nuts per panicle, 7.3g nut weight and 32.8 % shelling.

Fig. F1 hybrid plants in second year

Table 1.25 : Growth parameters of different cashew hybrids at Jhargram Centre during the year 2019 - 20 (Year of Planting : 2019)

Sl. No.	Hybrid No.	Cross combination	Tree height (m)
1	H - 202	Jhargram- 1 x BPP 8	0.30
2	H - 203	Bidhan Jhargram - 2 x Jhargram- 1	0.70
3	H - 204	Bidhan Jhargram - 2 x Jhargram- 1	0.45
4	H - 205	Jhargram- 1 x BPP 8	0.65
5	H - 206	Bidhan Jhargram - 2 x Jhargram- 1	0.52
6	H - 207	Jhargram- 1 x BPP 8	0..55
7	H - 208	Jhargram- 1 x BPP 8	0.60

Table 1.25 represents the growth parameters of different cashew F_1 hybrids planted at Jhargram Center in 2019 under un-replicated trial.

VENGURLE

Design	:	RBD
Replication	:	3
Treatment	:	18
Spacing	:	7m x 7m
Year of planting	:	July, 2016
Plant unit/ replication	:	3
Total plants	:	162

The trial is in initial stage. Growth of all the grafts is satisfactory. The vegetative growth parameters (2019-20) of new set of promising hybrid is recorded. Data revealed that there was a significant result with respect to all vegetative growth parameters except height (m) and girth (cm).

The flowering and fruiting parameters of new set of promising hybrid were recorded during the year 2019-20. It is seen from data that there was non-significant difference among the different hybrids with respect to flowering duration, number of flowering panicles per m^2, fruit set per m^2 and number of nuts per panicle however, showed significant results for number of laterals per m^2.

Yield parameters of new set of promising hybrid recorded during the year 2019-20 are presented in Table 1.26. It is revealed from the data that, the highest apple weight of 100.0g was recorded in H-1306 which was superior over rest of the treatments. Significantly the highest nut weight was recorded in H-883 (11.30g) and at par with H-735 (11.00g). The highest first year yield of new set of promising hybrid was recorded in H-1039 (2.30 kg/tree) and found significantly superior over rest of the treatments.

H-2992

H-3084

H-3140

Table 1.26 : Yield parameters of new set of promising hybrid at Vengurla Center during the year 2019-20

Hybrid No.	Apple weight (g)	Nut weight (g)	Yield (kg/tree)
H-778	65.50	8.40	0.13
H-883	76.00	**11.30**	0.98
H-969	68.80	9.80	1.01
H-958	40.00	10.17	0.23
H-1016	50.00	9.40	0.15
H-1039	60.00	8.80	**2.30**
H-2005	60.00	8.60	0.15
H-1187	64.70	8.50	0.57
H-1306	**100.00**	8.20	0.13
V-9 (Check)	72.90	8.90	0.15

CONCLUDED REPORT

CENTRE : RFRS, VENGURLE

Year of planting : 2004
Spacing : 5m x 5m
No. of F_1 cashew progenies evaluated : 197
No. of cross combinations : 61

On the basis of performance of F_1 cashew progenies during last ten years (2010-11 to 2019-20), the results are summarized under following heads.

1) Performance of F_1 cashew progenies at AICRP-Cashew, RFRS, Vengurla center with respect to flowering attributes.

Minimum mean flowering duration of 90.30 days observed in H-2995 while the maximum flowering duration of 107.70 days and 107 days was observed in H-2956 & H-2915, respectively. Almost all F_1 cashew progenies showed mid season flowering and none of the F_1 cashew progenies had short and medium flowering duration. Almost all F_1 cashew progenies started flowering in the month of November and onward. However, few F_1 cashew progenies (H-2857, H-2876, H-2934 & H-2969) had initiated flowering in fortnight of October.

2) Performance of F_1 cashew progenies at AICRP-Cashew, RFRS, Vengurla centre with respect to yield attributes.

Out of 197 F_1 cashew progenies, the maximum mean apple weight (g) was observed in H-3084 (118.70 g), H-3096 (111.00 g), H-3110 (117.0g), H-3141 (102.0g), H-2909, H-3027 & H-3138, (100g) while the minimum apple weight was found in H-3034 (27.50 g). None of the F_1 cashew progenies showed low apple weight (<27g) however, 87 and 110 Nos. of F_1 cashew progenies categorized under medium (27-52g) and high (>52g) apple weight categories respectively.

Out of total F_1 cashew progenies evaluated, the highest mean nut weight (g) was recorded in H-3096 (15.01 g),H-3043 (14.64 g), H-3084 (13.10g), H-3110 (12.00), H-3090 (11.22g), H-2983 (10.86 g), H-3139 (10.67g), H-3062 (10.52g), H-3157 (10.21g) & H-3104 (10.15g), while, the lowest nut weight was recorded in H-2961 (5.35 g). Data revealed that, none of the F_1 cashew progenies showed lower nut weight (<5g) however, 76, 111 and 10 Nos. of F_1 cashew progenies were categorized under medium (5-7g), high (7-10g) and jumbo (> 10 & above) nut weight, respectively

The highest mean yield of last 10 years (kg/tree) was recorded in H-3050 (5.68 kg/tree), H-3082 (4.87kg/tree), H-2992 (4.82kg/tree), H-3034 (4.69 kg/tree), H-3028 (4.06kg/tree) & H-3155 (4.05 kg/tree), and

minimum in H-2880 (0.23 kg/tree), out of 197 F_1 cashew progenies evaluated

The data on number of F_1 cashew progenies categorized into the low, medium and high yield (kg/tree) and the data revealed that, 135 Nos. of the F_1 cashew progenies showed lower yield (<2 kg/tree) however, 56 and 6 Nos. of F_1 cashew progenies categorized under medium (2-4 kg/tree) and high (>4 kg/tree) yield (kg/tree), respectively. Out of 197 F_1 cashew progenies, the highest cumulative yield of last 10 harvests (kg/tree) was recorded in H-3050 (51.14 kg/tree), followed by H-3082 (48.73 kg/tree), H-2992 (48.23 kg/tree), and minimum in H-2880 (2.09 kg/tree). 148 Nos. of the F_1 cashew progenies showed cumulative yield of <20 kg/tree however, 17 and 32 Nos. of F_1 cashew progenies categorized under 20-25 kg/tree and >25 kg/tree cumulative yield, respectively and cumulative yield more than 30kg (depicted in Fig.1).

Conclusion:

On the basis of highest cumulative yield of 10 harvests (more than 25 kg/tree), mean nut yield (kg/tree), bold nut size (g), medium to big size apple weight (g), number of nuts per panicle, high shelling percentage (more than 28%), 32 Nos. of top performing F_1 cashew progenies *viz.*,. H-2859, H-2861, H-2869, H-2870, H-2871, H-2872, H-2873, H-2875, H-2916, H-2917, H-2918, H-2992, H-3028, H-3030, H-3033, H-3034, H-3035, H-3036, H-3043, H-3050, H-3055, H-3056, H-3059, H-3081, H-3082, H-3084, H-3091, H-3092, H-3096, H-3105, H-3155 & H-3156 were screened as promising hybrids out of 197 cashew F_1 progenies planted in 2004 at AICRP-Cashew, Vengurla centre.

Gen.4a : Rapid polyclonal hybrid evaluation trial

Centres: East Coast : Bapatla, Bhubaneshwar and Vridhachalam

West Coast : Madakkathara and Vengurla

The objective of this experiment is to utilize accessions with high yield and other desirable traits selected from the germplasm conserved at various AICRP centres as parents, to combine the desirable traits such as high yield, bold nut, cluster bearing habit, compact canopy, short flowering period, late synchronized flowering and high shelling percentage in single genotype.

Experimental details:

No. of hybrids : 5

Spacing : 3m x 2m

Number of plants /hybrid : 5

Year of planting : 2017

List of hybrids :

Sr. No	Accession No.	Original source of collection
1	C2-6	CRS, Bhubaneshwar
2	H-12/05	ICAR Research Complex for Goa
3	H-2917	RFRS, Vengurla
4	VRI (cw) H1	CRS, Vridhachalam
5	H-504	CRS, Bapatla

BHUBANESWAR

Among the five hybrids, VRI (cw)-H1 was found to be most early type (flowering occurred in last week of October, 2019) while hybrid H-2917 is a mid-season flowering type (1st week of December, 2019). Other three hybrids viz. C2-6, H-504 and H-12/05 were late flowering type (flowering started in 1st week of January, 2020). The experiment was covered with insect proof mosquito net as soon as opening of flowers were started. Few nut sets were observed during the fruiting season. Seed nuts were harvested at maturity and 20 numbers of selected seeds were sown in polybags for raising seedlings. 16 numbers of seed nuts were germinated, out of which 12 numbers of selected seedlings were planted in the main field at a spacing of 4m x 4m for further evaluation.

MADAKKATHARA

The above hybrids were planted in Randomized Block Design with three replications in 3m X 2m spacing @ 5 grafts/ replication following all recommended package of practices. During the flowering season (2019-20), precocious flowering was observed in the accessions C2-6 and VRI (cw)H1. The hybrid nuts were collected and seedlings were raised in polybags. During the year 2020, flowering was initiated in the accessions C2-6 and VRI (cw)H1 during 2nd week of October.

VENGURLE

The grafts of all high yielding hybrids were planted in 3m x 2m spacing @ 5 grafts/hybrids in July, 2018 and the growth of all the grafts are satisfactory. The year 2019-20 is second year of experimentation. All grafts were covered with insect proof cover in cashew season 2019-20 and introduced pollinators for pollination. Total 194 Nos. of F_1 nuts were harvested and nuts were sown in the bags for germination. Precocity of flowering observed early in cashew accession H-2917 and VRI (cw) H1 (15th November, 2019).

Sr. No	Accession No.	Precocity of flowering (No. of grafts per accession-5)	Flowering duration (days)	Number of nuts harvested from each accession
1	C2-6	18 – 22 Nov., 2019	95.5	07
2	H-12/05	27th November, 2019	95.0	-
3	H-2917	15th Nov. to 10th Dec. 2019	92.8	64
4	VRI (cw) H1	15th Nov. to 20th Nov. 2019	98.2	123
5	H-504	-	-	-
			Total	**194**

Fig. Rapid Polyclonal hybrid evalution trial

VRIDHACHALAM

The trial was initiated during September 2018 and the plants are under vegetative stage. The yield data will be recorded from the ensuing year.

Gen. 5. Characterization of germplasm for cashew apple

Centres: East Coast :	Bapatla and Vridhachalam
West Coast :	Pilicode
Plains / others:	Jagdalpur

Objective: To identify germplasm having preferred apple characters suitable for value addition.

JAGDALPUR

The experiment was initiated during 2012-13 with collected germplasm of Bastar region. Eleven germplasm were evaluated for cashew apple characters desirable for processing to value added products. The details of physical and bio-chemical parameters of cashew apple germplasm pooled over seven years are presented in Table 1.27. The maximum apple weight was recorded in CARS-8 (103.36 g) followed by CARS-11 (87.08 g) and CARS-9 (79.09 g). The maximum nut weight was recorded in CARS-8 (12.44 cm) followed by CARS-10 (10.31 cm) whereas apple to nut ratio was observed in CARS-11 (10.43) followed by CARS-8 (8.31). Highest juice recovery was recorded in CARS-8 (76.53 %) followed by CARS-10 (71.32 %). The maximum TSS (15.91°Brix), ascorbic acid (264.51 mg/100g) and total sugars (16.49 %) were observed in genotype CARS-3.

It is concluded from the experiment that, CARS-8 exhibited superior performance for most of the physical parameters such as apple weight, nut weight and juice recovery. Also CARS-8 recorded the moderate to high TSS, low acidity and moderate total sugar content. Hence the present studies reveal the scope for utilizing CARS-8 for preparation of beverages and processed products under Bastar region of Chhattisgarh.

Table 1.27 : Apple characters of cashew germplasm (pooled over 7 years)

Germ plasm	Apple weight (g)	Nut weight (g)	Apple to nut ratio	Juice recovery (%)	Cashew apple colour	Total Soluble Solids (°Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Total Sugars (%)	Tannin (mg/100 g)
CARS-1	54.89	6.59	8.31	60.63	Red	12.19	0.32	233.29	11.59	3.46
CARS-2	62.63	7.05	8.96	62.20	Yellow	13.56	0.26	251.54	12.78	3.12
CARS-3	65.61	7.59	8.68	68.92	Red	15.91	0.33	264.51	16.49	3.25
CARS-4	42.82	6.55	6.52	62.17	Yellow	13.69	0.39	230.81	10.72	3.08
CARS-5	74.16	7.73	9.60	65.03	Yellow Red	11.32	0.41	231.94	14.10	3.11
CARS-6	65.72	7.37	8.93	66.15	Yellow Red	11.40	0.48	237.45	11.53	2.74
CARS-7	49.25	7.33	6.58	67.20	Yellow	13.72	0.37	252.70	13.48	3.65
CARS-8	103.36	12.44	8.31	76.53	Red	12.66	0.39	246.71	12.54	3.12
CARS-9	79.09	9.73	8.13	65.63	Yellow	10.63	0.60	212.97	9.29	3.22
CARS-10	78.20	10.31	7.59	71.32	Red	12.48	0.35	244.83	13.32	2.90
CARS-11	87.08	8.35	10.43	70.38	Yellow Red	13.69	0.48	216.47	10.85	3.45

PILICODE

Highest ascorbic acid content was observed in PLD 84 (345.45 mg/100g) followed by PLD 86 (327.22 mg/100g) and PLD 83 (327.27 mg/100g). Tannin content was highest in PLD 86 (0.169%) and PLD 83 (0.165%) and acidity percentage was highest in PLD 88 (0.90%). Least acidity was found in PLD 87 (0.33%). Highest TSS was recorded in Priyanka (10.10) followed by PLD 98 (8.00). Sugar Acid ratio was highest for PLD 87 followed by Priyanka.

Table 1.28 : Biochemical characters of apple in different germplasm

Germplasm details	Ascorbic Acid Content mg/100g	Tannin %	TSS (°Brix)	Acidity (%)	Sugar Acid Ratio
PLD 100	200.00	0.096 (0.77)	3.50	0.49 (1.00)	7.10
PLD 99	170.91	0.106 (0.78)	5.00	0.45 (0.98)	11.16
PLD 86	327.22	0.169 (0.82)	2.20	0.76 (1.12)	2.91
PLD 97	200.00	0.125 (0.79)	1.10	0.64 (1.07)	1.72
PLD 88	283.64	0.142 (0.80)	4.00	0.90 (1.18)	4.46
PLD 84	345.45	0.122 (0.79)	2.50	0.60 (1.05)	4.20
PLD 98	254.55	0.136 (0.80)	8.00	0.76 (1.12)	10.50
PLD 87	181.82	0.157 (0.81)	7.50	0.33 (0.91)	21.03
PLD 83	327.27	0.165 (0.82)	1.50	0.64 (1.07)	2.34
PLD 85	181.82	0.128 (0.79)	2.00	0.79 (1.14)	2.54
Priyanka	200.00	0.104 (0.78)	10.10	0.58 (1.04)	17.34
SEm ±	**4.803**	**0.006**	**0.398**	**0.014**	**0.496**
CD at 5%	**14.17**	**0.02**	**1.18**	**0.04**	**1.46**
CV%	**3.42**	**1.29**	**16.01**	**2.32**	**11.08**

Figures in parentheses Square root (n+0.5) transformed values

Highest nitrogen content was observed in PLD 100 (1.04%) which was statistically on par with PLD 84 (0.95%). P content was highest in Priyanka (0.44%) followed by PLD 83 (0.32%). Potassium content was highest in PLD 86 (7.18%) and Priyanka (7.11%), which was statistically on par with PLD 99 (6.89%). Estimated protein content was highest in PLD 100 (6.48%) which was statistically on par with PLD 84 (5.95%) however was found to be least in Priyanka (3.50%).

Table 1.29 : Nutritional content of apple in different germplasm

Germplasm details	Nitrogen (%)*	Phosphorus (%)*	Potassium (%)*	Estimated Protein#
PLD 100	1.04 (1.24)	0.25 (0.86)	3.51 (2.00)	6.48 (2.54)
PLD 99	0.84 (1.16)	0.26 (0.87)	6.89 (2.72)	5.25 (2.28)
PLD 86	0.84 (1.16)	0.24 (0.86)	7.18 (2.77)	5.25 (2.29)
PLD 97	0.70 (1.10)	0.22 (0.85)	5.68 (2.49)	4.38 (2.09)

Germplasm details	Nitrogen (%)*	Phosphorus (%)*	Potassium (%)*	Estimated Protein#
PLD 88	0.84 (1.16)	0.25 (0.86)	4.68 (2.23)	5.25 (2.29)
PLD 84	0.95 (1.21)	0.22 (0.85)	5.92 (2.53)	5.95 (2.44)
PLD 98	0.90 (1.18)	0.27 (0.88)	3.94 (2.11)	5.60 (2.37)
PLD 87	0.87 (1.17)	0.26 (0.87)	5.40 (2.43)	5.43 (2.33)
PLD 83	0.81 (1.15)	0.32 (0.91)	5.98 (2.55)	5.08 (2.25)
PLD 85	0.84 (1.16)	0.25 (0.87)	6.40 (2.63)	5.25 (2.29)
Priyanka	0.56 (1.03)	0.44 (0.97)	7.11 (2.78)	3.50 (1.87)
SEm ±	**0.017**	**0.006**	**0.034**	**0.055**
CD at 5%	**0.05**	**0.02**	**0.10**	**0.16**
CV%	**2.55**	**1.11**	**2.38**	**4.16**

*Figures in parentheses square root (n+0.5) transformed values
Figures in parentheses square root transformed values

PLD 84 had Highest Fe content (94 ppm), followed by PLD 86 (87ppm). PLD 98 had highest Magnesium content (9 ppm). Zinc content was highest in Priyanka (2.1ppm) followed by PLD 86 (1.5ppm), PLD 87 (1.4ppm) and PLD 88 (1.4 ppm) which were statistically on par. Copper content was highest in PLD 87 (62.1ppm) followed by PLD 86 (12.8ppm). Highest Calcium content was observed with PLD 84 (94ppm) followed by PLD 83 (81 ppm), PLD 97 (80 ppm) and Priyanka (80 ppm) which were statistically on par. Regarding magnesium content, highest was observed in Priyanka (516 ppm).

Table 1.30 : Nutritional content of cashew apple in different germplasm

Germplasm details	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Ca (ppm)	Mg (ppm)
PLD 100	76.00	7.60	1.10	2.30	62.00	442.00
PLD 99	59.00	6.00	1.00	3.93	39.00	410.00
PLD 86	87.00	6.00	1.50	12.80	38.00	454.00
PLD 97	36.00	7.00	1.20	1.40	80.00	278.00
PLD 88	60.00	7.00	1.40	1.80	21.00	450.00
PLD 84	**94.00**	6.00	1.30	5.20	**94.00**	331.00
PLD 98	47.00	**9.00**	0.70	4.10	46.00	236.00
PLD 87	46.00	6.00	1.40	**62.10**	37.00	286.00
PLD 83	10.00	6.00	1.30	1.70	81.00	227.00
PLD 85	71.00	7.00	1.20	2.60	75.00	284.00
Priyanka	27.00	5.00	**2.10**	1.40	80.00	**516.00**
SEm ±	**1.23**	**0.58**	**0.07**	**0.35**	**1.86**	**8.05**
CD at 5%	**3.65**	**1.71**	**0.21**	**1.05**	**5.50**	**23.76**
CV%	**3.85**	**15.25**	**9.68**	**6.85**	**5.44**	**3.92**

Gen 6. Varietal Screening of Cashew Apple for preparation of RTS and Jam

Centres: Plains / others: Jagdalpur

JAGDALPUR

Design of experiment	:	Completely Randomized Design
Treatments	:	10
Varieties	:	Vengurla-4, Vengurla- 7, Vengurla- 9, BPP-1, BPP-4, BPP-8, VRI-3, NRCC Selection-1, NRCC Selection-2 and Priyanka

The study was conducted to find out suitable variety for RTS preparation during the fruiting seasons 2018-19 and 2019-20 at SG CARS, Jagdalpur using ten varieties. The experiment on organoleptic evaluation was conducted in Horticulture Laboratory, SG CARS, Jagdalpur and 15 judges were involved in scoring the prepared product. Five point scale was used to draw the results. Among the varieties studied for the preparation of ready to serve beverage, the highest organoleptic score for appearance, taste, flavour and texture was recorded in variety VRI-3 whereas, the highest score for colour was reported in Vengurle-4. Variety BPP-4 had lowest scores for all sensory parameters under study. The overall acceptability was found to be highest in variety VRI-3.

From the present study it can be concluded that, variety VRI-3 is most suitable for preparation of ready to serve beverage whereas variety NRCC Selection-1 is recommended for preparation of cashew apple jam under Bastar region of Chhattisgarh.

Fig. Organoleptic evaluation of Jam

Gen. 7. Evaluation of promising bold nut, bigger size apple types and high yielding cashew genotypes

Centres: East Coast :	Bapatla, Bhubaneswar, Jhargram and Vridhachalam
West Coast :	Goa, Madakkathara, Pilicode and Vengurle
Plains / others:	Jagdalpur, Kanabargi

Objective : To evaluate the performance of promising bold nut, bigger size apple and high yielding cashew genotypes at different AICRP Centres

Experimental details :

Total Number of genotypes	:	17
No. of replications	:	2
No. of plants per genotype	:	4
Spacing	:	6m x 6m

Materials :

Sl. No.	Sponsoring centre	Cashew genotypes
1	CRS, Bapatla	H-218
2	CARS, Jagdalpur	CARS-8, CARS-10
3	CCARI, Goa	Tiswadi-3, Tudal-1, HB22/05
4	RFRS, Vengurle	H-3043, H-2873
5	CRS, Bhubaneswar	C-136, D-21, E-22
6	DCR, Puttur	H-126, H-130, NRC-301, NRC-493 and V-7

BHUBANESWAR

The experiment was laid out on 4th December, 2019. Now the plants are at vegetative stage. Data recording on different vegetative and flowering parameters will start with the onset of cashew fruiting season for the year 2020-21. However, flowering has been observed in one plant of 'E' code.

JAGDALPUR

The experiment was laid out during August 2019. The experimental findings on vegetative parameters of genotypes are presented in Table 1.31. The data revealed that there were significant difference among the genotypes studied under Bastar region for vegetative characters like plant height and canopy spread. The maximum plant height was recorded in 'F' which was at par with 'G', 'K', 'M', J', 'E', 'P' and 'L'. The maximum canopy spread in east west direction and north south direction was observed in 'J' and 'F' respectively.

Table 1.31 : Early vegetative growth parameters of cashew genotypes in Bastar region

S. No.	Genotypes	Plant height (m)	Canopy spread		Precocity
			E-W (m)	N-S (m)	
1	A	1.15	1.33	1.35	√
2	B	1.19	1.23	1.14	√
3	C	0.98	1.23	1.02	√
4	D	1.19	0.68	0.86	×
5	E	1.28	1.32	1.45	√

S. No.	Genotypes	Plant height (m)	Canopy spread		Precocity
			E-W (m)	N-S (m)	
6	F	1.41	1.45	1.51	√
7	G	1.39	1.10	1.27	√
8	H	1.05	0.98	0.70	√
9	I	1.17	1.22	1.35	√
10	J	1.26	1.59	1.09	√
11	K	1.38	1.35	1.42	√
12	L	1.26	1.05	1.09	√
13	M	1.36	1.37	1.13	√
14	N	1.06	1.20	1.32	√
15	O	1.28	1.52	1.23	√
16	P	1.30	1.52	1.50	√
Mean		NS	0.43	NS	-
S.E.(m) ±		0.14	0.15	0.18	-
CD at 5 %		0.20	0.21	0.25	-
C.V. (%)		19.71	20.54	25.07	-

JHARGRAM

Total Number of genotypes : 17

No. of replications : 2

No. of plants per genotype per replication : 3

Spacing : 6m x 6m

Design : Randomized Block Design

The trial has been initiated at the centre during 2019, so the plants are in growing stage.

MADAKKATHARA

Planting was done during September 2019 in Randomized Block design with two replications at 6m x 6m spacing. All recommended package of practices were followed as per KAU, POP. The plants are now at vegetative stage. Precocious flowering was observed in the genotypes E and Q during 2nd week of October 2020.

The growth parameters of 13 genotypes after one year of planting is presented in Table 1.32. There was no significant difference between the genotypes with respect to growth paramerters like height and canopy spread after one year of planting.

Table 1.32 : Growth parameters of bold nut genotypes at Cashew Research Station, Madakkathara during 2020

Genotypes	Height (cm)	Canopy diameter(cm)
C	107.87	98.62
D	119.75	79.87
E	145.00	101.50
F	124.00	107.37

Genotypes	Height (cm)	Canopy diameter(cm)
G	145.62	102.62
J	133.00	118.00
K	162.50	116.87
L	133.50	94.75
M	155.12	109.50
N	152.37	123.00
O	138.37	99.00
P	153.12	119.62
Q	138.87	91.25
SEm±	12. 57	12.82
CV (%)	12.78	17.31
CD @ 5%	NS	NS

PILICODE

Data recorded for the first year is furnished hereunder. Highest plant height was observed in germplasm, A (96.25cm), D (95.13) and O (93.38 cm). Lowest was observed in germplasm I (62.00 cm). Highest girth was observed in germplasm O (6.55 cm) which was statistically on par with K (6.36 cm), Q (6.13 cm) and E (6.13cm),). Least was observed in germplasm J (4.81cm).

Table 1.33 : Biometric observations on the germplasm planted in 2019 (2019-20)

Germplasm	Plant height (cm)	Trunk girth (cm)
A	96.25	5.66
B	87.88	5.63
C	88.00	5.58
D	95.13	6.01
E	82.88	6.13
F	70.63	5.75
G	82.75	5.24
H	72.13	5.04
I	62.00	5.00
J	76.38	4.81
K	84.75	6.36
L	83.38	5.59
M	87.63	5.95
N	72.75	5.89
O	93.38	6.55
P	88.13	5.80
Q	68.13	6.10
SEm ±	**5.48**	**0.28**
CD @ p=0.05	**16.42**	**0.83**
CV%	**9.46**	**6.86**

VENGURLA

Planting material collected from DCR, Puttur during Sept., 2019 and shifted in big size bag for healthy growth. The trial being laid out as per design in June, 2020 at Vengurla centre (after cutting of old trees, uprooting and cleaning of plot). The trial is in initial stage and growth of all the experimental grafts is satisfactory.

The initial soil properties of the experimental plot was analyzed and it is revealed from data that the soil of the experimental site is lateritic clay loam in texture and moderately acidic (pH 5.58) in reaction and showed safe limit of electrical conductivity (0.148 dSm^{-1}) for plant growth. Soil was high in organic carbon content (27.90 g/kg), low in available nitrogen content (238.30 kg ha^{-1}) and available phosphorus content medium (14.74 kg ha^{-1}). It showed very high content of available potassium (670.50 kg ha^{-1}). As far as the micronutrients in soil were concerned, it indicated sufficient range of available Iron (54.35 ppm), Manganese (11.89 ppm), Copper (3.14 ppm) and Zinc (1.26 ppm) content.

VRIDHACHALAM

The trial has been initiated with the planting materials (13 types) collected from DCR, Puttur during 2019 and the plants are under vegetative stage. The yield data will be recorded from the year 2022.

II. CROP MANAGEMENT

Hort. 1a : Nutrient management for yield maximization in cashew

Centres: East Coast :	Bhubaneshwar
West Coast :	Paria
Plains / others:	Hogalagere

Objective : To investigate the effect of nutrient management approaches on growth, yield and soil properties

Treatments:

T_1: 100% Recommended Dose of N, P and K Fertilizer (RDF)*
T_2: 100% RDF+10kg FYM / plant / year
T_3: 100% RDF+10kg FYM / plant / year + foliar spray of major nutrients (3% Urea+0.5% H_3PO_4+1% K_2SO_4)
T_4: 100% RDF+10kg FYM / plant / year + foliar spray of secondary and micronutrients (0.5% Zn SO_4+0.1% Solubor**+0.5% $MgSO_4$)
T_5: 100% RDF+10kg FYM / plant / year + foliar spray of major nutrients (3% Urea+0.5% H_3PO_4+1% K_2SO_4) + foliar spray of secondary and micronutrients (0.5% Zn SO_4+0.1% Solubor+0.5% $MgSO_4$)
T_6: Control
*100% RDF = The dose of N, P and K fertilizer as per the centre's recommendation
**Solubor = Source of fertilizer for Boron

BHUBANESWAR

The experiment was initiated during the year 2014 with four replications and six treatments in cashew variety Balabhadra at a spacing of 7m x 7m. Significant differences were noticed among the treatments with respect to plant height, trunk girth, canopy height, nut weight and nut yield/plant. The treatment T_5 i.e.100% RDF+10 Kg FYM along with foliar spray of major nutrients (3% Urea + 0.5% H_3PO_4+ 1% K_2SO_4), secondary and micro-nutrients (0.5% $ZnSO_4$+0.1% Boron+0.5% $MgSO_4$) recorded significantly highest nut weight (7.43g) and on par with the treatment T_4(7.25g). Similarly, significant highest nut yield (2.56 kg/plant) was obtained in treatment T_5 and it was superior over the rest of the treatments including the control. Lowest response with respect to all the growth and yield parameters was observed in the treatment T_6 i.e. control. The highest cumulative nut yield for fourth harvest was observed in the treatment T_5 (10.98 kg/plant) followed by T_3 (9.92 kg/plant) and T_4 (9.86kg/plant). The incidence of Tea Mosquito Bug infestation was low irrespective of the treatments.

It is revealed from the data that the treatment T_5 i.e application of 100% RDF+10 Kg FYM along with foliar spray of major nutrients (3% Urea + 0.5% H_3PO_4+ 1% K_2SO_4), secondary and micro-nutrients (0.5% $ZnSO_4$+0.1% Boron+0.5% $MgSO_4$) was the best treatment among all the six treatments with respect to all the growth and yield parameters.

Table 2.1 : Yield parameters of cashew at Bhubaneswar during 2019-20*

Treat-ments	Treatment details	Mean Apple Weight (gm)	Mean nut weight (gm)	Nut yield (kg/ plant)	Cum. nut yield (kg/plant) for 4th harvest	Tea Mosquito Bug infestation
T_1	100% recommended dose of NPK fertilizer (RDF) i.e.500:250:250g NPK/plant/ year	50.64	6.65	1.64	8.73	Low
T_2	100% RDF + 10kg FYM/plant/ year	51.25	6.73	1.81	9.34	Low

Treat-ments	Treatment details	Mean Apple Weight (gm)	Mean nut weight (gm)	Nut yield (kg/ plant)	Cum. nut yield (kg/plant) for 4th harvest	Tea Mosquito Bug infestation
T_3	100% RDF + 10kg FYM/plant/ year Foliar spray of major nutrients (3% Urea + 0.5% H_3PO_4 + 1% K_2SO_4	51.67	7.03	1.91	9.92	Low
T_4	100% RDF + 10kg FYM/ plant/year + Foliar spray of secondary and micro-nutrient 0.5% $ZnSO_4$+0.1% Solubor(Boron) + 0.5% $MgSO_4$	52.38	7.25	2.08	9.86	Low
T_5	100% RDF + 10kg FYM/ plant/year + Foliar spray of major nutrients(3% Urea + 0.5% H_3PO_4 +1% $K_2SO_{4)}$ + Foliar spray of secondary and micro-nutrient (0.5% $ZnSO_4$+0.1% Solubor(Boron) + 0.5% $MgSO_4$)	54.28	7.43	2.56	10.98	
T_6	Control	48.05	6.15	1.46	7.77	Low
	Mean	**51.38**	**6.87**	**1.91**		
	SEm±	**1.50**	**0.20**	**0.13**		
	CD at 5%	**4.53**	**0.60**	**0.40**		
	CV(%)	**5.86**	**5.79**	**14.03**		

***Plants were damaged by the cyclonic storm**

HOGALAGERE

The AICRP on Cashew, crop management research experiment of nutrient management for yield maximisation in cashew was carried out during the year 2019-20. The treatment-5 (T_5) i.e., cashew trees fed with 100% RDF + 10 kg FYM along with foliar spray of major nutrients (3% urea + 0.5 % H_3PO_4+1% K_2SO_4), secondary and micronutrients (0.5% $ZnSO_4$+ 0.1% solubor as boron source + 0.5% $MgSO_4$) was recorded significantly superior with relevant to vegetative parameters like stem girth (18.95cm), plant height (3.72m) except T_4(3.67m), canopy height (2.04m) except T_4 (1.96m) & canopy surface area (92.57m^2) but which was on par with T_4 (80.62 m^2). Whereas with relevant to yield parameters the treatment-5 (T_5) trees were elevated significantly superior over other treatments with respect to nut yield (12.10Kg/plant) and cumulative yield of 5 season harvest (42.32Kg/plant). However, treatment-5 (T_5) recorded numerically higher values in all the growth and yield attributing parameters over remaining treatments and the lowest values were recorded in T_6 i.e., control treatment which performed based only on nutrients available in soil. Along with this, the infestation of TMB was low irrespective of treatments (Table 2.2).

Table 2.2 : Influence of nutrient management approaches on reproductive parameters of cashew at HREC, Hogalagere during 2019-20

Treatments	Flowering duration (Days)	Mean apple weight (g)	Mean nut weight (g)	Nut yield (Kg/ plant)	TMB Infestation	Cumulative yield (Kg/ tree) (4th harvest)
T_1	120	37.49	7.40	9.90	low	33.88
T_2	123	37.52	7.42	10.30	low	35.52
T_3	124	37.64	7.43	10.60	low	37.71
T_4	125	37.86	7.44	11.05	low	38.21
T_5	127	37.92	7.46	12.10	low	42.32
T_6	118	37.43	7.34	8.42	low	28.78
SEm ±	1.035	0.16	0.02	0.23	-	1.11
CD@5%	3.12	0.49	0.05	0.69	-	3.36
CV	1.69	0.87	0.48	4.40	-	6.19

Hort.2: Fertilizer application in high density cashew plantations

Centres: East Coast : Bapatla

Plains / others: Hogalagere

This trial envisages identification of optimum population density for cashew and suitable fertilizer doses at different high density plantings for specific regional variety.

HOGALAGERE

The trial was conducted during 2019-20 with the combination of 3 spacing levels and 3 level doses of fertilizer treatments under split plot design. Among the spacing and fertilizer level interaction treatments there were no significant differences and irrespective of the treatments the tea mosquito bug (TMB) infestation was low. Looking from the view of productivity, S_3M_3 followed by S_3M_2 were best treatments because they accommodated more plants per unit area (Table 2.3).

Table 2.3 : Effect of spacing, fertilizers and Interaction of different spacing and fertilizer levels on yield contributing traits of Cashew at Hogalagere during 2019-20.

Treatments	Flowering duration (Days)	Apple weight (g)	Nut weight (g)	Nut yield (Kg/ plant)	TMB Infestation	Cumulative yield (3rd harvest) (Kg/ plant)
S_1M_1	120	35.63	7.16	4.40	low	11.52
S_1M_2	118	35.75	7.14	4.60	low	12.00
S_1M_3	120	36.02	7.21	4.74	low	12.24
S_2M_1	118	35.21	7.11	4.10	low	10.80
S_2M_2	120	35.42	7.15	4.30	low	11.16
S_2M_3	118	35.39	7.14	4.45	low	11.27
S_3M_1	118	35.15	7.08	3.80	low	10.17
S_3M_2	122	35.12	7.12	4.10	low	10.67
S_3M_3	122	35.16	7.16	4.15	low	10.65
Mean	**120**	**35.43**	**7.14**	**4.29**	**-**	**11.16**
S.Em±						
Spacing	0.60	0.12	0.02	0.04	-	0.10
Fertilizers	0.68	0.10	0.02	0.03	-	0.11
Spacing × Fertilizers	**1.13**	**0.19**	**0.03**	**0.06**	**-**	**0.19**
CD@5%						
Spacing	NS	0.47	NS	0.14	-	0.39
Fertilizers	NS	NS	NS	0.10	-	0.34
Spacing × Fertilizers	**NS**	**NS**	**NS**	**NS**	**-**	**NS**

Hort.3: Drip irrigation trial

Centres:: Plains / others: Jagdalpur and Hogalagere

The trial aims at studying the response of cashew to supplementary irrigation during flushing and flowering phases and to work out the critical stages of irrigation.

Treatments : 5

T1 : No Irrigation
T2 : Irrigation 20% of Cumulative Pan Evaporation (CPE).
T3 : Irrigation 40% of Cumulative Pan Evaporation (CPE).
T4 : Irrigation 60% of Cumulative Pan Evaporation (CPE).
T5 : Irrigation 80% of Cumulative Pan Evaporation (CPE).

Spacing = 7 x 7m
Variety = Chintamani-1
Vengurla-7
VRI-3

HOGALAGERE

During the experiment Treatment-5 (T5) i.e. 80% of irrigation on the basis of CPE was found to be significantly superior over other levels of irrigation in relevance to vegetative parameters like plant height (3.86m), canopy height (2.22m), canopy spread (E-W;6.25m & N-S;6.79m), mean canopy diameter (6.80m), mean canopy surface area (137.1 m^2), ground area covered by plant canopy (56.77%) and T5 was followed by T4, T3, T2 and T1. The least growth parameters values were observed in Treatment-1 (Table). Where as in case of yield parameters i.e. nut yield per plant and cumulative nut yield per plant were also significantly elevated in Treatment-5 12.05 kg per plant and 42.45 kg per plant respectively. However remaining yield contributing parameters recorded numerically higher values such as mean apple weight (37.48 g) & mean nut weight (7.20 g). The infestation of TMB was recorded low in all the treatments.

Looking into the performance of all the treatments, the Treatment-5 (T5) i.e., 80% of irrigation on the basis of CPE especially after 50% of flowering from January to April summer period was found to be the best treatment compared to other treatments.

Table 2.4 : Influence of different levels of drip irrigation on yield parameters of cashew at HREC, Hogalagere during 2019-20

Treatments	Flowering duration (Days)	Mean apple weight (g)	Mean nut weight (g)	Nut yield (Kg/ plant)	TMB Infestation	Cumulative yield (Kg/ plant) (4 harvests)
T_1	118	37.01	7.02	8.10	27.08	Low
T_2	121	37.08	7.11	9.84	31.92	Low
T_3	123	37.11	7.14	10.34	34.55	Low
T_4	124	37.35	7.16	10.83	36.97	Low
T_5	124	37.48	7.20	12.05	42.45	Low
SEm ±	0.60	0.13	0.02	0.09	0.48	-
CD@5%	1.85	0.42	0.09	0.29	1.49	-
CV	0.98	0.74	0.82	1.84	2.80	-

Table 2.5 : Table depicting the mean values of cumulative pan evaporation and quantity of water applied to plants based on CPE values for different treatments during the year 2019-20 (January - April 2020)

Month	Evaporation rate (mm)	20% CPE (litres/plant/ day)	40% CPE (litres/plant/day)	60% CPE (litres/plant/ day)	80% CPE (litres/plant/ day)
January	5.00	21.89	43.78	65.67	87.56
February	4.93	21.59	43.18	64.76	86.35
March	6.55	28.67	57.34	86.01	114.68
April	6.61	31.06	62.12	93.18	124.23
Average	**5.91**	**26.37**	**52.74**	**79.11**	**105.49**

T1= Control, T2= 20% CPE, T3=40% CPE, T4= 60% CPE, T5=80% CPE

Table 2.6 : Weather parameters of HREC, Hogalagere 2020

Month	Rainfall (mm)	Rainy days (No.s)	Temperature (°C)		Relative Humidity (%)		Wind speed (km/hr)
			Max. (average)	Min. (average)	Max. (average)	Min. (average)	Max. (average)
January	0.0	0	28.15	15.76	90.23	42.16	18.83
February	0.0	0	30.06	17.42	87.62	34.90	24.07
March	0.0	0	34.67	19.96	80.29	32.84	22.38
April	39.4	3	35.48	21.24	83.87	32.93	22.07

JAGDALPUR

The trial has been initiated during 2018 with the variety Vengurla-4. All five treatments were replicated four times. Each treatments will be imposed in four plants per replication. The drip irrigation system has been established in experimental plot. Evapotranspiration data of last 30 years has been collected and mean values will be used for imposing the irrigations levels.

CONCLUDED TRIALS

CENTRE : RFRS, VENGURLE

Treatments	:	5 T_1 No irrigation T_2 Irrigation 20% of CPE T_3 Irrigation 40% of CPE T_4 Irrigation 60% of CPE T_5 Irrigation 80% of CPE
Replications	:	Four
Variety	:	Vengurla-7
Spacing	:	5m x 5m
Year of planting	:	1999
Year of irrigation start	:	2000
Year of completion		2016-17
Year of concluding of trial	:	2018 (As per the decision taken in AGM-2017 held at ICAR-DCR, Puttur during 21st -23rd December, 2017)

An experiment initially planted at a spacing of 5m x 5m with cashew variety Vengurla-7 during the year 1999 and application of irrigation treatments was started in the year 2000. Due to overcrowding of branches and reduction in yield at the 10th year (2010-11), the experimental trees were diagonally thinned as per the decision taken in Annual Group Meeting of Scientists of AICRP-Cashew held at TNAU, Coimbatore during the year 2011. After diagonal thinning, yield of the experimental trees was found increased.

The various growth and yield attributing observations of the trial during the period of investigation (2003-04 to 2016-17) were recorded.

On the basis of sixteen years (2001-2016) pooled data it is revealed that, application of irrigation @ 80 % CPE (T_5) recorded significantly higher mean pooled fruit set (35.9/m^2), number of nut/panicle (6.44), nut weight (9.6g) and apple weight (72.5g). Considering the last 6 years pooled yield data during 2011-12 to 2016-17 i.e. after diagonal thinning; the data revealed that application of drip irrigation @ 80% CPE (T_5) recorded the highest mean pooled yield of 9.43 kg/tree and 1.89 ton/ha and superior over rest of the treatments. This treatment T_5 recorded 62.0% increment of yield over control. So far as the economics of the trial is concerned, the application of irrigation @ 80 % CPE (T_5) had recorded the highest cumulative net returns of Rs. 6,97,591/- per ha with highest C:B ratio 1:3.18.

Recommendation:

Application of drip irrigation @ 80% CPE i.e. 90.4 ltr in January, 101.7 ltr in February, 120 ltr in March and 133.36 ltr during April per tree per day is recommended.

Hort.4: Expt.2 High density planting – Observational trials

Centres: East Coast : Bapatla and Vridhachalam

Plains / others: Jagdalpur

The trial aims to identify the optimum population density for cashew to maximize the returns per unit area.

BAPATLA

As per the recommendations of AGM held at Vridhachalam limb pruning was done at 4x4 m spacing up to 1m height on 10.09.2017.

Note:

1. All the limb pruned plants showed emergence of new shoots within a month.
2. Control measures were taken for CSRB by Spraying of Chloripyriphos@2ml/liter.
3. 25% of the trees died due to CSRB infestation after limb pruning.

Fig . Development of canopy in 4x4m spacing after limb pruning

During the year 2019-20, observations were recorded in 8x8m spacing with respect to the mean plant height (5.42m), mean canopy height (5.07m), mean trunk girth (97.00 cm), mean canopy spread (9.10m), mean canopy surface area (97.29 m^2) and percentage ground area coverage by canopy (101.57 m^2).

Flowering duration was recorded as 99 days in 8x8m spacing trial, whereas mean number of flowering laterals, mean number of nuts/m^2 and mean number of nuts per panicle was found to be 9.60, 12.30 and 2.40 respectively in 8x8m spacing trial.

Table 2.7 : Yield parameters of cashew in normal and high density planting at Bapatla centre

Spacing	Nut weight (g)	Apple weight (g)	Nut yield kg/tree (Harvest No.13)	Nut yield (kg/ha)	Cumulative Nut Yield (kg/tree) (2008-2020)
4m x 4m	5.16	52.30	1.80	1125.0	16.99
8m x 8m	5.42	56.35	3.12	486.72	33.88

The mean nut yield was recorded highest in 8x8 m spacing (3.12 kg/tree) and cumulative nut yield was also recorded highest in 8x8 m spacing (33.88 kg/tree) for thirteen annual harvests.

Table 2.8 : Yield and B: C ratio in high density trials at Bapatla Centre

Harvest	Yield (kg/ha.)		Net returns (Rs/ha.)		B.C.ratio	
	(4m x 4m)	(8m x 8m)	(4m x 4m)	(8m x 8m)	(4m x 4m)	(8m x 8m)
1st harvest	268.75	50.00	-8875.00	-3240.00	-0.35	-0.51
2nd harvest	400.00	71.76	-1000.00	-1934.4	-0.04	-0.31
3rd harvest	515.00	112.5	5350.00	-292.5	0.19	-0.04
4th harvest	587.5	142.0	10062.50	2210.00	0.35	0.31
5th harvest	2000.0	436.8	111875.00	23556.00	3.97	3.35
6th harvest	1825	567.8	96500.00	31946.00	3.08	4.09
7th harvest	1487.5	650.52	80312.5	40987.500	2.57	5.25
8th harvest	1012.5	486.7	51000	18936.00	1.76	2.05
9th harvest	662.50	605.28	28750	23422.00	0.43	1.42
10th harvest	562.50	399.36	26250	19936.00	0.60	1.00
11th harvest	-	686.40	-	48640.00	-	2.43
12th harvest	687.50	436.80	30000	15000.00	1.15	0.83
13th harvest	1125.0	486.72	50000.00	18937.00	1.25	0.94

JAGDALPUR

The present trial was replanted in the year 2019 as per recommendation of AGM-2018 with variety NRCC selection-2. The trial is in the initial experimentation and the crop is in the initial stage of vegetative growth. All the plants in each block were established. The early vegetative growth of plants in both the spacing is presented in Table 2.9.

Table 2.9 : Early growth parameters in spacing trial

Spacing	Plant height (m)	Canopy spread	
		E-W (m)	N-W (m)
4 x 4 m	0.78	0.71	0.75
8 x 8 m	0.80	0.71	0.79

Fig . High density trial planting

Hort.6: Intercropping in Cashew

Centres: East Coast :	Bapatla, Jhargram and Vridhachalam
West Coast :	Madakkathara, Paria and Vengurla
Plains / others:	Darisai and Kanabargi

The objectives of this trial are to identify compatible intercrops with cashew in the initial stages of orchard development, to study the economic benefits of inter-cropping system and to work out a soil fertility management strategy for the intercropping system.

BAPATLA

Among the different intercrops studied during the initial years of cashew the treatment T2 (Cashew + Marigold) recorded maximum yield of intercrop 2753 kg/ha and was superior over rest of the treatments. This was followed by T_1 (Cashew + China aster) of 1164kg/ha and T_4 (Cashew + Crossandra) recorded the lowest yield (201 kg/ha).

Fig. Marigold as a inter crop in cashew

Further, the economics of growing intercrops seen from the data presented in table 2.10 showed that growing Marigold as inter crop in cashew orchard gave the higher net profit of Rs.93700/- with BC ratio of 2.34 followed by China aster Rs.81400/- and BC ratio of 1.81 and the lowest net profit was obtained in Chrysanthemum Rs.49800/- with BC ratio 1.00.

Table 2.10 : Yield and economics of cashew and inter crops in intercropping trial at Bapatla centre

Treatment details	Yield of intercrop		Yield of cashew		Cost of cultivation (Rs./ ha)			Returns (Rs./ha)				B:C ratio
	Kg/ plot	Q/ha	Kg/ tree	Q/ha	Cashew	Inter crop	Total	Cashew	Inter crop	Total	Net	
T1 Cashew + China Aster	7.45	11.64	6.40	9.98	20000	25000	45000	79840	46560	126400	81400	1.81
T2 Cashew + Marigold	17.62	27.53	6.30	9.83	20000	20000	40000	78640	55060	133700	93700	2.34

Treatment details	Yield of intercrop		Yield of cashew		Cost of cultivation (Rs./ ha)			Returns (Rs./ha)				B:C ratio
	Kg/ plot	Q/ha	Kg/ tree	Q/ha	Cashew	Inter crop	Total	Cashew	Inter crop	Total	Net	
T3 Cashew + Chrysanthemum	3.59	5.61	6.20	9.67	20000	30000	50000	77360	22440	99800	49800	1.00
T4 Cashew + Crossandra	1.29	2.01	6.10	9.52	20000	30000	50000	76160	60300	136460	86460	1.72
T5 Cashew Alone	-	-	5.00	7.80	20000	---	20000	62400	---	62400	42400	2.12
C.D.@5%	0.84	2.26	0.93	1.45								
S.Em. ±	0.26	0.70	0.30	0.46								

Sale Price (Rs/Kg)

Raw Cashew Nuts : 80.00
China aster : 40.00
Marigold : 20.00
Chrysanthemum : 40.00
Crossandra : 300.00

DARISAI

Table 2.11 : Yield and economics of cashew and intercrops in intercropping trial at ZRS, Darisai Centre during the year 2019-20

Treat-ment details	Mean Yield of intercrop	Mean Yield of cashew	Cost of Cultivation (Rs./ha)			Returns (Rs./ha)				B:C
	Q/ha	Q/ha	Cashew	Inter-crop	Cashew + Intercrop	Cashew	Inter-crop	Total	Net Profit	Ratio
T1	105.32	7.54	52038	46777	98815	131950	242236	374186	275371	2.79
T2	209.85	8.65	52038	56364	108402	151375	251820	403195	294793	2.72
T3	40.46	7.73	52038	28586	80624	135275	121380	256655	176031	2.18
T4	49.29	8.12	52038	42331	94369	142100	172515	314615	220246	2.33
T5	---	9.73	52038	---	52038	170275	---	170275	118237	2.27

Treatment Details :

- T1- Cashew (Var.V4) + Tomato (Var. Swarn Samridhi)
- T2- Cashew (Var.V4) + Cabbage (Var. Golden acre)
- T3- Cashew (Var.V4) + Frenchbean (Var. Arka Komal)
- T4- Cashew (Var.V4) + Pea (Var. Arkel)
- T5- Cashew (Var.V4)

Selling Price :

Cashew Rs.175 /kg, Tomato Rs.23/kg, Cabbage Rs.12/kg, French bean Rs.30/kg,

Pea Rs.35/kg.

Cashew + Tomato recorded the highest B:C ratio 2.79 followed by cashew + cabbage 2.72.

JHARGRAM

Cashew Variety BPP-8 spaced at 4mx4m and Cowpea (Local), cluster bean (Pusa Nababahar), soyabean (Local), black gram (Local) and turmeric (Local) were grown as intercrops with the newly planted plantation leaving 1.0m space from the base of the cashew plants. The table presents the performance of cashew plants under intercropping system. The results showed that the treatments were on par with respect to the growth and yield parameters of the cashew plants studied. The different intercrops did not have any special impact on the growth and yield of cashew plants at the age of 3 years.

The available space for intercrop was 50 %. Soyabean plants were destroyed by the wild rabbits, so could not produce beans. Cost benefit ratio revealed that turmeric was the most profitable crop (1: 6.40) in the 3rd year of planting of high density cashew plantation followed by cluster bean (1: 4.75). Therefore, the cost benefit revealed that it is better to grow intercrops instead of growing cashew as a sole crop even at third year after planting to maximise the per unit area income during the initial years of cashew plantation.

Table 2.12 : Performance of cashew plants in the intercropping system at Jhargram

Crop combination	Tree ht. (m)	Stem girth (cm)	Spread (m)	Canopy area (m^2)	Yield /tree (kg) 1st harvest	Yield/ha (Kg)
Cashew + Cowpea	2.14	28.33	1.04	2.15	0.47	2.93
Cashew + Black Gram	2.20	31.50	1.12	2.55	0.50	3.15
Cashew + Cluster bean	2.29	31.67	1.19	3.02	0.54	3.38
Cashew + Turmeric	2.22	29.83	1.11	2.59	0.45	2.79
Cashew alone	2.50	30.33	1.20	3.46	1.23	7.68
S.Em ±	0.05	2.24	0.05	0.28	0.35	
C.D. at 5%	0.15	6.44	0.14	0.81	1.01	
CV %	3.93	12.77	7.66	17.81	9.23	

Cashew + Cowpea

Cashew + Black Gram

Table 2.13 : Yield and economics of cashew and intercrops in intercropping trial at Jhargram Centre during the year 2019 - 20

Treatment details	Yield of intercrop	Yield of cashew *	Cost of Cultivation (Rs./ha)			Returns (Rs./ha)				C:B Ratio
	Q/ha	Q/ha	Cashew	Inter-crop	Cashew + Intercrop	Cashew	Inter-crop	Total	Net	
Cashew + Cowpea	12.70	2.93	23052	8000	31052	29300	25400	54700	23648	1:1.76
Cashew + Black Gram	6.00	3.15		10456	33508	31500	27000	58500	24992	1:1.75
Cashew + Cluster bean	40.25	3.38		10580	33632	33800	161000	194800	161168	1:4.79
Cashew + Turmeric (Green)	100	2.79		21250	44302	27900	300000	327900	283598	1:6.40
Cashew alone	--	7.68		--	23052	76800		76800	53748	1:2.33

Available area for intercropping (Age 3 year) : 50%
Price of intercrop :: Cowpea : Rs.20 /Kg, Black gram : 45 Rs. /Kg, Turmeric : 30 Rs. /Kg, and Cluster Bean : 40Rs. /Kg.
Price of raw cashew nut : Rs. 100/kg

KANABARGI

Year of planting (intercrop) : 2016
Location : Horticultural Research & Extension Centre, Kanabargi
Design : RBD
Treatments : 6
Replications : 4

The trial was laid out for third year by planting six intercrops in the existing cashew plantation (Planted in the year 1992 and limb pruned) spaced at 6m x 6m apart at Kanabargi. Protective irrigation was given during longer dry spells. Intercrops included for the study was China aster; Gaillardia, Chrysanthemum, Cabbage, Cauliflower, Knol khol in a plot of 6 m x 4 m size.

Table 2.14 : Yield and economics of cashew based intercropping system based on mean yield at HREC, Kanabargi

Sl. No.	Intercrop	Estimated yield (q/ha)	Cost of cultivation of intercrop (Rs/ ha)	Total returns from intercrops (Rs./ha)	Net profit from intercrop (Rs./ha)
1	Cabbage	14.24	18980	12759.04	-6220.96
2	Cauliflower	7.42	10881	5500.16	-5380.84
3	Knol khol	23.48	23791	25452.32	1661.32
4	Gaillardia	23.48	68532	100964.00	32432.00
5	China Aster	16.22	32318	64880.00	32562.00

Sl. No.	Intercrop	Estimated yield (q/ha)	Cost of cultivation of intercrop (Rs/ ha)	Total returns from intercrops (Rs./ha)	Net profit from intercrop (Rs./ha)
6	Chrysanthemum	17.66	46210	84768.00	38558.00

Cabbage @ Rs. 8.96/kg, Cauliflower @Rs. 7.48/kg, Knol khol @Rs. 10.84/kg,
Gaillardia @ RS. 43/kg, China Aster 40/kg, Chrysanthemum @ Rs. 48/kg
(Rates as per APMC)

Mean cashew nut yield per tree as influenced by intercropping systems.

Mean cashew nut yield was significantly influenced by different intercrops. Highest cashew yield per plant was recorded when inter cropped with Knol khol (5.74 kg/plant) followed by Cashew alone (5.72 kg/ plant). Minimum yield was recorded in Cashew and Gaillardia (5.62 kg/plant).

Table 2.15 : Yield of cashew (Main crop) and economics of cashew based intercropping systems at HREC, Kanabargi

Sl. No.	Intercropping system	Cashew nut yield (Mean)		Gross Expenditure (Main crop + Intercrop) (Rs/ha)	Gross income (Main crop + Intercrop) (Rs/ha)	Net Profit (Main crop + Intercrop) (Rs/ha)	Benefit Cost Ratio (BCR)
		Kg/ tree	Q/ha (Estimated)				
1	Cashew + Cabbage	5.64	15.62	58880.00	161149.04	102269.04	1.73
2	Cashew + Cauliflower	5.66	15.67	50781.00	154365.16	103584.16	2.03
3	Cashew + Knol khol	5.74	15.89	63691.00	176407.32	112716.32	1.76
4	Cashew + Gaillardia	5.62	15.56	108432.00	248784.00	140352.00	1.29
5	Cashew + China Aster	5.64	15.62	72218.00	213270.00	141052.00	1.95
6	Cashew + Chrysanthemum	5.68	15.73	86110.00	234203.00	148093.00	1.71
7	Cashew alone	5.72	15.84	39900.00	150480	110580.00	2.77

Maximum net profit from main crop and intercrop was recorded from Cashew + Chrysanthemum (Rs 1,48,093.00) followed by Cashew + China Aster (1,41,052.00). Minimum was recorded in Cashew + Cabbage intercrop (Rs. 102269.00). Highest benefit to cost ratio was recorded in cashew alone (2.77) followed by Cashew + Cauliflower intercrop (2.03) and Cashew + China Aster (1.95) whereas minimum was recorded in Cashew + Gaillardia (1.29).

MADAKKATHARA

Experimental details:

Design : RBD
Replication : 3
Treatments : 7

Treatment details :

Sl. No.	Treatments
T_1	Cashew + Bhindi (*Abelmoschus esculentus*)
T_2	Cashew + Cowpea (*Vigna ungiculata*)
T_3	Cashew + Brinjal (*Solanum melongena*)
T_4	Cashew + Tomato (*Solanum lycopersicum*)
T_5	Cashew + Amaranthus (*Amaranthus* sp.)
T_6	Cashew + Chilli (*Capsicum annum*)
T_7	Control (Cashew alone)

Selling Price : Cashew @ Rs. 110/kg, Bhindi @ Rs. 20/ kg, Cowpea @ Rs.40/kg, Brinjal @ Rs. 20/kg, Tomato @ Rs.24/kg, Amaranthus @ Rs.18/kg, Chilly @ Rs. 40/kg

Yield and economics of vegetables as intercrop in cashew plantation are given in Table 2.16. Among six vegetables grown as intercrop, bhindi recorded the highest yield of 113.76 Q/ha followed by chilli with a yield of 75.18 Q/ha. Lowest yield was recorded for cowpea (4.06 Q/ha).

Economic analysis revealed a highest B:C ratio of 2.19 in the treatment intercropped with chilli followed by bhindi (1.32). The high yield and market price of these vegetable crops resulted in highest BC ratio. Hence, growing high value seasonal vegetables as intercrop in the initial stage of orchard development has economic benefit.

Table 2.16 : Yield and economics of cashew and intercrops in intercropping trial at Madakkathara centre (2019-20)

Treatments	Yield of intercrop	Yield of cashew	Cost of cultivation (Rs./ha)			Returns (Rs. /ha)				B:C ratio
	Q/ha	Q/ha	Cashew	Intercrop	Total	Cashew	Intercrop	Total	Net	
T_1	113.76	1.54	20000	85000	105000	16940	227520	244460	139460	1.32
T_2	4.06	1.45	20000	92000	112000	15950	16240	32190	-79810	-0.71
T_3	6.7	1.34	20000	80000	100000	14740	13400	28140	-71860	-0.72
T_4	33.26	1.51	20000	100,000	120000	16610	79824	96434	-23566	-0.19
T_5	54.3	1.77	20000	70000	90000	19470	97740	117210	27210	0.30
T_6	75.18	1.71	20000	80000	100000	18810	300720	319530	219530	2.19
T_7	-	1.66	20000	-	20000	18260		18260	-1740	-0.08
SEm±	6.34	1.12								
CV (%)	22.94	13.37								
CD @ 5%	19.98	NS								

Experimental details (2020) :

The experiment was laid out in Randomized block design with seven popular aromatic spice crops having medicinal value as intercrop in cashew. The crops were planted in three replications during May 2020. The treatment details are given below.

Sl. No.	Treatments
T_1	Cashew + Ginger (*Zingiber officianale*)
T_2	Cashew + Turmeric (*Curcuma longa*)
T_3	Cashew + Black Turmeric (*Curcuma caesia*)
T_4	Cashew + Manjakoova (*Curcuma angustifolia*)
T_5	Cashew + Mango Ginger (*Curcuma amada*)
T_6	Cashew + Kasthoorimanjal (*Curcuma aromatica*)
T_7	Cashew + Galagal (*Alpinia* sp.)
T_8	Control (Cashew alone)

PARIA

The yield and economics of intercropping in cashew is presented in the Table 2.17. The highest inter crop yield/ha was recorded in treatment cashew + coriender (T1) which was followed by treatment cashew + spinach (T3) and treatment cashew + fenugreek (T2) in gaining higher yield of intercrops. Highest net return of Rs. 112604 ha^{-1} was observed under the inter crop of coriender (T1) alongwith highest benefit: cost ratio of 3.26. It was followed by the inter crop of spinach (T3) with benefit: cost ratio of 2.50.

Table 2.17 : The yield and economics of intercropping in cashew

Tret.	Yield of IC	Yield of Cashew	Cost of Cultivation(Rs./ha)			Returns(Rs./ha)				B:C Ratio
	q/ha	q/ha	Cashew	IC	Cashew+IC	Cashew	IC	Total	Net	
T1: C + Coriender	43.00	4.77	11500	23000	34500	52504	94600	147104	112604	3.26
T2: C + Fenugreek	33.00	3.91	11500	23000	34500	43003	72600	115603	81103	2.35
T3: C + Spinach	45.00	1.97	11500	23000	34500	21616	99000	120616	86116	2.50
T4: C+ Amaranthus	8.50	2.91	11500	23000	34500	32032	21250	53282	18782	0.54
T5: Cashew alone	0.0	2.53	11500	0	11500	27816	0	27816	16316	1.42
	SEm.±	0.64								
	CD @5%	NS								
	CV %	34.38								

VENGURLE

Design : R. B. D.

Replication : Five

Treatments : Five different inter-crops

T_1 Cashew + Yardlong bean (Wali) *(Vigna unguiculata sp. sesquipedalis)*
T_2 Cashew + French bean-Ghewda (*Phaseolus vulgaris*)
T_3 Cashew + Cowpea (*Vigna unguiculata)*
T_4 Cashew + Chilli (*Capsicum annum)*
T_5 Cashew + Brinjal (*Solanum melongena*)
T_6 Control (Cashew alone)

Spacing : Cashew - 7m x 7m (204 plants/ha)
Area planted with intercrop/ha- 4900 sq. m.
Intercrop plot size - 25 sq. m. (5m x 5m)
No. of intercrop plots/ha. – 196

Sole intercrop : Sole intercrops are planted near the experimental plot for comparison.

Year of start : *Rabi* season, 2018

Cashew variety : Vengurle-9 (planted in December, 2016)

Cashew spacing : 7 x 7 m

Package of practices : Recommended package of practices including recommended dose of fertilizers and plant protection were followed for both main crop cashew and intercrops. Details of intercrop plantation at Vengurla centre presented in Table.

Intercropping in cashew with new sets of regionally important intercrops trial (second year) was laid out in *Rabi* season, 2019 at AICRP-Cashew, Vengurla centre. Yield observation of both (main & inter-crops) was recorded during 2019-20 and presented in Table 2.18.

From the data presented in Table, it is observed that treatment Yardlong bean (T_1) recorded significantly the highest yield of 70.99 q/ha and superior over rest of the treatments. The maximum main crop cashew yield was recorded when Yardlong bean (T_1) intercropped with cashew (6.77 q/ha) however it was at par with treatment T_3 - Cashew + Cowpea (5.73 q/ha).

The maximum net returns of Rs. 2,69,372/- was obtained from cashew + Yardlong bean (T_1) with C:B ratio of 1:3.81.

Table 2.18 : Details of intercrop plantation at Vengurla centre

Treatment		Variety	Plot size (m^2)	Spacing (cm)	Duration (Days)	No. of harvests
T_1	Cashew + Yardlong bean	Konkan Wali	25	60 x 60	156	13
T_2	Cashew + French bean	Konkan Bhushan	25	60 x 60	143	11
T_3	Cashew + Cowpea	Konkan Sadabahar	25	45 x 30	103	7
T_4	Cashew + Chilli	Konkan Kirti	25	60 x 45	139	7
T_5	Cashew + Brinjal	Konkan Prabha	25	60 x 60	178	11
T_6	Cashew (Control)	Vengurle-9	-	7m x 7m	-	-

Table 2.19 : Yield and economics of cashew and intercrops in intercropping trial at Vengurla Centre during 2019-20

Treatment details	Yield of inter-crop	Yield of cashew	Cost of Cultivation (Rs./ha)			Returns (Rs./ha)				C:B Ratio
	Q/ha	Q/ha	Cashew	Inter-crop	Cashew + Intercrop	Cashew	Inter-crop	Total	Net	
T_1: Y. L.bean	**70.99**	**6.77**	64766	31062	95828	81240	283960	365200	**269372**	**1:3.81**
T_2: F. bean	16.07	5.08	64766	20436	85202	60960	64280	125240	40038	1:1.47
T_3: Cowpea	20.14	**5.73**	64766	25732	90498	68760	120840	189600	99102	1:2.09
T_4: Chilli	11.69	4.61	64766	18034	82800	55320	46760	102080	19280	1:1.23
T_5: Brinjal	28.96	4.37	64766	19234	84000	52440	115840	168280	84280	1:2.00
S.Em.±	1.97	0.56	-	-	-	-	-	-	-	-
CD at 5%	5.91	1.65	-	-	-	-	-	-	-	-
CV%	14.91	24.74	-	-	-	-	-	-	-	-
T_6: Control Cashew alone	0	3.84	64766	0	64766	46080	0	46080	-18686	1:0.71

Area planted with intercrop/ha- 4900 sq. m.
Intercrop plot size - 25 sq. m.; No. of intercrop plots/ha. - 196

Price of produce (Rs. /kg): Yardlong bean - 40/kg; French bean - 40/ kg; Cowpea - 60/kg; Chilli - 40/kg; Brinjal - 40/kg.
Cashew raw nut - Rs.120/- per kg (University rate for the year 2019-20).

VRIDHACHALAM

Flower crops namely cosmos, zinnia and marigold were sown as intercrops in cashew VRI 3 plot (year of planting 2013) in an area of 20 cents during 2020-21. The annual flower crops sown in the experimental field is under vegetative stage and yield characters will be observed during December 2020 - January 2021.

Hort.7: Organic Management of Cashew

Centres: East Coast :	Bapatla, Bhubaneshwar and Vridhachalam
West Coast :	Madakkathara and Vengurla
Plains / others:	Darisai, Hogalagere and Kanabargi

The objective of this trial is to evaluate and standardize an organic management schedule for cashew cultivation to optimize the returns and to work out economic feasibility of organic farming systems over conventional farming.

Treatments:

T1 - 100 % N as FYM
T2 - 100 % N as FYM +Bio-fertilizers (Azatobacter + Azospirillum + PSB) 200 g
T3 - 50 % N as FYM + Bio-fertilizers (200g) + Rock phosphate
T4 - 100 % N as Vermicompost + Bio-fertilizers (200g)
T5 - Recycling of organic residue with the addition of 20 % cow dung slurry (20.0 % weight of organic residue as cow dung)
T6 - In situ green manuring / green leaf manuring to meet 100 % N
T7 - 25 % N as FYM + Recycling of organic residue + *in situ* green manuring green leaf manuring + Bio-fertilizers (200 g)
T8 - Recommended doses of fertilizer +10 kg FYM (Control)

BAPATLA

Techniques to be adopted:

Design	:	RBD
Variety	:	BPP-8
Spacing	:	7m X 7m
Year of planting	:	October,2014
Number of Replications	:	3
Number of Treatments	:	8
Number plants/treatment	:	6
Duration	:	12 years

Among the treatments, the highest mean plant height was recorded in T4 (3.14m) followed by T1 (3.06m) and T2 (2.88m). Highest mean canopy height was noticed in T4 (2.87 m) followed by T1 (2.79 m). The mean trunk girth was recorded highest in T4 (47.09 cm) followed by T3 (41.07 cm). The mean canopy spread was recorded maximum in T4 (4.56 m) followed by T2 (4.51 m) and canopy surface area was recorded maximum in T4 (26.20 m^2) followed by T2 (25.52).

The shortest flowering duration was recorded in T4 (78.0 days) and followed by T5 (86.0 days). With respect to mean number of nuts per square meter and mean number of nuts per panicle was found to be significant. The flowering intensity per square meter was highest in T4 (7.60) followed by T1 and T6 (7.20). The mean no. of nuts per square meter was found highest in T4 (7.69) followed by T1 (7.57). The mean no. of nuts per panicle was found maximum in T4 (1.70), T1 (1.56) followed by T1 (1.49).

Table 2.20 : Yield parameters of cashew in organic management at Bapatla Centre

Sl. No.	Variety/ Genotype	Nut weight [g]	Apple weight (g)	Shelling (%)	Nut yield /tree (kg) (3rd harvest) 2020	CNY kg/tree (2018-2020)
1.	T1	8.34	78.10	30.86	**4.50**	**11.42**

Sl. No.	Variety/ Genotype	Nut weight [g]	Apple weight (g)	Shelling (%)	Nut yield /tree (kg) (3rd harvest) 2020	CNY kg/tree (2018-2020)
2.	T2	**7.84**	76.90	30.28	4.80	11.35
3.	T3	8.12	74.24	31.39	3.80	9.67
4.	T4	8.02	**79.80**	**31.27**	**5.65**	**13.20**
5.	T5	**7.87**	69.80	31.06	4.00	9.10
6.	T6	**8.00**	69.70	31.14	4.10	9.40
7.	T7	8.00	68.50	**29.44**	4.20	9.63
8.	T8	7.59	73.60	30.84	4.40	10.26
	CD@5%	N.S.	3.28	N.S.	0.85	
	SEm ±	0.16	1.07	1.53	0.28	

With respect to mean nut weight and shelling percentage, they were found to be non-significant whereas the mean annual nut yield per tree and mean apple weight were found to be significant. Among the treatments, the mean nut weight was found maximum in T1 (8.34 g) followed by T3 (8.12 g) and T4 (8.02 g). The maximum mean annual nut yield per tree during the year was recorded in T4 (5.65 kg) followed by T2 (4.80 kg) and T1(4.50 kg). With regard to the mean apple weight, the highest was recorded in T4 (79.80g). The shelling percentage was recorded highest in T3 (31.39) followed by T4 (31.27). The cumulative nut yield was recorded highest in T4 (13.20kg/tree) for three annual harvests.

Fig. Organic management in cashew

DARISAI

Table 2.21 : Yield parameters of cashew under organic management at ZRS, Darisai centre during the year 2019-20

Treatment	Mean flowering laterals/m²	Mean nut wt. (g)	Mean apple wt. (g)	Mean annual nut yield (kg/plant) 5th Harvest	Cumulative nut Yield (kg/plant) for Five harvest
T1 - 100 % N as FYM	22.57	6.85	60.52	4.08	15.48
T2 - 100 % N as FYM + Bio-fertilizers (Azatobacter + Azospirillum + PSB) 200g	23.19	7.20	54.58	4.52	16.95

Treatment	Mean flowering laterals/m²	Mean nut wt. (g)	Mean apple wt. (g)	Mean annual nut yield (kg/plant) 5th Harvest	Cumulative nut Yield (kg/plant) for Five harvest
T3 - 50 % N as FYM + Bio-fertilizers (200g)	12.28	6.58	66.34	2.96	12.47
T4 - 100 % N as Vermicompost + Bio-fertilizers (200g)	22.14	7.02	59.17	4.27	15.85
T5 - Recycling of organic residue with the addition of 20 % cow dung slurry (20.0 % weight of organic residue as cow dung)	15.46	6.18	61.73	2.48	11.11
T6 – In situ green manuring / green leaf manuring to meet 100 % N	25.52	6.60	63.98	3.95	14.87
T7 - 25 % N as FYM + Recycling of organic residue + *In situ* green manuring / green leaf manuring + Bio-fertilizers (200g)	27.11	7.40	69.85	4.46	17.30
T8 - Recommended doses of fertilizer + 10 kg FYM (Control)	30.24	8.02	73.06	5.02	18.85
SEm±	1.68	0.35	2.43	0.26	0.32
CD (5%)	4.53	0.97	7.36	0.71	0.84
CV (%)	14.36	13.25	16.63	14.86	15.28

Recommended dose of fertilizer (N 500 gm, P_2O_5 250 gm & K_2O 250 gm) + 10 Kg FYM (Control) recorded the maximum nut yield / plant (5.02 Kg) which was statistically on par with T_2 (4.52 Kg) where 100% N + Bio-fertilizer 200gm/plant was applied and T_7 (4.46 Kg/plant) where, 25 % N as FYM + recycling of organic residue + *in situ* green manuring + Bio-fertilizer (200 gm/plant) was applied. On the basis of cumulative yield (Five harvests) T_8 (Control) was found significantly superior to all other organic treatments.

HOGALAGERE

The experiment was conducted during the year 2019-20. The different combination of organic manures, bio-fertilizers, naturally available rock phosphate, *in-situ* green manuring were applied in different quantity levels along with control i.e., recommended dose of fertilizers and FYM. Among the eight treatments T8 i.e., Recommended dose of fertilizers (500:250:250 NPK gram/tree/year) with 10 kg FYM and T7 i.e., 25% N as FYM + Recycling of organic residue + *In-situ* green manuring/green leaf manuring + BFC @ 200g /tree/year were on par in majority of yield contributing parameters such as flowering duration, mean nut weight, nut yield per tree and cumulative yield from season harvests.

However T8 recorded numerically higher values in both growth and yield attributing parameters. But when looking from the point of view of organic produce the treatment T7 was significantly superior over remaining organic combination treatments in terms of flowering duration 122 days, mean nut weight 7.12 gram, nut yield per plant 6.21 kg per plant and cumulative yield 14.86 kg per plant from 4 season harvest.

The infestation of TMB was low irrespective of the treatments. The overall performance of the treatment 7 was the best treatment compared to other treatments.

Table 2.22 : The influence of organic manures, bio-fertilizers and other organic sources on yield parameters of cashew at HREC, Hogalagere during 2019-20

Treatments	Flowering duration (Days)	Apple weight (g)	Nut weight (g)	Nut yield (Kg/ plant)	TMB Infestation	Cumulative yield (3 harvests)
T_1	120	34.75	6.90	5.24	Low	11.66
T_2	118	35.04	6.93	5.80	Low	13.22
T_3	120	34.78	6.88	5.00	Low	11.71
T_4	120	35.84	6.90	5.85	Low	12.92
T_5	118	34.56	6.82	4.50	Low	10.70
T_6	120	34.79	6.80	4.00	Low	10.01
T_7	122	35.96	7.12	6.21	Low	14.86
T_8	125	36.14	7.06	6.25	Low	14.81
SEm±	1.14	0.20	0.02	0.07	-	
CD@5%	3.47	0.63	0.08	0.22	-	
CV	1.64	0.12	0.71	2.39	-	

KANABARGI

Year of planting : 2011
Design : RBD
Replication : Three
Spacing : 6 m X 6m
Number of plant per replication : 5
No. of treatments : 8

Highest tree height (4.87m) trunk girth (62.64 cm) and canopy height (4.54 m) and Nut yield (11.09 kg/tree) was with 100% N from FYM + Bio fertilizer consortium (200g/tree/year). Whereas lowest yield was recorded in 100% N from vermi-compost + Bio fertilizer consortium (200g/tree/year) (7.70 kg/tree) (Table 2.23).

Table 2.23 : Vegetative and yield parameters of Cashew organic trial during the year 2019-20

Sl. No.	Treatments	Tree height (m)	Trunk girth (cm)	Trunk height (m)	Canopy height (m)	Canopy diameter (m)	Nut yield (kg/ tree)
1	100% N from FYM	3.88	62.64	0.50	3.38	4.95	9.06
2	100% N from FYM+Bio fertilizer consortium (200g/tree/year)	4.87	63.86	0.76	4.54	5.24	11.09
3	50% N from FYM+Bio fertilizer consortium (200g/tree/year)+rock phosphate	3.54	58.73	0.52	3.02	4.55	10.84
4	100% N from vermi-compost + Bio fertilizer consortium (200g/tree/year)	3.31	59.27	0.48	2.82	4.65	7.70
5	Recycling of organic residue with the addition of 20% cow dung slurry	3.43	61.19	0.43	3.01	4.69	10.82
6	In situ green manuring	3.23	51.81	0.55	2.82	4.17	8.35
7	25% N as FYM + recycling of organic residue + insitu green manuring	3.60	60.88	0.56	3.15	4.80	9.97

Sl. No.	Treatments	Tree height (m)	Trunk girth (cm)	Trunk height (m)	Canopy height (m)	Canopy diameter (m)	Nut yield (kg/ tree)
8	Recommended dose of fertilizer + 10kg FYM	3.66	63.41	0.59	3.19	4.93	8.78
	SEm±	0.11	2.29	0.09	0.15	0.43	0.41
	CV (%)	5.49	6.59	29.09	8.52	15.75	7.50
	CD 5%	0.35	6.95	0.28	0.48	1.30	1.25

MADAKKATHARA

Experimental details:

Design: RBD
Variety: Dhana
Spacing: 7m x 7m
No. of treatments: 8
No. of replications: 3
No. of trees per replication: 4

Table depicts the influence of treatments on the growth and yield parameters of cashew. No significant difference was observed among the treatments in terms of their response on growth and yield parameters studied.

Table 2.24 : Yield parameters of cashew under organic management at Madakkathara during 2020

Treatments	No. of panicles/m²	Nut wt. (g)	Apple wt. (g)	Yield (Kg/tree)	B:C ratio
T_1	7.31	9.067	55.847	4.12	1.31
T_2	8.23	9.700	67.023	4.01	0.23
T_3	8.69	9.400	57.797	3.64	0.16
T_4	9.75	9.567	75.043	3.68	-0.47
T_5	7.03	8.367	68.307	3.6	1.12
T_6	7.02	8.667	57.093	4.22	1.25
T_7	8.14	9.600	73.670	3.63	0.19
T_8	9.33	8.600	69.300	3.54	1.19
SEm±	1.24	0.53	6.98	0.57	
CV (%)	26.23	10.02	18.45	26.09	
CD	NS	NS	NS	NS	

VENGURLE

Data pertaining to vegetative growth parameters during the year 2019-20 was recorded and presented in Table 2.25. Data revealed that there was no significant difference among the various treatments in respect of growth attributes.

During the year 2019-20, the various organic treatments significantly affected the flowering attributes except flowering duration (days). The flowering duration ranged to the minimum from 95.43 days (T_2 and T_7) to the maximum 97.10 days (T_1). Significantly the maximum flowering panicles (22.03/m²) was recorded in the treatment T_6 (*In situ* green manuring /green leaf manuring to meet 100% - Retain litter + planting cowpea) and at par with treatments T_8 (20.43/m²), T_1 (19.77/m²), T_4 (19.13/m²) and T_2 (18.50/m²).

The different treatments significantly influenced the yield attributes of cashew cv. Vengurla-4 under organic management except nut weight (Table 2.25).

The nut weight ranged from a minimum of 8.63 g in treatment T_5 to a maximum of 9.37 g in treatment T_2.

Significantly the highest apple weight (110.33 g) was recorded in treatment T_8 (Recommended dose of fertilizer + 10 kg FYM - Control) and on par with treatment T_1 -100 % N as FYM (100.33 g). The annual nut yield of cashew cv. Vengurla-4 under organic management was significantly highest 1833.96 kg/ha with application of recommended dose of fertilizer + 10 kg FYM-Control (T_8) and it was at par with treatments T_4 (1787.04 kg/ha), T_7 (1662.60 kg/ha), T_3 (1655.80 kg/ha), T_1 (1620.44 kg/ha) and T_2 (1519.80 kg/ha). While, the lowest yield of 1162.80 kg/ha was obtained by *In situ* green manuring /green leaf manuring to meet 100% - Retain litter + planting cowpea (T_6). The highest cumulative yield for 9 harvests was recorded in treatment T_8 (57.26 kg/tree) followed by T_4 (50.75 kg/tree).

Table 2.25 : Yield parameters of cashew under organic management at Vengurla centre during the year 2019-20

Treatment		Duration of flowering (days)		Flow. panicle /m²	Nut wt. (g)	Apple wt. (g)	Annu. nut yield (kg/ha)	Cum. nut yield (kg/ tree) 9 harvts)
		Range	Mean					
T_1	100 % N as FYM	91-102	**97.10**	**19.77**	9.13	**100.33**	**1620.44**	40.08
T_2	100% N as FYM + Biofertilizers consortium (BCF) (200g/tree)	92-97	**95.43**	**18.50**	**9.37**	87.53	**1519.80**	47.35
T_3	50% N as FYM + BCF (200g/tree) + Rock phosphate	92-99	96.17	16.50	9.00	88.23	**1655.80**	36.99
T_4	100% N as Vermicompost + BCF (200g/ tree)	91-101	96.33	**19.13**	8.80	79.00	**1787.04**	**50.75**
T_5	Recycling of organic residue with the addition of 20 % cow dung slurry (20% weight of organic residue as cow dung slurry)	92-100	96.00	15.10	**8.63**	85.60	1444.32	29.12
T_6	*In situ* green manuring /green leaf manuring to meet 100% (Retain litter + planting cowpea)	92-100	96.10	**22.03**	9.03	82.83	1162.80	38.66
T_7	25% N as FYM + Recycling of organic residues + *In situ* green manuring/ green leaf manuring + BCF (200g/tree)	90-101	**95.43**	17.43	8.97	81.00	**1662.60**	36.31
T_8	Recommended dose of fertilizer + 10 kg FYM (Control)	92-99	95.97	**20.43**	8.93	**110.33**	**1833.96**	**57.26**
SEm ±		-	0.73	1.29	0.19	5.63	127.03	-
CD @ 5%		-	N.S.	3.92	N.S.	17.07	385.31	-
CV %		-	1.32	12.04	3.74	10.91	13.87	-

The data on economics of cashew under organic management (Table 2.26) revealed that the maximum net returns of Rs. 1,55,949/- and C:B ratio of 1:3.43 was obtained from treatment T_8 (Recommended dose of fertilizer + 10 kg FYM-Control).

Table 2.26 : Yield and economics of cashew under organic management at Vengurla Centre

Treatment details		Yield of cashew (kg/ha)	Cost of Cultivation (Rs./ha)	Returns (Rs./ha)		C:B Ratio
				Total	Net	
T_1	100 % N as FYM	1620.44	148076	194453	46377	1:1.31

Treatment details		Yield of cashew (kg/ha)	Cost of Cultivation (Rs./ha)	Returns (Rs./ha)		C:B Ratio
				Total	Net	
T_2	100% N as FYM + BCF (200g/tree)	1519.80	153076	182376	29300	1:1.19
T_3	50% N as FYM + BCF (200g/tree) + Rock phosphate	1655.80	107316	198696	91380	1:1.85
T_4	100% N as Vermicompost + BCF (200g/tree)	1787.04	193076	214445	21369	1:1.11
T_5	Recycling of organic residue with the addition of 20 % cow dung slurry (20% weight of organic residue as cow dung slurry)	1444.32	60076	173318	113242	1:2.88
T_6	*In situ* green manuring /green leaf manuring to meet 100% (Retain litter + planting cowpea)	1162.80	54076	139536	85460	1:2.58
T_7	25% N as FYM + Recycling of organic residues + *In situ* green manuring/ green leaf manuring + BCF (200g/tree)	1662.60	81876	199512	117636	1:2.44
T_8	Recommended dose of fertilizer + 10 kg FYM (Control)	1833.96	64126	220075	155949	1:3.43

Note : Rate of cashew raw nut @ Rs. 120/- per kg during the year 2019-20 (As per sanctioned RCN rate of University)

The data on TMB incidence (0 – 4 scale) under organic management of cashew trial at Vengurla centre during the year 2019-20 presented in Table 2.27. The results are non-significant.

Table 2.27 : TMB incidence under organic management of cashew trial at Vengurla centre during the year 2019-20

Treatment Details		TMB incidence (0-4 scale)
T_1	100 % N as FYM	**0.252**
T_2	100% N as FYM + Biofertilizers consortium (BCF) (200g/tree)	0.264
T_3	50% N as FYM + BCF (200g/tree) + Rock phosphate	0.290
T_4	100% N as Vermicompost + BCF (200g/tree)	**0.291**
T_5	Recycling of organic residue with the addition of 20 % cow dung slurry (20% weight of organic residue as cow dung slurry)	0.276
T_6	*In situ* green manuring/green leaf manuring to meet 100% (Retain litter + planting cowpea)	0.290
T_7	25% N as FYM + Recycling of organic residues + *In situ* green manuring/ green leaf manuring + BCF (200g/tree)	0.253
T_8	Recommended dose of fertilizer + 10 kg FYM (Control)	0.275
	SEm ±	0.014
	CD @ 5%	N.S
	CV %	8.71

VRIDHACHALAM

Table 2.28 : Yield parameters of cashew under organic management at Vridhachalam

Treatment	Duration of flowering (days)		Flowering laterals/ panicles per m^2	Nut weight (g)	Apple wt. (g)	Annual nut yield (kg/ha)*	Cum. nut yield (Kg/tree) (10 huts)
	Range	Mean					
T1 - 100 % N as FYM	60-71	66	18.6	6.9	55.7	1130	42.58

Treatment	Duration of flowering (days)		Flowering laterals/ panicles per m^2	Nut weight (g)	Apple wt. (g)	Annual nut yield (kg/ha)*	Cum. nut yield (Kg/tree) (10 huts)
	Range	Mean					
T2 - 100 % N as FYM + Bio-fertilizers (Azatobacter + Azospirillum + PSB) 200 g	57-70	64	17.7	6.8	55.5	1098	39.59
T3 - 50 % N as FYM + Bio-fertilizers (200 g)	64-68	66	17..1	6.8	56.6	1089	35.01
T4 - 100 % N as Vermicompost + Bio-fertilizers (200 g)	68-73	70	16.5	6.9	55.9	1245	43.57
T5 - Recycling of organic residue with the addition of 20 % cow dung slurry (20.0 % weight of organic residue as cow dung)	65-72	68	16.5	6.8	57.8	1112	42.02
T6 - In situ green manuring / green leaf manuring to meet 100 % N	64-68	66	19.6	6.8	56.0	1164	41.05
T7 - 25 % N as FYM + Recycling of organic residue + In situ green manuring / green leaf manuring + Bio-fertilizers (200 g)	64-70	67	19.5	7.0	56.1	1253	45.58
T8 - Recommended doses of fertilizer + 10 kg FYM (Control)	64-72	68	21.0	**7.2**	**58.3**	**1697**	52.53
CD @ 5%		3.88	1.04	0.40	3.42	0.30	0.82
SEm±		1.82	0.50	0.19	1.38	0.13	0.34
CV %		3.39	3.51	4.26	3.49	6.47	5.64

Inorganic fertilizer treatment (T8) recorded the highest values for mean canopy diameter, mean surface area,mean flowering laterals per m^2 , nut yield and cumulative yield followed by T7 with 25 % N as FYM + Recycling of organic residue + *In situ* green manuring / green leaf manuring + Bio-fertilizers consortium (200g).

Table 2.29 : Benefit Cost ratio of cashew under organic management at Vridhachalam

Treatment	Materials required	Cost of Material	Cost of Cultivation	Annual nut yield (kg/ha)*	Income @Rs.100/Kg of raw nuts	BC ratio
T1 - 100 % N as FYM	FYM 40 tonnes	24000	42000	1130	113000	2.69
T2 - 100 % N as FYM + Bio-fertilizers (Azatobacter + Azospirillum + PSB) 200 g	40 T FYM and Biofertilizers	28000	46000	1098	109800	2.39
T3 - 50 % N as FYM + Bio-fertilizers (200 g)	20 T FYM & Biofertilizers	16000	38000	1089	108900	2.87
T4 - 100 % N as Vermicompost + Bio-fertilizers (200 g)	10 T Vermicompost	50000	68000	1245	124500	**1.83**

Treatment	Materials required	Cost of Material	Cost of Cultivation	Annual nut yield (kg/ha)*	Income @Rs.100/Kg of raw nuts	BC ratio
T5 - Recycling of organic residue with the addition of 20 % cow dung slurry (20.0 % weight of organic residue as cow dung)	Organic residue collection and labour cost	16000	53000	1112	111200	2.10
T6 - In situ green manuring / green leaf manuring to meet 100 % N	Growing cost of green manure crops (3 seasons)	24000	42000	1164	116400	2.77
T7 - 25 % N as FYM + Recycling of organic residue + In situ green manuring / green leaf manuring + Bio-fertilizers (200 g)	FYM 10 tonnes + Growing cost of green manure	22000	44000	1253	125300	2.85
T8 - Recommended doses of fertilizer + 10 kg FYM (Control)	Urea 440 Kg SSP 150 Kg Potash 80 Kg FYM 2 T	16000	43000	**1697**	**169700**	**3.95**

The benefit cost ratio is high (3.95) in T8 with recommended dose of fertilizers and lowest in T4 (1.83) with 100 per cent Nitrogen given in the form of vermicompost. The lower benefit cost ratio is due to high cost of vermicompost.

CONCLUDED TRIAL

CENTRE : RRS, JHARGRAM

It was observed that there were almost no significant difference among the different organic treatments as well as between the organic and inorganic treatment (T8 Control) with respect to different growth and reproductive characters studied. In case of yield /tree significant variation was noticed at the age of 12 years i.e in 2019. T_8 (Control) supported maximum yield/tree (7.64 kg/tree) followed by T_7, T_1, T_4 and T_2 which were on par with respect to yield /tree. The cost of cultivation by organic manures was quite high compared to inorganic fertilizer application in cashew, especially when green leaf manure was used to meet 100 % Nitrogen requirement of the cashew plants. Therefore, the net return was negative compared to other treatments.

Though there were very little variation among the organic treatments on growth and yield characters of cashew variety BPP- 8 during 12 years of study but it can be observed that organic treatments had its positive effect on soil nutrients and soil micro flora. Mechanization in cashew cultivation may reduce the cost of cultivation and there by the benfit cost ratio for organic cultivation can be increased. This study revealed that organic cultivation of cashew will definitely improve the soil health and in long run the cost of organic cultivation can be compensated by the increase in the productivity by selection of more suitable varieties for organic cultivation.

Table: Yield/tree of cashew Variety BPP – 8 under organic management during 2011 - 2019

Treatment	Yield/tree (Kg)										Cumulative yield /tree (For 9 harvests)
	2011	2012	2013	2014	2015	2016	2017	2018	2019	Pooled	
T_1	0.25	1.58	7.1	7.66	6.82	7.80	5.82	7.57	6.26 **b**	5.65	50.11
T_2	0.02	1.50	5.5	7.46	5.33	7.10	3.37	8.01	5.95 **b**	4.92	41.94
T_3	0.27	0.93	4.5	7.24	5.49	6.38	4.74	8.71	4.38 **c**	4.74	40.64
T_4	0.07	1.10	3.9	5.08	2.33	7.41	3.21	11.48	5.68 **b**	4.47	38.61
T_5	0.08	1.13	3.6	5.52	3.27	6.56	2.26	7.75	3.91 **c**	3.79	32.74
T_6	0.06	1.51	3.7	6.73	3.59	6.18	2.43	7.27	3.82 **c**	3.92	34.13
T_7	0.04	1.25	3.9	6.61	3.31	5.68	1.80	8.82	6.34 **b**	4.19	37.58
T_8	0.07	1.35	3.6	5.58	3.72	4.19	7.29	13.64	7.64 **a**	5.23	45.88
S.Em .±	NS	NS	NS	NS	NS	NS	NS	NS	0.28	NS	
CD at 5%									0.85		
CV%									8.78		

Table: Economics of organic management in cashew (2007 – 2019)

Treatment	Yield/ha (Kg) 2019	Cumulative cost/ha (2007 – 2019) (Rs.)	Cumulative return /ha(Rs.)	Cumulative net return/ha (Rs.)	B:C
T_1 - 100 % N as FYM	7934.7	2,58,081	7,56,835	4,98,754	1.93
T_2 - 100 % N as FYM + Bio-fertilizers	6901.6	2,79,336	6,66,284	3,86,948	1.39
T_3 - 50 % N as FYM + Bio-fertilizers	6651.7	2,18,665	6,56,350	4,37,685	2.00
T_4 - 100 % N as Vermicompost + Bio-fertilizers	6281.0	4,07,425	6,58,186	2,50,761	0.62
T_5 - Recycling of organic residue	5316.5	2,27,036	5,28,995	3,01,959	1.33
T_6 – In situ green manuring / green leaf manuring to meet 100 % N	5505.0	8,73,569	5,36,361	-3,37,208	-0.39
T_7 - 25 % N as FYM + Recycling of organic residue + In situ green manuring / green leaf manuring + Bio-fertilizers (200 g)	5888.3	9,47,042	5,88,360	-3,58,682	-0.38
T_8 - Recommended doses of fertilizer + 10 kg FYM (Control)	7344.7	2,06,690	7,86,765	5,80,075	2.81

Hort.8 : Spacing cum fertilizer trial

Centres: Plains / others: Darisai, Kanabargi, Paria and Tura

The objective of this trial is to arrive at an appropriate spacing and fertilizer doses for maximizing returns from cashew.

DARISAI

S1: 10mx5m, S2:6mx4m, S3: 5mx4m.

Fertilizer Application Level

1st Year - 1/5th
2nd Year - 2/5th
3rd Year - 3/5th
4th Year - 4/5th
5th Year - full dose

M1: 75 Kg N, 25 Kg P_2O_5, 25Kg K_2O,
M2: 150 Kg N, 50 Kg P_2O_5, 50Kg K_2O
M3: 225 Kg N, 75 Kg P_2O_5, 75Kg K_2O

Var.: BPP-8

Table 2.30 : Interaction Effect Between Tree Densities and Fertilizer Dose on Yield parameters of cashew under spacing cum fertilizer trial at ZRS, Darisai centre during the year 2019-20

Treatment	Flowering Days	Flowering lateral/(m^2)	Nut wt.(g)	Apple wt.(g)	Nut yield (kg/tree)	Cumulative Yield for five harvests Kg/plant
S1M1	101.39	23.32	6.89	82.35	6.53	21.37
S1M2	120.12	34.09	7.66	89.14	7.85	25.72
S1M3	103.35	25.48	6.62	79.92	5.59	18.79
S2M1	109.82	34.56	7.16	85.16	4.71	16.49
S2M2	100.47	44.18	7.41	85.65	4.53	16.67
S2M3	97.63	37.74	7.22	82.25	3.07	12.75
S3M1	93.74	31.72	6.98	80.70	2.74	11.33
S3M2	91.48	37.53	6.79	78.37	3.19	13.52
S3M3	85.30	33.66	6.63	73.91	2.15	9.96
SEm±	3.78	2.75	0.22	2.83	0.35	0.42
CD(5%)	11.18	8.13	0.53	8.23	1.03	1.17
CV (%)	15.38	14.25	12.76	16.24	14.17	15.23

S_1M_2 is significantly superior in current year yield and also in cumulative yield on the basis of five harvests among all other interactions tested.

KANABARGI

Year of planting : 2012
Design : Split plot
Replication : Three
Spacing : S1- 8m x 8m
S2- 10m x 5m
S3- 6.5m x 6.5 m

Fertilizer : F1- 52:13:13 g NPK/plant /year
F2- 78: 20:20 g NPK/plant/year
F3- 117: 29: 29g NPK/plant/year

Number of plant per replication : 5

Table 2.31 : Vegetative and yield parameters in cashew as influenced by spacing cum fertilizer interaction effect during the year 2019-20

Sl. No.	Treatments	Tree height (m)	Trunk girth (cm)	Trunk height (m)	Canopy height (m)	Canopy diameter (m)	Nut yield kg/tree	Nut yield t/ha
1	S_1F_1	4.69	67.92	0.92	3.50	6.40	8.13	12.69
2	S_1F_2	4.36	62.57	0.72	3.65	5.73	7.91	12.35
3	S_1F_3	4.58	65.67	1.22	3.85	6.29	8.27	12.91
4	S_2F_1	3.81	56.90	0.80	2.85	6.43	4.96	9.92
5	S_2F_2	3.84	59.28	0.93	3.00	5.71	5.81	11.62
6	S_2F_3	4.16	64.79	0.84	3.36	5.59	7.35	14.69
7	S_3F_1	4.47	62.28	0.78	3.48	5.48	4.78	11.27
8	S_3F_2	4.20	59.56	0.81	3.45	4.81	5.15	12.16
9	S_3F_3	4.74	65.93	1.01	3.61	5.95	5.83	13.75
	Treatment Mean	4.47	62.59	0.87	3.51	5.41	5.25	12.37
	S.Em±	0.24	1.92	0.06	0.20	0.30	0.35	0.65
	CD 5%	0.69	5.58	0.18	0.58	0.88	1.02	1.89

Spacing cum fertilizer effect showed that there was no significant difference among vegetative parameters except trunk height which was maximum in S_1F_3 (1.22 m) and the least recorded was in S_3F_1 (0.78m). Whereas nut yield per hectare was significant in S_2F_3 (14.69 t/ha) followed by S_3F_3, least was recorded in S_2F_1 (9.92 t/ha).

PARIA

The results on effect of different levels of spacing and fertilizers on growth and yield of cashew at Paria are presented in table 2.32. All the growth as well as yield parameters were observed to be non-significant at individual as well as interaction level.

Spacing: S1-8x8m S2-6.5x6.5m S3-5x5m
Fertilizer:F1-75-25-25NPK F2-150-50-50NPK F3-225-75-75NPK

Var.:V-4

Table 2.32 : Effect of different levels of spacing and fertilizers on growth and yield of cashew at Paria

Treatments	Trunk girth (m)	Plant height (m)	Mean canopy area (m)	Canopy volume (m^3)	Nut yield (q/ha)
S_1F_1	0.70	4.63	5.64	80.06	1.34
S_1F_2	0.68	4.57	5.78	86.35	1.01
S_1F_3	0.62	4.37	5.29	79.82	0.81
S_2F_1	0.67	4.78	6.21	96.45	1.63
S_2F_2	0.72	5.38	7.25	156.09	1.29
S_2F_3	0.59	4.34	5.36	73.89	1.81
S_3F_1	0.55	5.04	4.66	56.92	1.84
S_3F_2	0.63	5.01	5.78	90.80	2.51
S_3F_3	0.55	4.21	4.80	52.10	2.15
SEm±	NS	NS	NS	NS	NS
CD@5%					
CV%	19.71	17.50	22.85	56.24	28.59

Hort.9: Evaluation of production potential of newly developed variety Bidhan Jhargram - 2 at different spacings

Centres: East Coast : Jhargram

Plains / others: Darisai

The objective of this trial is to evaluate the new variety at different location for production potential under different spacing.

JHARGRAM

The variety Bidhan Jhargram – 2 was pruned in different methods under different densities. The variety spaced at 10m x 10m was pruned to keep the shape of the plant and the dead branches, branches bending and touching the ground were removed. Under 8m x 8m spacing the same variety was pruned to remove 1m of each of the overlapping branches of adjoining trees. Moreover to keep the shape of the plant the dead branches, branches bending and touching the ground were removed. Under 7m x 5m spacing the same variety was pruned to remove 1.5m of each of the overlapping branches of adjoining trees. Moreover to keep the shape of the plant the dead branches, branches bending and touching the ground were removed. Under 4m x 4m the height of the plant was reduced to 2 - 2.5 m and side branches overlapping with the adjoining trees were pruned back to 1.5 m from the main trunk. The pruning was done in August, 2019.

The growth characters were recorded in January, 2020 just before flowering. Significant differences were recorded among the different spacing treatments with respect to growth characters studied. Table 2.33 presents the growth parameters of Bidhan Jhargram - 2 under spacing trial at Jhargram centre during the year 2019 – 20. In case of height and girth of the plants under different spacing, they were on par in T_1, T_2 and T_3 but the T_4 plants were shorter and the girth was also less than that of the other treatments. The east – west spread of the plants under different spacing was significantly different from each other.

North – south spread was on par in T_1, T_2 and T_3 but it was significantly different from T_4. Similar result was observed in canopy surface area; where maximum canopy surface area was noticed in 10mx10m spacing followed by 8mx 8m and 7mx5m, while canopy surface area was minimum in 4mx4m spacing. In case of percentage ground coverage by canopy was recorded maximum in 4mx4m spacing where 66.2 % of the interspace was already covered by the canopy while it was 64. 87% for 7m x 5m, 38.01% for 8m x 8m and 30.83% in 10m x 10m.

Table 2.33 : Yield parameters of Bidhan Jhargram - 2 under Spacing trial at Jhargram centre during the year 2019 - 20

Treatment	No. of panicles/ m^2	No. of nuts/ m^2	Nut weight (g)	Annual nut yield (kg/tree)	Cumulative yield/ha (Kg/ ha) (3 harvests)
T_1 - 10m x 10m	14.71	6.88	8.03	2.70	740.13
T_2 - 8m x 8m	18.79	8.25	8.00	2.05	1030.76
T_3 - 7m x 5m	18.79	6.67	8.06	2.10	1654.56
T_4 - 4m x 4m	16.79	5.96	8.00	1.03	2848.72
SEm ±	NS	NS	NS	0.16	
CD at 5%				0.48	
CV%				20.39	

There were no significant differences noticed among the four spacing treatments with respect to panicles/ m^2, nuts/ m^2 and nut weight. Highest yield per tree was recorded in plants spaced at 10m x 10m, while the other two wide spacing were on par with respect to yield/ tree. Yield per tree was minimum in 4m x 4m spacing. Cumulative yield/ha at third harvest reveals that the narrowest spacing had the highest yield/ha and the yield /ha reduced with widening of the spacing.

Hort. 11: Ultra high density planting in cashew

Centres: East Coast : Bapatla, Bhubaneswar and Jhargram

West Coast : Madakkathara, Paria and Vengurla

The objective of this trial is to identify the suitable variety for ultra high density and to study the economic feasibility of ultra high density vs normal planting density planting in cashew.

BHUBANESWAR

Experimental details:

Date of Planting : 2020
Design : Split plot
Replication : 03

Treatment details:

Main plot : Spacing
- S_1: 2.5 m x 2.5 m
- S_2: 3 m x 3 m
- S_3: 7.5 m x 7.5 m (Control)

Sub plot : Varieties
- V_1: VRI-3
- V_2: NRCC Sel-2
- V_3: Balabhadra (Local check)

No. of plants/treatment/ Replication : 6 plants for UHDP and 3 plants for normal planting

The experiment was laid out during the year 2020 in split plot design with three replications. The initial soil status of the experimental plot was analysed. The growth of all the grafted plants is satisfactory. Care and maintenance of the grafted cashew plants are in progress.

JHARGRAM

The recorded data is of 1.5 year old plants. The plants were pruned at the first year itself. Lower branches arising upto 1m were removed from the plants spaced at 8m x 8m, while similar training was also practiced in 5m x 5m spaced plants. In case of 3m x 3m spaced plants the apical bud was removed at 45 cm above ground level. Then the axillary buds got activated and the side branches emerged. 3 – 4 branches were allowed to grow to make the frame work of the plants.

Fig. UHDP in cashew at RRS, Jhargram

The variation among the treatments with respect to most of the growth parameters was non – significant except biomass removal. The weight of fresh biomass removal was significantly different with different spacing and it was maximum in S_3 (3m x 3m). Yield parameters were also recorded though it was noticed that the treatments, spacing as well as varieties were equivalent with respect to yield of plant. While significant spacing effect was clear from yield per unit area.

Table 2.34 : Yield of varieties under ultra high density planting of cashew at Jhargram centre during the year 2019 - 20

Treatment	Fresh Biomass Removal during pruning (kg)	Flowering laterals/m²	Nut yield (g/tree)	Nut yield (Kg/ha)
S1	0.28	6.78	163.01	25.43
S2	0.37	6.51	67.40	26.96
S3	0.76	9.38	214.12	233.17
C.D. at 5%	**0.17**	NS	NS	52.87
V1	0.52	8.08	121.24	70.19
V2	0.49	7.17	197.71	133.50
V3	0.41	7.42	125.58	81.87
C.D. at 5%	NS	NS	NS	NS
S1V1	0.30	7.09	136.96	21.36
S1V2	0.30	6.75	216.88	33.83
S1V3	0.25	6.50	135.21	21.09
S2V1	0.50	7.85	83.78	33.51
S2V2	0.32	6.17	62.50	25.00
S2V3	0.30	5.52	55.92	22.37
S3V1	0.76	9.29	142.98	155.70
S3V2	0.86	8.60	313.75	341.67
S3V3	0.66	10.23	185.63	202.15
C.D. at 5%	NS	NS	NS	NS

S_1 : 8m x 8m , S_2 : 5m x 5m , S_3 : 3m x 3m ; V_1 : VRI-3, V_2 : NRCC sel - 2, V_3 : K- 22 -1

MADAKKATHARA

Experimental details:

Date of planting : 2017
Design : Split plot
Replication : 4

Treatment details:

Main plot-	Spacing	Sub plot -	Varieties
S_1 :	2.5 x 2.5 m	V_1 :	Vri-3
S_2 :	3 x 3 m	V_2 :	NRCC Selection-2
S_3 :	3.5 x 3.5 m	V_3 :	Poornima
S_4 :	8 x 8 m (Control)		

Fig. Flowering in UHDP Trial at Madakkathara

There were four spacings (2.5m, 3.0m, 3.5m and 8.0m) and three varieties (VRI-3, NRCC Selection-2 and Poornima) and the experiment was laid out in split plot design with 12 treatments and three replications. The data on the effect of spacing and varieties on growth parameters during flowering period of 2020 are presented in Table 2.35.

Table 2.35 : Effect of spacing and varieties on growth parameters under ultra high density planting at Madakkathara during 2020

Treatments	Height (m)	Girth (m)	Canopy diameter (m)	Canopy surface area (m^2)	Trunk height (m)
S_1	2.495	0.264	2.439	7.057	0.334
S_2	2.266	0.256	2.616	7.415	0.349
S_3	2.216	0.241	2.458	6.913	0.277
S_4	2.037	0.236	2.083	5.584	0.263
SEm±	**0.07**	**0.009**	**0.086**	**0.33**	**0.037**
CV (%)	**9.94**	**11.82**	**10.79**	**14.85**	**36.69**
CD @ 5%	**0.25**	**NS**	**0.29**	**1.15**	**NS**
V_1	2.422	0.268	2.645	7.739	0.317
V_2	2.143	0.235	2.193	5.93	0.316
V_3	2.196	0.244	2.35	6.55	0.285
SEm±	**0.04**	**0.007**	**0.100**	**0.35**	**0.014**
CV (%)	**6.51**	**10.22**	**14.51**	**18.45**	**16.16**
CD @ 5%	**0.12**	**0.02**	**0.30**	**1.07**	**NS**
S_1 X V_1	2.513	0.27	2.438	7.034	0.363
S_1 X V_2	2.243	0.24	2.325	6.387	0.353

Treatments	Height (m)	Girth (m)	Canopy diameter (m)	Canopy surface area (m^2)	Trunk height (m)
S_1 X V_3	2.728	0.283	2.555	7.749	0.287
S_2 X V_1	2.504	0.263	2.889	8.669	0.33
S_2 X V_2	2.256	0.257	2.314	6.352	0.367
S_2 X V_3	2.039	0.247	2.646	7.224	0.35
S_3 X V_1	2.377	0.26	2.815	8.261	0.307
S_3 X V_2	2.248	0.233	2.257	6.229	0.297
S_3 X V_3	2.024	0.23	2.303	6.249	0.227
S_4 X V_1	2.293	0.28	2.44	6.99	0.267
S_4 X V_2	1.823	0.21	1.877	4.751	0.247
S_4 X V_3	1.993	0.217	1.931	5.012	0.277
CD (Factor A*at same level of factor B) (α=0.05)	**0.25**	**NS**	**NS**	**NS**	**NS**
CD (Factor B* at same level of factor A) (α=0.05)	**0.33**				

*Factor A: Spacing; Factor B: Varieties

Statistical analysis of data revealed that spacing have significant effect on the height, canopy diameter and canopy surface area of the trees. All these three growth parameters were found to be high in S2 (3m x 3m). Significant difference was observed between the subplot treatments for all the growth parameters studied except trunk height. Variety, V_1 (VRI-3) showed highest value for, height (2.42 m), girth (0.26m), canopy diameter (2.64m) and canopy surface area (7.74 m^2).

Interaction effect between spacing and varieties was significant for height. The highest height (2.73m) was observed for V_3 at spacing S_1. But no significant interaction was observed between mainplot and subplot treatments for other growth parameters.

Flowering was observed in more than 50 per cent of plants in variety V_1 at spacing S_1 and S_2 with an average yield of 0.397g/tree and 0.256g/tree respectively. The plants were pruned in the month of May 2020 and maintained at a height of 1.5m.

VENGURLE

Date of planting : 1st July, 2018
Design : Split plot
Replication : 3
Treatment details : Main Plot : Spacing

S_1 : 2.5m x 2.5m
S_2 : 3m x 3m
S_3 : 8m x 8m (Control)

Sub plot : Varieties

V_1 : VRI-3
V_2 : Ullal-1
V_3 : V-9 (Control)

No. of plants/ treatment/ repl. for UHDP	:	6
Operation to be performed after planting	:	1) Removal of side sprouts up to 1.5' – 2.0' on main stem 2) Terminal bud can be nipped off at 1 m height from ground level
Development of framework of primary branches	:	➢ 3-5 major branches be allowed in different directions and later the pruning of secondary & territory branch after completion of fruiting season. ➢ Yearly to be repeated. ➢ 1% Bordeaux spray after pruning. ➢ Regular pest control measures to be followed.
Manuring	:	Half of the dosage of regular spaced plants sufficient for the UHD plantation can be given in two splits. Recommended dose should be given at least 2 months before flushing and flowering.
Irrigation	:	Depending on the locality, water requirement may be decided for the initial establishment. Subsequently need based irrigation to be given after flowering depending on the availability of the water and varieties planted.

The trial is initiated at AICRP-Cashew, RFRS, Vengurla centre in July, 2018. The growth of all the grafts is satisfactory. The initial training (Removal of side sprouts up to 1 m on main stem) was done. Similarly, terminal bud was nipped off at 1 m height from ground level.

Year 2019-20 is the first year of experimentation. The trial is in initial stage and experimental grafts are yet to start flowering and fruiting. The vegetative growth observations of the trial for the year 2019-20 (first year) was recorded and presented in Table 22 and 23.

The effect of spacing, variety and their interaction showed non-significant difference for vegetative growth attributes. However, individual effect of variety (V) showed significant difference for mean canopy spread (m), EW and NS spread (m). Significantly the highest mean spread (0.70 m), EW spread (0.73 m) and NS spread (0.68 m) was recorded in variety VRI-3 (V_1) and at par with variety Ullal-1 (V_2) i.e. 0.61m, 0.62m and 0.60m, respectively.

Fig. Pruned grafts in Experimental UHDP plot

Table 2.36 : Effect of spacing, variety and interaction on height (m), girth (cm) & mean canopy spread (m) under UHDP at Vengurla centre during the year 2019-20

Treatments	Height (m)				Girth (cm)				Mean canopy spread (m)			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
S_1	1.03	1.39	0.79	1.07	7.70	6.43	5.63	6.58	0.71	0.58	0.40	0.56
S_2	1.14	1.04	1.03	1.07	7.43	7.13	7.53	7.37	0.69	0.64	0.54	0.62
S_3	1.00	1.08	1.06	1.04	7.43	7.60	7.43	7.49	0.71	0.61	0.50	0.61
Mean	1.05	1.17	0.96	1.06	7.52	7.05	6.87	7.15	0.70	0.61	0.48	0.60
	S	V	SXV		S	V	SXV		S	V	SXV	
SEm±	0.10	0.09	0.15		0.43	0.29	0.52		0.08	0.04	0.06	
CD at 5%	N.S.	N.S.	N.S.		N.S.	N.S.	N.S.		N.S.	0.12	N.S.	

Table 2.37 : Effect of spacing, variety and interaction effect on EW, NS spread and mean canopy height under ultra high density planting in cashew

Treatments	EW (m)				NS (m)				Mean canopy height (m)			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
S_1	0.76	0.58	0.40	0.58	0.66	0.59	0.39	0.54	0.62	0.60	0.50	0.89
S_2	0.71	0.67	0.51	0.63	0.68	0.61	0.56	0.62	0.60	0.54	0.63	0.60
S_3	0.71	0.62	0.50	0.61	0.72	0.60	0.50	0.61	0.55	0.66	0.59	0.87
Mean	**0.73**	0.62	0.47	0.61	**0.68**	0.60	0.48	0.59	0.57	0.59	0.60	0.58
	S	**V**	SXV		S	**V**	SXV		S	**V**	SXV	
SEm±	0.08	0.05	0.08		0.09	0.04	0.07		0.05	0.04	0.07	
CD at 5%	N.S.	**0.14**	N.S.		N.S.	**0.12**	N.S.		N.S.	N.S.	N.S.	

III. CROP PROTECTION

Ent. 1: Chemical Control of pest complex in cashew

Expt. 3. Evaluation of insecticides for control of TMB and other insect pests

Centres: East Coast :	Bapatla, Bhubaneshwar, Jhargram and Vridhachalam
West Coast :	Madakkathara, Paria and Vengurla
Plains / others:	Hogalagere, Jagdalpur and Kanabargi

The project aims at identifying the effective insecticide amongst the newer synthetic insecticides in comparison with recommended spray schedule, which are safer as well as economically feasible for managing the insect pests of cashew.

No. of replications : 4
No. of trees per replication : 2
Design : R.B.D.

BAPATLA

Treatment details:

T_1	:	Thiamethoxam 25 WG	:	0.1 g/l
T_2	:	Thiamethoxam 25 WG	:	0.2 g/l
T_3	:	Carbosulfan 25 EC	:	2 ml/l
T_4	:	Buprofezin 25 SC	:	2 ml/l
T_5	:	*Beauveria bassiana* WP	:	1 g/l
T_6	:	*Beauveria bassiana* WP	:	5 g/l
T_7	:	λ – Cyhalothrin 5 EC	:	0.6 ml/l
T_8	:	Monocrotophos 36 SL (1.6 ml/l) at flushing, Chlorpyriphos 20 EC (2.0 ml/l) at flowering and Profenofos 50 EC (1.0 ml/l) at fruit & nut development stage.		
T_9	:	Untreated check		

Three sprays were imposed at 30-35 days interval during flushing, flowering and fruit & nut development stages.

The data on pest incidence was recorded from 8 trees per treatment. Fifty two leader shoots from each tree from all the four sides in respect of leaf and blossom webber and shoot tip caterpillar at one day before spray and 30 days after each spray were used for observations. In case of apple and nut borer, total number of nuts in 52 panicles and the nuts damaged by the borer were counted at 30 days after 3rd spray. Thrips damage on nut surface was graded on 100 nuts per tree following 0 to 4 scale. Counts of spiders and ants were recorded at 30 days after 3rd spray by tapping 52 panicles per tree on 1 sq. foot card board. During the year 2019-20, the activity of different foliage, flower and nut feeding pests incidence was very low in all the treatments. Hence, treatments were not imposed during this season.

JAGDALPUR

The results of the insecticides against TMB revealed that, after first, second and third spray, the efficacy of different insecticides were statistically superior over untreated control. The pre-treatment damage score of TMB was non-significant in all the treatments including untreated control with 2.089 damage score (DS). After 30 days of 3rd spray, T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) showed least (0.206) damage score followed by T_2 (Thiamethoxam 25 WG @ 0.2 g/l) with 0.534 DS which was at par with T_1 (Thiamethoxam 25 WG @ 0.1 g/l) with 0.634 DS.

The efficacy of most effective insecticides which ranked in the order against the TMB incidence at Jagdalpur are T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) with 0.206 DS followed by T_2 (Thiamethoxam 25 WG @ 0.2 g/l) with 0.534 DS, T_1 (Thiamethoxam 25 WG @ 0.1 g/l) with 0.634 DS, T_4 (Buprofezin 25 SC @ 2ml/l) with 0.725

DS and T_6 (*Beauveria bassiana* WP @ 5 g/l) with 1.091 DS. However, the efficacy of insecticides was statistically superior over untreated control.

The five year mean data of each pest pooled are presented in Table 3.2 for drawing the results of the experiment for recommendation in the region. It is evident from the data that the treatments T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) and T_2 (Thiamethoxam 25 WG @ 0.2 g/l) are the best for sucking pests and for leaf chewing insect pests, whereas T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) and T_2 (Thiamethoxam 25 WG @ 0.2 g/l) and T_6 (*Beauveria bassiana* WP @ 5 g/l) are best for the managements of leaf folder, leaf miner and shoot tip caterpillar. Hence both the insecticides L-cyhalothrin 5 EC @ 0.6ml/l and Thiamethoxam 25 WG @ 0.2 g/l can be recommended for controlling the pest complex of cashew in Bastar Plateau Region of Chhattisgarh.

The effects of insecticides on natural enemies presented in Table 3.3 revealed that, the mean population of natural enemies increased with decrease in insecticide toxicity. The mean population of natural enemies was considerably lower in sprayed trees, but in unsprayed trees, higher number of natural enemies were observed throughout the season. The population trends of various natural enemies in respect of all the insecticide treatments gradually decimated the population of ants, spiders, lady bird beetle and *Brumus* after each round of insecticide spray. The *Beauveria bassiana* strain used in present experiment is procured from state Bio-control laboratory, BTC College of Agriculture and Research Station, Bilaspur (IGKV, Raipur,C.G.). In the present investigation, the mean population of ants, spiders, lady bird beetle and *Brumus* showed non-significant difference among treatments including untreated control. However, after 30 days of third spray of the treatments T_5 (*Beauveria bassiana* @ 1g/l) showed maximum mean population of ants, spider, lady bird beetle and *Brumus* with 1.363, 0.550, 0.081 and 0.204 respectively, which was on par with T_6 (*Beauveria bassiana* WP @ 5 g/l) with varied level of mean population except spider population. The minimum population of natural enemies was observed in T_3 (Carbosulfan 25 EC @ 2 ml/l) with 0.269, T_4 (Buprofezin 25 SC @ 2ml/l) with 0.219 and T_2 (Thiamethoxam 25 WG @ 0.2 g/l) with 0.131 respectively for ants, spider, lady bird beetle and *Brumus*. All the treatments showed lower population over untreated control (T_8).

Table 3.1 : Efficacy of different insecticides on insect pests of cashew at Jagdalpur during 2019-20

Treatment		Mean damage after third spray									
		TMB		Thrips		Shoot tip caterpillar		Leaf miner		Leaf folder	
		*Pre treatment DS (0-4)	*Post treatment DS (0-4)	*Pre treatment DS (0-4)	*Post treatment DS (0-4)	**Pre treatment % damage	**Post treatment % damage	**Pre treatment % damage	**Post treatment % damage	**Pre treatment % damage	**Post treatment % damage
T_1	Thiamethoxam 25 WG (0.1 g/l)	2.469 (1.862)	0.634 (1.278) bc	1.928 (1.711)	0.449 (1.203) cd	5.875 (14.014)	2.593 (9.254) e	1.887 (8.364)	0.618 (4.501) bcd	2.767 (9.554)	1.150 (6.146) bcd
T_2	Thiamethoxam 25 WG (0.2 g/l)	2.125 (1.767)	0.534 (1.238) b	1.960 (1.719)	0.298 (1.138) ab	7.060 (15.343)	1.555 (7.142) ab	2.080 (8.708)	0.248 (2.843) ab	2.832 (9.676)	0.648 (4.604) ab
T_3	Carbosulfan 25 EC (2 ml/l)	2.244 (1.788)	1.294 (1.515) f	1.548 (1.596)	0.568 (1.252) e	6.015 (14.193)	1.970 (8.003) bc	1.712 (7.985)	0.563 (4.298) bc	2.590 (9.242)	1.030 (5.821) bc
T_4	Buprofezin 25 SC (2ml/l)	1.830 (1.681)	0.725 (1.312) cd	1.956 (1.716)	0.350 (1.161) bc	6.005 (14.156)	2.612 (9.281) ef	2.091 (8.867)	0.775 (5.047) cde	2.137 (8.369)	1.380 (6.741) cde
T_5	*Beauveria bassiana* (1g/l)	2.220 (1.793)	1.379 (1.540) fg	1.875 (1.691)	0.920 (1.383) g	6.963 (15.247)	3.359 (10.551) g	2.134 (8.649)	1.113 (6.049) efg	2.283 (8.638)	1.840 (7.789) efg

Treatment		Mean damage after third spray									
		TMB		Thrips		Shoot tip caterpillar		Leaf miner		Leaf folder	
		*Pre treatment DS (0-4)	*Post treatment DS (0-4)	*Pre treatment DS (0-4)	*Post treatment DS (0-4)	**Pre treatment % damage	**Post treatment % damage	**Pre treatment % damage	**Post treatment % damage	**Pre treatment % damage	**Post treatment % damage
T_6	*Beauveria bassiana* (5g/l)	2.019 (1.736)	1.091 (1.445) ^{e}	1.910 (1.705)	0.701 (1.301) ^{f}	6.109 (14.299)	2.605 (9.282) ^{d}	1.907 (8.456)	0.880 (5.380) ^{cdef}	2.342 (8.757)	1.643 (7.358) ^{def}
T_7	L-cyhalothrin 5EC (0.6ml/l)	1.738 (1.652)	0.206 (1.099) ^{a}	1.975 (1.720)	0.228 (1.108) ^{a}	6.123 (14.302)	1.005 (5.739) ^{a}	2.740 (9.631)	0.173 (2.383) ^{a}	2.249 (8.535)	0.358 (3.377) ^{a}
T_8	Untreated check	2.600 (1.890)	2.089 (1.757) ^{h}	2.019 (1.733)	2.175 (1.776) ^{h}	6.983 (15.296)	6.928 (15.247) ^{h}	3.098 (10.055)	3.200 (10.294) ^{h}	3.146 (10.213)	4.094 (11.667) ^{h}
	Mean	2.155	0.994	1.896	0.711	6.392	2.828	2.206	0.946	2.543	1.518
	CD (p=0.05)	NS	0.105	NS	0.111	NS	0.911	NS	0.378	NS	0.525
	SE(m) ±	0.065	0.035	0.014	0.038	0.461	0.308	0.639	0.128	0.455	0.177
	CV (%)	7.293	5.071	1.990	5.816	6.313	6.611	14.451	5.004	9.969	5.301

*Values in the parentheses of damage score are square root transformation values
**Values in the parentheses of per cent damage are arc sin transformation values

Table 3.2 : Efficacy of different insecticides on insect pests of cashew at Jagdalpur pooled over 2015-16 to 2019-20

Treatment		Mean damage of pests (five year data)					Yield (kg/ tree) 2019-20
		TMB	Thrips	Shoot tip caterpillar	Leaf miner	Leaf folder	
		*Post treatment mean D S (0-4)	*Post treatment mean D S (0-4)	**Post treatment mean % damage	**Post treatment mean % damage	**Post treatment mean % damage	
T_1	Thiamethoxam 25 WG (0.1 g/l)	0.37 (1.16) ^{c}	0.60 (2.19) ^{d}	9.35 (17.17) ^{cd}	5.41 (11.49) ^{bc}	7.97 (15.29) ^{abc}	3.86
T_2	Thiamethoxam 25 WG (0.2 g/l)	0.28 (1.12) ^{ab}	0.38 (1.95) ^{a}	8.04 (15.45) ^{c}	4.15 (10.01) ^{a}	7.78 (14.68) ^{abc}	4.09
T_3	Carbosulfan 25 EC (2 ml/l)	0.63 (1.26) ^{efg}	0.67 (2.30) ^{e}	8.84 (16.29) ^{cd}	5.83 (12.03) ^{cd}	8.04 (15.16) ^{abcde}	3.17
T_4	Buprofezin 25 SC (2ml/l)	0.48 (1.21) ^{cd}	0.44 (1.98) ^{abc}	8.48 (16.41) ^{cde}	4.46 (10.96) ^{ab}	8.02 (15.41) ^{abcd}	3.47
T_5	*Beauveria bassiana* (1g/l)	0.62 (1.26) ^{ef}	0.79 (2.37) ^{fg}	9.82 (17.73) ^{def}	7.07 (13.55) ^{ef}	9.84 (16.75) ^{f}	3.21
T_6	*Beauveria bassiana* (5g/l)	0.58 (1.25) ^{e}	0.70 (2.30) ^{ef}	6.83 (14.28) ^{ab}	6.37 (12.77) ^{cde}	7.12 (14.67) ^{a}	3.36
T_7	L-cyhalothrin 5EC (0.6ml/l)	0.21 (1.09) ^{a}	0.42 (2.11) ^{ab}	6.15 (13.14) ^{a}	5.09 (10.74) ^{ab}	7.29 (13.74) ^{ab}	4.26

Treatment		Mean damage of pests (five year data)					Yield (kg/ tree) 2019-20
		TMB	Thrips	Shoot tip caterpillar	Leaf miner	Leaf folder	
		*Post treatment mean D S (0-4)	*Post treatment mean D S (0-4)	**Post treatment mean % damage	**Post treatment mean % damage	**Post treatment mean % damage	
T_8	Untreated check	1.22 (1.48) ^{h}	1.45 (2.79)^{h}	19.22 (25.34) ^{g}	9.88 (17.09) ^{g}	16.03 (22.53) ^{g}	2.69
	Mean	0.55	0.68	9.59	6.03	9.01	3.51
	CD (p=0.05)	0.07	0.12	1.47	1.09	1.35	0.27
	SE(m) ±	0.03	0.05	0.48	0.37	0.50	0.10
	CV (%)	5.82	4.22	7.86	6.97	7.30	15.34

*Values in the parentheses of damage score are square root transformation values

**Values in the parentheses of per cent damage are arc sin transformation values

Table 3.3 : Effect of insecticides on occurrence of natural enemies at Jagdalpur during 2019-20

Treatment		Mean population after third spray							
		Ants		Spiders		Lady bird beetle		*Brumus*	
		Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
T_1	Thiamethoxam 25 WG (0.1 g/l)	1.125 (1.451)	0.513 (1.228)^{bcd}	0.569 (1.251)	0.488 (1.219) ^{f}	0.055 (1.027)	0.038 (1.018) ^{ab}	0.188 (1.089)	0.161 (1.078) ^{abcd}
T_2	Thiamethoxam 25 WG (0.2 g/l)	1.394 (1.544)	0.438 (1.194)^{b}	0.569 (1.252)	0.305 (1.142) ^{b}	0.219 (1.103)	0.119 (1.058) ^{f}	0.350 (1.162)	0.131 (1.063) ^{a}
T_3	Carbosulfan 25 EC (2 ml/l)	0.875 (1.368)	0.269 (1.126)^{bc}	0.594 (1.248)	0.330 (1.153) ^{bc}	0.154 (1.074)	0.056 (1.028) ^{abc}	0.281 (1.132)	0.144 (1.069) ^{abc}
T_4	Buprofezin 25 SC (2ml/l)	1.081 (1.443)	0.575 (1.252)^{c}	0.438 (1.199)	0.219 (1.104) ^{a}	0.169 (1.080)	0.031 (1.016) ^{a}	0.246 (1.114)	0.163 (1.078) ^{abcde}
T_5	*Beauveria bassiana* (1g/l)	0.875 (1.367)	1.363 (1.537)^{ef}	0.538 (1.239)	0.550 (1.244) ^{g}	0.150 (1.072)	0.075 (1.036) ^{cd}	0.238 (1.110)	0.204 (1.097)^{fg}
T_6	*Beauveria bassiana* (5g/l)	1.306 (1.517)	1.013 (1.417) ^{e}	0.400 (1.181)	0.381 (1.175) ^{cde}	0.163 (1.077)	0.081 (1.040) ^{cde}	0.206 (1.097)	0.183 (1.087) ^{def}
T_7	L-cyhalothrin 5EC (0.6ml/l)	1.075 (1.440)	0.475 (1.210)^{a}	0.650 (1.282)	0.338 (1.156) ^{bcd}	0.266 (1.125)	0.081 (1.040) ^{cde}	0.456 (1.206)	0.139 (1.066) ^{ab}
T_8	Untreated check	1.300 (1.513)	1.413 (1.552) ^{efg}	0.506 (1.226)	0.725 (1.313) ^{h}	0.225 (1.104)	0.213 (1.101) ^{g}	0.200 (1.092)	0.350 (1.062) ^{h}
	Mean	1.129	0.757	0.533	0.417	0.175	0.087	0.271	0.184
	CD (p=0.05)	NS	0.134	NS	0.055	NS	0.035	NS	0.032
	SE (m) ±	0.050	0.045	0.046	0.019	0.027	0.012	0.032	0.011
	CV (%)	6.938	6.865	7.429	3.146	5.030	2.247	5.672	2.007

*Values in the parentheses are square root transformation values

MADAKKATHARA

Treatment details:

Sl. No.	Treatments
T_1	Thiamethoxam (0.1g/l)
T_2	Thiamethoxam (0.2g/l)
T_3	Carbosulfan (2ml/l)
T_4	Buprofezin (2ml/l)
T_5	*Beauveria bassiana* WP (0.5 g/l)
T_6	*Beauveria bassiana* WP (1g/l)
T_7	*Beauveria bassiana* WP (5g/l)
T_8	L-cyhalothrin (0.6 ml/l)
T_9	POP, KAU (L-cyhalothrin-quinalphos-thiamethoxam)
T_{10}	Untreated check

Influence of insecticides on tea mosquito bug (TMB) damage

The trial was conducted in the mid season variety, Priyanka. Two sprays were given during flowering and nut development stage. The TMB damage score recorded before spray and 15 days after second and third spray is presented in Table 3.4.

Before spraying, the average damage score was 0.037 and 0.189 respectively on laterals and panicles. However, after 15 days of second spray, treatments T_8 (lambda cyhalothrin (0.6ml/l), T_2 (Thiamethoxam (0.2g/l) and T_9 (POP, KAU) recorded less damage score on laterals. On panicles, T_8 (lambda cyhalothrin (0.6ml/l), T_2 (Thiamethoxam (0.2g/l), T_9 (POP, KAU), T_1 (Thiamethoxam (0.1g/l) and T_3 (Carbosulfan (2ml/l) recorded less damage score. After 15 days of third spray, least damage score was recorded in T_2 (Thiamethoxam (0.2g/l), T_8 (lambda cyhalothrin (0.6ml/l) T_9 (POP, KAU) and T_1 (Thiamethoxam (0.1g/l) on both laterals and panicles.

Treatments have a significant effect on nut yield. Nut yield was the highest in T_1 (Thiamethoxam 0.1g/l) and T_2 (Thiamethoxam (0.2g/l) followed by T_9 (POP, Kerala) and T_8 (lambda cyhalothrin (0.6ml/l).

Table 3.4 : Efficacy of different insectcides against TMB incidence in cashew at Madakkathara Centre (2019-20)

Treatments	TMB incidence on 30 leader shoots/panicles at different days after spray (DAS)						Nut yield (kg/ tree
	On laterals			On panicles			
	Before spray	15 days after II spray	15 days after III spray	Before spray	15 days after IIspray	15 days after III spray	
T_1	0.000 *(0.707)^{b}	0.016 (0.717)^{ab}	0.324 (0.913)^{bc}	0.066 (0.751)	0.154 (0.807)^{b}	0.427 (0.948)^{bc}	7.83^{a}
T_2	0.013 (0.716)^{b}	0.010 (0.713)^{b}	0.184 (0.835)^{c}	0.102 (0.774)	0.137 (0.798)^{b}	0.267 (0.860)^{c}	7.70^{a}
T_3	0.017 (0.719)^{b}	0.016 (0.717)^{ab}	0.297 (0.896)^{bc}	0.178 (0.821)	0.267 (0.876)^{b}	0.644 (1.063)^{b}	3.74^{b}
T_4	0.000 (0.707)^{b}	0.083 (0.760)^{ab}	0.761 (1.123)^{ab}	0.160 (0.812)	0.514 (1.007)^{a}	1.151 (1.294)^{a}	3.29^{bc}
T_5	0.087 (0.765)^{ab}	0.051 (0.742)^{ab}	0.479 (0.988)^{b}	0.257 (0.869)	0.445 (0.970)^{a}	0.916 (1.196)^{a}	2.46^{c}

Treatments	TMB incidence on 30 leader shoots/panicles at different days after spray (DAS)						Nut yield (kg/ tree
	On laterals			On panicles			
	Before spray	15 days after II spray	15 days after III spray	Before spray	15 days after IIspray	15 days after III spray	
T_6	0.012 (0.715) [b]	0.098 (0.771) [a]	0.524 (1.005) [ab]	0.317 (0.881)	0.469 (0.983) [a]	0.878 (1.181) [a]	2.51[c]
T_7	0.075 (0.758)[ab]	0.041 (0.736) [ab]	0.504 (0.995) [b]	0.250 (0.863)	0.448 (0.973) [a]	0.675 (1.085) [b]	2.35 [c]
T_8	0.042 (0.735)[ab]	0.002 (0.706)[b]	0.409 (0.950)[bc]	0.200 (0.836)	0.196 (0.832) [b]	0.557 (1.010)[bc]	4.88[b]
T_9	0.024 (0.724)[ab]	0.006 (0.710)[b]	0.416 (0.958)[bc]	0.044 (0.736)	0.264 (0.872) [b]	0.533 (1.008)[bc]	5.26[b]
T_{10}	0.100 (0.775)[a]	0.042 (0.737) [ab]	0.789 (1.130) [a]	0.316 (0.903)	0.514 (1.003) [a]	1.021 (1.245) [a]	2.58[c]
Mean	0.037	0.036	0.469	0.189	0.341	0.706	4.26
SEm±	0.004	0.007	0.050	0.017	0.009	0.016	0.601
CD @ 5 %	**0.054**	**0.054**	**0.133**	**NS**	**0.093**	**0.154**	**1.798**
CV (%)	1.40	4.32	7.91	11.5	6.0	5.74	24.42

*Figures in parentheses are square root √x+0.5 transformed values

Benefit to cost ratio analysis

The yield and economics of cashew in chemical control of pest complex is presented in Table 3.5. The highest benefit cost ratio was recorded in T_1 followed by T_2, T_9 and T_8.

Table 3.5 : Yield and economics of cashew in chemical control trial at Madakkathara centre during 2019-20

Treatments	Yield of Cashew (Kg/ ha)	Cost of Cultivation (Rs. /ha)	Returns (Rs. /ha)		B: C
			Total	Net	
T_1	1566	73680	172260	98580	2.34
T_2	1540	75360	169400	94040	2.25
T_3	748	78240	82280	4040	1.05
T_4	658	76800	72380	-4420	0.94
T_5	492	72120	54120	-18000	0.75
T_6	502	72240	55220	-17020	0.76
T_7	470	73200	51700	-21500	0.71
T_8	976	73260	107360	34100	1.47
T_9	1052	74740	115720	40980	1.55
T_{10}	316	72000	34760	-37240	0.48

Selling price of cashew @Rs. 110/kg nut

Influence of insecticides on other insect pests

The infestations of leaf miner, apple and nut borer and thrips were noticed during this period. However, no significant difference was observed among the treatments.

Influence of insecticides on natural enemies

Population of natural enemies (Black ant and spiders) was observed and recorded before and after 30 days of each spray. No significant difference was observed among the treatments with respect to the population of natural enemies.

The trees are being monitored for tea mosquito bug infestation in order to impose the treatments for the year 2020.

PARIA

The population of Tea Mosquito Bug (TMB) on shoots and panicles ranged between 1.51 to 1.65 and 1.55 to 1.71, respectively before spraying the insecticides. The TMB damage score at 7 days and 15 days after the spray ranged from 0.75 to 1.65 and 0.28 to 1.82 on shoots and 0.57 to 1.72 and 0.24 to 1.85 on panicles. Almost all the treatments were observed to be significantly superior over the control for reducing the TMB population on both shoots and panicles after spraying the insecticides. After 15 days of spray, treatment T4 (Buprofezin) was found to be superior for the management of TMB on shoots and panicles and it was statistically at par with other treatment, T3 (Carbosulfan). The maximum TMB damage score was observed in the control treatments.

Table 3.6 : Efficacy of different insecticides against tea mosquito bug incidence in cashew at Paria centre during the year 2019-20

Treatments		On shoots (%)			On panicles (%)		
		BS	7 DAS	15 DAS	BS	7 DAS	15 DAS
T1	Thiamethoxam 25% WG 1g/10 lit	1.59	1.37	1.25	1.62	1.42	1.28
T2	Thiamethoxam 25% WG 2g/10 lit	1.55	1.26	0.94	1.58	1.32	1.16
T3	Carbosulfan 25% EC 20ml/10 lit	1.63	0.78	0.36	1.71	0.66	0.33
T4	Buprofezin 25% SC 20 ml/10 lit	1.62	0.75	0.28	1.63	0.57	0.24
T5	*Beauveria bassiana* 10 g/10 lit	1.59	1.55	1.28	1.55	1.46	1.23
T6	*Beauveria bassiana* 50 gm/10 lit	1.51	1.26	0.99	1.64	1.35	1.11
T7	L-Cyhalothrin 5% EC 6 ml /10 lit	1.65	1.02	0.75	1.60	0.98	0.61
T8	Untreated control	1.52	1.65	1.82	1.55	1.72	1.85
	SEm ±	0.09	0.07	0.58	0.09	0.07	0.06
	CD at 5%	NS	0.23	0.17	NS	0.21	0.19
	CV%	10.24	11.07	10.56	9.83	10.43	11.48

The results on the efficacy of different treatments against thrips indicated that all the insecticidal treatments significantly reduced the incidence of thrips over the control in cashew crop. In case of nut thrips damage, minimum damage was recorded with Buprofezin (0.39 nut thrips damage score) after 3rd spray which was statistically at par with Carbosulfan with 0.43 thrips damage score. *Beauveria bassiana* (10g/10 lit) and thiamethoxam (1g/10 lit) proved to be less effective for the control of thrips. The maximum nut yield (kg/plant) was recorded in the treatment of buprofezin with 4.31kg/plant while it was at par with Carbosulfan (4.11 kg/plant).

Table 3.7 : Efficacy of different insecticides against pest complex in cashew at Paria centre during the year 2019-20

Treatment		Thrips damage score on nuts	Nut Yield (kg/plant)
		30 days after 3rd Spray	
T1	Thiamethoxam 25% WG 1g/10 lit	1.42	2.32
T2	Thiamethoxam 25% WG 2g/10 lit	0.97	2.41

Treatment		Thrips damage score on nuts	Nut Yield (kg/ plant)
		30 days after 3rd Spray	
T3	Carbosulfan 25% EC 20ml/10 lit	0.43	4.11
T4	Buprofezin 25% SC 20 ml/10 lit	0.39	4.31
T5	*Beauveria bassiana* 10 g/10 lit	1.57	1.22
T6	*Beauveria bassiana* 50 gm/10 lit	1.04	2.75
T7	L-Cyhalothrin 5% EC 6 ml /10 lit	0.77	3.79
T8	Untreated control	2.46	0.83
	SEm ±	0.06	0.10
	CD at 5%	0.19	0.31
	CV%	10.13	6.57

The population of natural enemies was higher before spraying the insecticides. The populations of natural enemies spiders, ants and lady bird beetle were recorded before 3rd spray and 30th days after 3rd spraying. Maximum populations of spiders, ants and lady bird beetles within the treated trees were recorded in the treatment with *Beauveria bassiana* and also with untreated control.

Table 3.8 : Influence of different insecticides on natural enemies in cashew at paria centre during the year 2019-20

Treatment		Spiders		Ants		Lady bird beetle	
		Before spray	30 days after 3rd spray	Before spray	30 days after 3rd spray	Before spray	30 days after 3rd spray
T1	Thiamethoxam 25% WG 1g/10 lit	0.12	0.04	2.53	1.78	0.08	0.06
T2	Thiamethoxam 25% WG 2g/10 lit	0.12	0.04	2.74	1.97	0.10	0.07
T3	Carbosulfan 25% EC 20ml/10 lit	0.11	0.06	2.62	2.21	0.09	0.05
T4	Buprofezin 25% SC 20 ml/10 lit	0.12	0.04	2.87	1.60	0.11	0.05
T5	*Beauveria bassiana* 10 g/10 lit	0.12	0.12	2.72	2.86	0.09	0.12
T6	*Beauveria bassiana* 50 gm/10 lit	0.10	0.11	2.68	2.81	0.09	0.13
T7	L-Cyhalothrin 5% EC 6 ml /10 lit	0.08	0.02	2.83	1.55	0.10	0.02
T8	Untreated control	0.11	0.14	2.92	3.19	0.09	0.14
	SEm ±	0.01	0.01	0.08	0.12	0.01	0.01
	CD at 5%	NS	0.04	NS	0.35	NS	0.03
	CV%	18.44	27.44	5.34	8.88	21.27	24.33

VENGURLE

During the year 2019-20, the data presented in Table 3.9 showed that all the insecticidal treatments reduced the incidence of tea mosquito bug over control. Among the insecticides tested, the treatment T_2 Thiamethoxam recorded significantly lowest incidence of tea mosquito bug on shoot (0.057) and panicle (0.067) whereas, it was on par with the treatment T_4 Buprofezin on shoot and treatment T_5 L-cyhalothrin on panicle.

In case of yield (kg per tree), treatment T_2 Thiamethoxam recorded highest yield (6.65 kg/tree). More number of natural enemies was observed in treatment T_6 (Untreated check).

Table 3.9 : Efficacy of different insecticides against tea mosquito bug incidence in cashew at Vengurla centre during the year 2019-20

Treatments		On shoots		On panicles		Yield (kg/tree)	Natural enemies recorded after spraying
		Pre count	15 days after spray	Pre count	15 days after spray		
T_1	Thiamethoxam	0.182	0.110	0.187	0.101	5.35	2.31 (2.73)
T_2	Thiamethoxam	0.192	**0.057**	0.182	**0.067**	6.65	2.41 (1.45)
T_3	Carbosulfan	0.182	0.173	0.192	0.125	5.10	2.77 (1.67)
T_4	Buprofezin	0.183	0.096	0.187	0.158	5.26	2.87 (1.63)
T_5	L-cyhalothrin	0.183	0.110	0.144	0.096	5.16	1.95 (1.22)
T_6	Untreated check	0.192	0.269	0.178	0.370	1.42	3.20 (3.74)
	SEm ±	0.007	0.010	0.018	0.011	0.219	0.267
	CD at 5%	NS	0.031	NS	0.032	0.661	0.569
	CV%	18.22	15.45	19.79	14.13	9.09	13.0

*The figure in parenthesis are square root transformed value

In case of thrips (Table 3.10), all the insecticidal treatment reduced the incidence of thrips over control. Among the insecticide tested, the treatment, T_2 (Thiamethoxam) recorded the lower incidence of thrips thirty days after the third spray and it was also on par with treatment T_1 (Thiamethoxam).

Table 3.10 : Efficacy of different insecticides against Thrips incidence in cashew at Vengurla centre during the year 2019-20

Treatments		Before spray	30 days after spray
T_1	Thiamethoxam	0.16	0.07
T_2	Thiamethoxam	0.16	**0.05**
T_3	Carbosulfan	0.16	0.14
T_4	Buprofezin	0.17	0.15
T_5	L-cyhalothrin	0.15	0.18
T_6	Untreated check	0.13	0.25
	SEm ±	0.01	0.01
	CD at 5%	NS	0.03
	CV%	13.14	14.04

VRIDHACHALAM

Experimental details

Design	:	RBD	No. of trees/treatment	:	Two
Treatment	:	Nine	Replication	:	Four
Variety	:	VRI-3	Year of Planting	:	2005

Treatments

The following treatments were imposed as per approved technical programme.

T-1 : Thiamethoxam 25 WG @ 0.1g/lit. all the three sprays
T-2 : Carbosulfan 25 EC @ 2 ml/lit. all the three sprays
T-3 : Buprofezin 25 % SC @ 2 ml/lit. all the three sprays
T-4 : *Beauveria bassiana* WP @ 1 g/lit.
T-5 : *Beauveria bassiana* WP @ 2 g/lit.
T-6 : *Beauveria bassiana* WP @ 5 g/lit.
T-7 : Lambda-Cyhalothrin 5 EC -(0.6ml/lit) all the three sprays
T-8 : Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays
T-9 : Untreated control

Three round spray schedule of chemical insecticides was followed at flushing, flowering and fruit nut development stages. The entomopathogenic fungal treatment was also sprayed during flushing to fruiting at the interval of 15 days. Totally five round of sprays were imposed with maximum spray suspension usage of 10 lit./each spray per tree.

The data on the pest incidence for each treatment was recorded from randomly selected 52 leader shoots of each tree at four sides (East, West, North, South) on 7th, 15th and 30th days after each spray. Observations were recorded on the infestation of TMB (damage in 0-4 scale) on flushes, TMB population (adults and nymphs), leaf miner(% infestation), leaf folder(% infestation), Leaf and blossom webber (% infestation), apple and nut borer damage (% infestation) were recorded. Natural enemies population *viz*., Spiders, ants, coccinellids and cotesia were also recorded.

The results of evaluation of insecticides against TMB revealed that after first, second and third spraying, the efficacy of different insecticides was observed and they were statistically superior over untreated control (Table 3.11). The pre-treatment damage score of TMB was non-significant in all treatments including the untreated control. Gradual reduction of fresh infestation was observed two weeks after each round of spray. After first spray, the damage score was low (0.500) in T7 (Lambda-Cyhalothrin 5 EC @ 0.6ml/lit. all the three sprays), followed by T8 (Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays) and T1 (Thiamethoxam 25 WG @ 0.1 g/lit. all the three sprays) which was at par with each other. It was followed by T2 (Carbosulfan 25 EC @ 2 ml/lit. all the three sprays) and T3 (Buprofezin 25 % SC @ 2 ml/lit. all the three sprays) which was at par with each other, followed by T6 (*Beauveria bassiana* WP @ 5 g/lit.), T5 (*Beauveria bassiana* WP @ 2 g/lit.) and T4 (*Beauveria bassiana* WP @ 1 g/lit.) ranging between 0.625 and 1.825 as against 2.35 in the control on 7 DAS. The same was observed in 15 DAS and 30 DAS also. After the second spray, the damage score ranged between 0.100 and 1.07 in different treatments as against an increased damage score of 3.47 in untreated control. Thirty days after third spray, the damage score decreased and ranges between 0.002 and 0.65 in various treatments as against an increased score of 3.62 in control (Table 3.11). The overall efficacy ranked in the order against the incidence of TMB and its population at Vridhachalam are as follows: T7 (Lambda-Cyhalothrin 5 EC @ 0.6ml/lit. all the three sprays) > T8 (Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays) > T1 (Thiamethoxam 25 WG @ 0.1 g/lit. all the three sprays) > T2 (Carbosulfan 25 EC @ 2 ml/lit. all the three sprays) > T3 (Buprofezin 25 % SC @ 2 ml/lit. all the three sprays) >T6 (*Beauveria bassiana* WP @ 5 g/lit.) > T5 (*Beauveria bassiana* WP @ 2 g/lit.) > T4 (*Beauveria bassiana* WP @ 1 g/lit.) Reduction of fresh infestation was observed when fourth and fifth spraying was given to the treated trees of T5 (*Beauveria bassiana* WP @ 5 g/lit.), T5 (*Beauveria bassiana* WP @ 2 g/lit.), T4 (*Beauveria bassiana* WP @ 1 g/lit.). The efficacy of different insecticides was at par, but statistically superior over untreated control.

Table 3.11 : Effect of insecticides on the incidence of TMB at Vridhachalam

(Mean of four replications)

Treatment		Pre-treatment damage score (0-4)	Post treatment mean damage score (0-4)			Pre-treatment damage score (0-4)	Post treatment mean damage score (0-4)			Pre-treatment damage score (0-4)	Post treatment mean damage score (0-4)		
			I Spray				II Spray				III Spray		
			7 DAS	15 DAS	30 DAS		7 DAS	15 DAS	30 DAS		7 DAS	15 DAS	30 DAS
T1	Thiamethoxam 25 WG @ 0.1 g/lit. all the three sprays	2.813 (1.952)	0.650 (1.284)	0.550 (1.245)	0.425 (1.194)	3.075 (2.019)	0.525 (1.235)	0.450 (1.204)	0.350 (1.162)	3.600 (2.145)	0.250 (1.118)	0.1500 (1.072)	0.0083 (1.004)
T2	Carbosulfan 25 EC @ 2 ml/lit. all the three sprays	2.773 (1.942)	0.900 (1.378)	0.800 (1.342)	0.700 (1.304)	3.000 (2.000)	0.850 (1.360)	0.775 (1.332)	0.675 (1.294)	3.525 (2.127)	0.375 (1.172)	0.2750 (1.129)	0.2500 (1.118)
T3	Buprofezin 25 % SC @ 2 ml/lit. all the three sprays	2.835 (1.958)	1.300 (1.516)	1.200 (1.483)	1.050 (1.431)	3.150 (2.037)	1.000 (1.414)	0.925 (1.387)	0.825 (1.351)	3.500 (2.121)	0.625 (1.275)	0.5250 (1.235)	0.3750 (1.172)
T4	*Beauveria bassiana* WP @ 1 g/lit.	2.800 (1.949)	1.875 (1.696)	1.775 (1.666)	1.675 (1.635)	3.050 (2.012)	1.225 (1.492)	1.150 (1.466)	1.050 (1.432)	3.525 (2.126)	0.875 (1.369)	0.7750 (1.332)	0.6500 (1.285)
T5	*Beauveria bassiana* WP @ 2 g/lit.	2.800 (1.949)	1.700 (1.643)	1.600 (1.612)	1.450 (1.565)	3.075 (2.019)	1.250 (1.500)	1.175 (1.475)	1.075 (1.440)	3.625 (2.150)	0.825 (1.350)	0.7250 (1.313)	0.6000 (1.265)
T6	*Beauveria bassiana* WP @ 5 g/lit.	2.675 (1.917)	1.575 (1.605)	1.475 (1.573)	1.350 (1.533)	2.975 (1.994)	1.200 (1.483)	1.125 (1.457)	1.025 (1.423)	3.525 (2.127)	0.800 (1.342)	0.7000 (1.304)	0.5500 (1.245)
T7	Lambda-Cyhalothrin 5 EC @ 0.6ml/lit. all the three sprays	2.800 (1.949)	0.500 (1.225)	0.400 (1.183)	0.275 (1.129)	3.000 (2.000)	0.375 (1.172)	0.300 (1.140)	0.100 (1.049)	3.450 (2.109)	0.124 (1.060)	0.0806 (1.040)	0.0020 (1.001)
T8	Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays	2.780 (1.944)	0.625 (1.275)	0.500 (1.225)	0.325 (1.151)	3.125 (2.031)	0.500 (1.225)	0.425 (1.194)	0.225 (1.107)	3.450 (2.109)	0.225 (1.107)	0.1250 (1.060)	0.0078 (1.004)
T9	Untreated control	2.795 (1.948)	2.875 (1.968)	2.925 (1.981)	3.025 (2.006)	3.125 (2.031)	3.425 (2.104)	3.450 (2.109)	3.475 (2.115)	3.500 (2.121)	3.525 (2.127)	3.5750 (2.139)	3.6250 (2.151)
C.D.		NS	0.036	0.034	0.033	NS	0.034	0.032	0.031	NS	0.032	0.033	0.026
SEm ±		0.015	0.012	0.011	0.011	0.013	0.012	0.011	0.011	0.021	0.011	0.011	0.009
SE(D)		0.021	0.018	0.016	0.016	0.018	0.017	0.016	0.015	0.030	0.016	0.016	0.012
CV		1.520	1.645	1.551	1.566	1.288	1.629	1.550	1.554	1.978	1.666	1.748	1.395

DAS – Days After Spraying

Values in the parentheses are $\sqrt{x+0.5}$ transformed values

Table 3.12 : Efficacy of insecticides on TMB population / 52 leader shoot at Vridhachalam

(Mean of four replications)

Treatment		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)			Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)			Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)		
			I Spray				II Spray				III Spray		
			7 DAS	15 DAS	30 DAS		7 DAS	15 DAS	30 DAS		7 DAS	15 DAS	30 DAS
T1	Thiamethoxam 25 WG @ 0.1 g/lit. all the three sprays	3.525 (2.127)	0.475 (1.214)	0.065 (1.032)	0.050 (1.025)	4.350 (2.312)	0.135 (1.065)	0.043 (1.021)	0.048 (1.023)	2.925 (1.981)	0.008 (1.004)	0.006 (1.003)	0.003 (1.002)
T2	Carbosulfan 25 EC @ 2 ml/lit. all the three sprays	3.650 (2.156)	0.725 (1.313)	0.350 (1.162)	0.075 (1.037)	4.403 (2.324)	0.788 (1.337)	0.450 (1.201)	0.081 (1.040)	2.950 (1.987)	0.048 (1.023)	0.024 (1.023)	0.018 (1.009)
T3	Buprofezin 25 % SC @ 2 ml/lit. all the three sprays	3.525 (2.127)	0.825 (1.351)	0.525 (1.235)	0.083 (1.040)	4.733 (2.394)	0.858 (1.363)	0.550 (1.245)	0.288 (1.135)	2.875 (1.968)	0.080 (1.039)	0.048 (1.039)	0.030 (1.015)
T4	*Beauveria bassiana* WP @ 1 g/lit.	3.550 (2.132)	1.188 (1.479)	0.700 (1.304)	0.125 (1.060)	4.675 (2.382)	1.300 (1.516)	0.890 (1.375)	0.625 (1.274)	2.850 (1.962)	0.200 (1.095)	0.225 (1.095)	0.068 (1.033)
T5	*Beauveria bassiana* WP @ 2 g/lit.	3.650 (2.156)	1.150 (1.466)	0.650 (1.284)	0.095 (1.046)	4.623 (2.371)	1.250 (1.500)	0.658 (1.287)	0.613 (1.270)	2.975 (1.994)	0.175 (1.083)	0.125 (1.083)	0.060 (1.030)
T6	*Beauveria bassiana* WP @ 5 g/lit.	3.800 (2.191)	1.050 (1.431)	0.625 (1.275)	0.090 (1.044)	4.725 (2.393)	1.150 (1.466)	0.640 (1.281)	0.500 (1.224)	2.925 (1.981)	0.125 (1.060)	0.089 (1.060)	0.055 (1.027)
T7	Lambda-Cyhalothrin 5 EC @ 0.6ml/lit. all the three sprays	3.600 (2.145)	0.029 (1.014)	0.045 (1.022)	0.023 (1.011)	4.675 (2.382)	0.033 (1.016)	0.023 (1.011)	0.011 (1.006)	2.925 (1.981)	0.003 (1.001)	0.002 (1.001)	0.001 (1.000)
T8	Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays	3.675 (2.162)	0.450 (1.204)	0.063 (1.031)	0.048 (1.023)	4.650 (2.377)	0.105 (1.051)	0.038 (1.019)	0.025 (1.012)	2.975 (1.994)	0.007 (1.003)	0.005 (1.003)	0.003 (1.001)
T9	Untreated control	3.750 (2.179)	3.875 (2.208)	3.969 (2.229)	4.544 (2.354)	4.544 (2.354)	4.719 (2.390)	5.094 (2.468)	5.369 (2.523)	5.244 (2.499)	5.319 (2.514)	5.369 (2.514)	5.544 (2.558)
C.D.		NS	0.041	0.033	0.037	NS	0.052	0.059	0.056	NS	0.035	0.035	0.012
SEm ±		0.012	0.014	0.011	0.013	0.022	0.018	0.020	0.019	0.008	0.012	0.012	0.004
SE(D)		0.017	0.020	0.016	0.018	0.031	0.025	0.029	0.027	0.011	0.017	0.017	0.006
CV		1.149	1.989	1.756	2.135	1.846	2.511	3.053	2.992	0.772	1.990	1.989	0.695

PTC – Pre Treatment Count ; DAS – Days After Spraying

Values in the parentheses are $\sqrt{x+0.5}$ transformed values

Table 3.13 : Efficacy of insecticides against foliar pests at Vridhachalam

(Mean of four observations)

Treatment		Mean damage after 3rd spray										Yield (Kg per tree)
		TMB Damage %		Leaf Miner %		Leaf and Blossom Webber %		Leaf Thrips Population (Nos.)		Apple and Nut Borer %		
		PTC	30 DAS	PTC	30 DAS	PTC	30 DAS	PTC	30 DAS	PTC	30 DAS	
T1	Thiamethoxam 25 WG @ 0.1 g/lit. all the three sprays	3.725 (11.119)	2.125 (8.378)	4.700 (12.515)	1.475 (6.968)	4.475 (12.207)	0.888 (5.402)	8.675 (3.110)	0.400 (1.182)	1.325 (6.588)	0.002 (0.266)	6.125
T2	Carbosulfan 25 EC @ 2 ml/lit. all the three sprays	3.825 (11.260)	2.388 (8.883)	4.700 (12.514)	1.575 (7.206)	4.400 (12.103)	0.825 (5.209)	8.625 (3.102)	0.475 (1.214)	1.525 (7.072)	0.028 (0.939)	5.925
T3	Buprofezin 25 % SC @ 2 ml/ lit. all the three sprays	3.650 (11.009)	2.450 (8.999)	4.775 (12.616)	1.800 (7.706)	4.500 (12.242)	1.013 (5.764)	8.575 (3.094)	0.575 (1.255)	1.550 (7.134)	0.035 (1.062)	5.825
T4	*Beauveria bassiana* WP @ 1 g/lit.	3.725 (11.123)	2.788 (9.607)	4.775 (12.616)	2.100 (8.328)	4.475 (12.208)	1.438 (6.863)	8.575 (3.094)	0.800 (1.341)	1.625 (7.312)	0.075 (1.568)	5.513
T5	*Beauveria bassiana* WP @ 2 g/lit.	3.600 (10.933)	2.700 (9.452)	4.750 (12.582)	1.788 (7.679)	4.550 (12.311)	1.275 (6.470)	8.625 (3.102)	0.750 (1.322)	1.625 (7.310)	0.060 (1.401)	5.575
T6	*Beauveria bassiana* WP @ 5 g/lit.	3.775 (11.194)	2.575 (9.228)	4.775 (12.616)	1.875 (7.865)	4.550 (12.311)	1.063 (5.906)	8.775 (3.126)	0.700 (1.304)	1.575 (7.199)	0.043 (1.167)	5.750
T7	Lambda-Cyhalothrin 5 EC @ 0.6ml/lit. all the three sprays	3.800 (11.236)	1.563 (7.136)	4.775 (12.617)	0.798 (5.120)	4.525 (12.276)	0.785 (5.060)	8.650 (3.106)	0.200 (1.093)	1.625 (7.317)	0.001 (0.200)	6.725
T8	Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays	3.750 (11.152)	2.075 (8.277)	4.700 (12.515)	1.175 (6.219)	4.475 (12.207)	0.908 (5.456)	8.750 (3.122)	0.425 (1.193)	1.700 (7.486)	0.003 (0.311)	6.450
T9	Untreated control	3.800 (11.236)	3.875 (11.348)	4.750 (12.582)	4.860 (12.730)	4.500 (12.242)	4.700 (12.515)	8.725 (3.118)	9.100 (3.178)	1.600 (7.257)	1.813 (7.733)	4.550
C.D.		NS	0.509	NS	0.233	NS	0.474	NS	0.065	NS	0.180	0.026
SEm ±		0.150	0.173	0.057	0.079	0.057	0.161	0.010	0.022	0.141	0.061	0.009
SE(D)		0.212	0.245	0.081	0.112	0.081	0.228	0.014	0.031	0.200	0.087	0.012
CV		2.696	3.840	0.911	2.043	0.936	4.955	0.640	3.026	3.934	7.526	0.669

PTC- Pre Treatment Count; DAS: Days After Spraying

Values in the parentheses are arc sine $\sqrt{\text{per cent}}$ transformed values for per cent damage and $\sqrt{x+0.5}$ transformed values for population numbers.

The population trend of TMB and other foliar feeding insects was recorded (Table 3.13). Thirty days after 3rd spray, all the insecticides effective in controlling TMB populations to zero as against 4.5 bugs/ 52 leader shoots observed in untreated control. Furthermore, the per cent damage of leaf miner, leaf folder, leaf and blossom webber and nut borer was very low in all insecticides treated trees as compared to untreated trees.

The population trends of various natural enemies in respect of all the insecticide treatments gradually decimated the population of spiders, coccinellids, ants and braconid wasp after each round of insecticidal spray. In untreated trees, the activities of weaver ants and *Cotesia* wasps were predominant among different forms of natural enemies (Table 3.14).

Table 3.14 : Effect of insecticide sprays on natural enemies at Vridhachalam

(Mean of four observations)

Treatment		Mean number of natural enemies / pollinators in 52 inflorescence 30 days after 3rd spray			
		Spiders	Ants	Coccinellids	*Cotesia*
		30 DAS	30 DAS	30 DAS	30 DAS
T1	Thiamethoxam 25 WG @ 0.1 g/lit. all the three sprays	4.875 (2.423)	6.250 (2.691)	3.000 (1.994)	4.050 (2.239)
T2	Carbosulfan 25 EC @ 2 ml/lit. all the three sprays	5.125 (2.474)	6.625 (2.760)	3.125 (2.022)	4.250 (2.289)
T3	Buprofezin 25 % SC @ 2 ml/lit. all the three sprays	5.375 (2.522)	6.750 (2.783)	3.250 (2.061)	4.375 (2.307)
T4	*Beauveria bassiana* WP @ 1 g/lit.	4.250 (2.291)	7.125 (2.850)	4.125 (2.259)	4.500 (2.343)
T5	*Beauveria bassiana* WP @ 2 g/lit.	3.875 (2.207)	7.125 (2.849)	3.750 (2.176)	4.250 (2.289)
T6	*Beauveria bassiana* WP @ 5 g/lit.	3.750 (2.179)	6.875 (2.803)	3.375 (2.084)	4.500 (2.337)
T7	Lambda-Cyhalothrin 5 EC @ 0.6ml/lit. all the three sprays	3.375 (2.089)	5.625 (2.573)	2.250 (1.796)	3.450 (2.098)
T8	Thiamethoxam 25 WG @ 0.2 g/lit. all the three sprays	5.125 (2.472)	6.125 (2.667)	2.625 (1.903)	3.550 (2.122)
T9	Untreated control	9.725 (3.275)	11.675 (3.560)	5.550 (2.559)	8.450 (3.074)
	CD	0.126	0.149	0.197	0.247
	SE(m) ±	0.043	0.051	0.067	0.084
	SE(d)	0.061	0.072	0.095	0.119
	C.V.	3.528	3.581	6.420	7.191

Values in the parentheses are $\sqrt{x+0.5}$ transformed values

The mean population of natural enemies was considerably lower in sprayed trees, but in unsprayed trees, higher number of natural enemies were observed throughout the season.

Expt.4 : Evaluation of Botanicals for the control of Tea Mosquito Bug and other insect pests

Centres: East Coast :	Bapatla, Bhubaneshwar and Vridhachalam
West Coast :	Paria, Pilicode, Madakkathara and Vengurla
Plains / others:	Hogalagere and Jagdalpur

Objective : Evaluation of botanicals for the control of foliage and floral pests of Cashew.

BAPATLA

Treatments: 9 (Nine)

Treatment details:

T_1 : Custard leaf extract @ 7.5%
T_2 : Chilli Garlic Extract @ 2%
T_3 : Pongamia seed extract @ 4%
T_4 : Azadirachtin 10000 ppm@ 5 ml/l
T_5 : Ajith paul botanical formulation (AAVYA Botanical pesticide)
T_6 : Lamda Cyahalothrin 5EC @ 0.6 ml/l
T_7 : Water spray

Three sprays were imposed at 30-35 days interval at flushing, flowering and at fruit & nut development stages.

No. of replications	:	3
No. of trees per replication	:	2
Design	:	R.B.D.

The data on pest incidence will be recorded from 6 trees per each treatment. Fifty two leader shoots of each selected tree from all the four sides were tagged for observation in respect of leaf and blossom webber, shoot tip caterpillar at one day before spray and 7 days interval after each spray. In the case of apple and nut borer, total number of nuts in 52 tagged panicles and the nuts damaged by the borer were counted at 7 days interval after 3rd spray. Thrips damage on nut surface was graded on 100 nuts per tree following 0 to 4 scale. Counts of spiders and ants were recorded at 7 days interval after 3rd spray by tapping 52 panicles per tree on 1 sq. foot card board.

During the year 2019-20, the activity of different important foliage, flower and nut feeding pests incidence was very low in all treatments. Hence, treatments were not imposed during this season.

HOGALAGERE

The damage of tea mosquito bug (TMB) on shoots and panicles ranged between 2.12 to 2.32 and 2.10 to 2.52, respectively at before application of the treatments, the TMB damage on young shoots at 7 days and 15 days after spray ranged from 0.55 to 2.78 and 0.94 to 3.13 and on panicles, it ranged from 0.69 to 2.86 and 0.79 to 3.19. In both cases, the damage on shoots and panicles at 7 days and 15 days after each spray was significantly reduced in treatment Lambda-cyhalothrin 5 EC (0.6 ml/l) in all the sprays. The Azadirachtin 1% (1 ml/l), NSKE 5% and Ajith Paul solution (AAVYA) (4 g/l) were found to be next best treatments to reduce TMB damage both on shoots and panicles in all the sprays. Whereas, Pongamia seed extract 4% and Chilli-garlic extract 7.5% treatments were found to be least effective in reducing TMB damage. The maximum nut yield and cost benefit ratio were recorded in treatment Lambda-cyhalothrin 5 EC (0.6 ml/l) (4.25 kg/tree & 1: 3.06), followed by Azadirachtin 1% (1 ml/l) with (3.76 kg/tree & 1: 2.50) and NSKE 5% (3.47 kg/tree & 1: 2.14). The minimum yield was recorded in Chilli-garlic extract 7.5% and Pongamia seed extract 4% treatments. The results on efficacy of different treatments against apple and nut borer, thrips, aphids and mealybugs indicated similar trend in management of these pests in cashew just like TMB and recorded enhanced nut yield

(Table 3.15). However, the maximum spider, ladybird beetles, green lacewing and syrphid population were recorded in all the treatments except Lambda cyhalothrin 5EC treatment.

Table 3.15 : Efficacy of botanicals against Tea Mosquito Bug (TMB) incidence in cashew at HREC, Hogalagere center during 2019-20

Treatments		TMB damage on shoots / inflorescences (0-4 scale) at DAS						Mean	Nut yield (Kg/ tree) (3rd harvest)
		On shoots			On Inflorescence				
		BS	7 DAS	15 DAS	BS	7 DAS	15 DAS		
T_1	NSKE 5%	2.21 (1.65)	0.79 (1.14)	1.67 (1.47)	2.36 (1.69)	0.86 (1.17)	1.96 (1.57)	1.32	3.47
T_2	Azadiracthin 1% @ 1ml/l	2.12 (1.62)	0.77 (1.13)	1.02 (1.23)	2.11 (1.61)	0.93 (1.20)	1.11 (1.27)	0.96	3.76
T_3	*Pongamia* seed extract 4%	2.24 (1.65)	1.91 (1.55)	2.68 (1.78)	2.17 (1.63)	2.12 (1.62)	2.51 (1.73)	2.31	2.60
T_4	Chilli-Garlic Extract 7.5%	2.14 (1.62)	2.27 (1.66)	3.22 (1.93)	2.24 (1.65)	2.21 (1.65)	3.18 (1.92)	2.72	2.50
T_5	*Ajith Paul (AAVYA) @4g/l	2.19 (1.64)	1.69 (1.48)	1.75 (1.50)	2.10 (1.61)	1.80 (1.51)	1.89 (1.54)	1.78	3.01
T_6	L - Cyhalothrin 5EC@0.6ml/l	2.17 (1.63)	0.55 (1.02)	0.94 (1.20)	2.23 (1.65)	0.69 (1.09)	0.79 (1.14)	0.74	4.25
T_7	Untreated control	2.32 (1.68)	2.78 (1.81)	3.13 (1.90)	2.52 (1.74)	2.86 (1.83)	3.19 (1.92)	2.99	2.43
	SEm ±	0.43	0.06	0.12	0.14	0.12	0.15	-	0.14
	CD @ 5%	0.15	0.18	0.36	0.42	0.34	0.44	-	0.42
	CV	11.50	7.09	10.24	11.05	12.23	12.59	-	7.87

Table 3.16 : Efficacy of different insecticides against pest complex in cashew at HREC Hogalagere centre during 2019-20

Treatment		Incidence of diff. pests on shoots or inflorescence at DAS					
		Apple & Nut Borer (% damage)*		Thrips (No./shoot or panicle)**		Aphids (No. affected shoots/plant)**	
		BS	15 DAS	BS	15 DAS	BS	15 DAS
T_1	NSKE 5%	2.56 (1.74)	0.82 (1.15)	4.21 (2.17)	2.04 (1.59)	3.56 (2.01)	2.67 (1.78)
T_2	Azadiracthin 1% @ 1ml/l	2.76 (1.80)	0.76 (1.12)	4.19 (2.17)	1.98 (1.57)	3.76 (2.06)	1.87 (1.54)
T_3	*Pongamia* seed extract 4%	2.33 (1.68)	2.11 (1.62)	4.06 (2.13)	3.33 (1.95)	3.33 (1.96)	2.98 (1.87)
T_4	Chilli-Garlic Extract @ 7.5%	2.34 (1.77)	2.76 (1.81)	4.17 (2.16)	3.98 (2.11)	3.34 (1.96)	2.95 (1.86)
T_5	*Ajith Paul (AAVYA) @4g/l	2.63 (1.79)	2.02 (1.59)	4.26 (2.18)	3.24 (1.93)	3.63 (2.03)	2.74 (1.80)

Treatment		Incidence of diff. pests on shoots or inflorescence at DAS					
		Apple & Nut Borer (% damage)*		Thrips (No./shoot or panicle)**		Aphids (No. affected shoots/plant)**	
		BS	15 DAS	BS	15 DAS	BS	15 DAS
T_6	L - Cyhalothrin 5EC@ 0.6ml/l	2.72 (1.80)	0.54 (1.02)	4.15 (2.15)	1.76 (1.50)	3.72 (2.05)	2.23 (1.65)
T_7	Untreated control	2.53 (1.74)	3.11 (1.90)	4.22 (2.17)	4.88 (2.32)	3.53 (2.01)	4.64 (2.26)
	SEm±	0.16	0.13	0.25	0.28	0.18	0.21
	CD at 5%	NS	0.39	0.74	0.83	0.52	0.62
	CV	-	13.37	10.48	12.28	8.76	12.79

Table 3.17 : Evaluation of Botanicals safety to natural enemies in cashew during 2019-20 at HREC, Hogalagere

Treatment		No. of predators on shoots or inflorescence at DAS**							
		Oxypes sweta		*Menochilus sexmaculatus*		*Chrysoperla* sp		Syrphid	
		BS	15 DAS	BS	15 DAS	BS	15 DAS	BS	15 DAS
T_1	NSKE 5%	2.22 (1.65)	1.53 (1.42)	2.34 (1.68)	1.84 (1.53)	2.27 (1.66)	1.81 (1.52)	2.35 (1.69)	1.61 (1.45)
T_2	Azadiracthin 1% @ 1ml/l	2.01 (1.58)	1.71 (1.49)	2.13 (1.62)	1.92 (1.56)	2.27 (1.66)	1.99 (1.58)	2.14 (1.62)	1.79 (1.51)
T_3	*Pongamia* seed extract 4%	2.31 (1.67)	2.12 (1.62)	2.43 (1.71)	2.33 (1.68)	2.57 (1.75)	2.40 (1.70)	2.44 (1.71)	2.70 (1.79)
T_4	Chilli - Garlic Extract @ 7.5%	2.14 (1.62)	2.25 (1.66)	2.26 (1.66)	2.46 (1.72)	2.40 (1.70)	2.53 (1.74)	2.27 (1.66)	2.93 (1.85)
T_5	*Ajith Paul (AAVYA) @4g/l	2.17 (1.63)	2.28 (1.67)	2.29 (1.67)	2.49 (1.73)	2.43 (1.71)	2.56 (1.75)	2.30 (1.67)	2.86 (1.83)
T_6	L - Cyhalothrin 5EC@ 0.6ml/l	2.19 (1.63)	1.30 (1.34)	2.31 (1.68)	1.51 (1.42)	2.45 (1.72)	1.58 (1.44)	2.32 (1.68)	1.38 (1.37)
T_7	Untreated control	2.23 (1.65)	2.34 (1.68)	2.35 (1.69)	2.55 (1.75)	2.49 (1.73)	2.62 (1.77)	2.36 (1.69)	2.77 (1.81)
	SEm±	0.15	0.11	0.16	0.14	0.14	0.12	0.15	0.16
	CD	0.44	0.33	0.46	0.42	0.41	0.36	0.44	0.48
	CV	11.93	10.23	11.84	11.47	10.17	9.75	11.42	12.45

JAGDALPUR

The results of the evaluation of botanicals against TMB revealed that, after first and second spraying, the efficacy of different botanicals was statistically superior over untreated control. The results revealed that the mean of two spray T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) showed least (0.35) damage score (DS) which was at par with T_4 (*Datura* decoction @ 3 %/l) with 0.41 DS which was also at par with T_5 (Cow urine+ Mixed leaves putrefaction 3 %/l) with 0.60 DS. The efficacy of different botanicals against thrips revealed that before spray of insecticide the mean damage score of thrips was statistically non significant including untreated control (0.73 DS). The mean of two spray, the damage score was low (0.17) in T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) which was on par with T_4 (*Datura* decoction @ 3 %/l) with 0.26 damage score.

The pre-treatment observation of shoot tip caterpillar was non-significant including untreated control (T_9) with 5.86 per cent incidence. The data

recorded on 15 and 30 days after each spray and mean of two spray data of botanicals showed that the per cent leaf damage was low (1.47 %) in T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) which was on par with T_3 (*Calotropis* decoction 3 %/l) with 2.92 per cent. The lowest per cent incidence (0.19%) of leaf miner was observed in T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) which was at par with T_4 (*Datura* decoction @ 3 %/l) with 0.38 per cent, which was statistically on par with T_6 (Mixed leaves decoction 3 % /l) with 0.53 per cent. Similarly, leaf folder damage per cent was minimum (0.69%) in T_7 (L-cyhalothrin 5 EC @ 0.6ml/l) which was at par with T_2 (*Andrographus* decoction 5 %/l) with 1.14 per cent. All the treatments were statistically superior over untreated control (T_9) with 2.25 per cent incidence. The natural enemies population was also recorded in all treatments with varied level of population. None of the treatment was found to be significantly unsafe for natural enemies.

Table 3.18 : Efficacy of different botanicals on incidence of TMB and thrips at Jagdalpur during 2019-20

Treatment		Mean damage score of pests							
		*TMB				*Thrips			
		Pre treatment D S (0-4)	15 DAS after 1st spray	30 DAS after 1st spray	30 DAS after 2nd spray	Pre treatment DS (0-4)	15 DAS after 1st spray	30 DAS after 1st spray	30 DAS after 2nd spray
T_1	*Andrographus* decoction 3 %	1.99 (1.72)	1.85 (1.66) ^{fgh}	1.21 (1.46) ^{ef}	0.93 (1.39) ^{fg}	0.88 (1.36)	0.30 (1.13) ^{def}	0.24 (1.11) ^{de}	0.29 (1.11) ^{cdef}
T_2	*Andrographus* decoction 5 %	2.17 (1.78)	1.24 (1.49) ^{d}	0.70 (1.26) ^{cd}	0.44 (1.20) ^{bcd}	0.86 (1.36)	0.12 (1.05) ^{ab}	0.17 (1.07) ^{abc}	0.25 (1.13) ^{cde}
T_3	*Calotropis* decoction 3 %	2.07 (1.75)	1.77 (1.66) ^{f}	1.55 (1.58) ^{g}	1.20 (1.48) ^{h}	1.15 (1.46)	0.42 (1.18) ^{h}	0.33 (1.15) ^{g}	0.24 (1.11) ^{bcd}
T_4	*Datura* decoction 3 %	1.27 (1.50)	0.48 (1.21) ^{ab}	0.39 (1.17) ^{ab}	0.37 (1.16) ^{ab}	0.78 (1.32)	0.24 (1.11) ^{d}	0.16 (1.07) ^{ab}	0.15 (1.07) ^{ab}
T_5	Cow urine+ Mixed leaves putrefaction 3 %	1.50 (1.58)	0.72 (1.29) ^{c}	0.67 (1.28) ^{bc}	0.41 (1.18) ^{bc}	0.99 (1.41)	0.20 (1.09) ^{bc}	0.20 (1.09) ^{abcd}	0.21 (1.10) ^{abc}
T_6	Mixed leaves decoction 3 %	2.38 (1.83)	1.80 (1.67) ^{fg}	1.03 (1.41) ^{e}	0.90 (1.37) ^{ef}	0.90 (1.37)	0.31 (1.14) ^{defg}	0.26 (1.12) ^{def}	0.35 (1.16) ^{fg}
T_7	L-cyhalothrin 5EC (0.6ml/l)	1.80 (1.67)	0.47 (1.21) ^{a}	0.31 (1.14) ^{a}	0.27 (1.12) ^{a}	0.85 (1.36)	0.07 (1.03) ^{a}	0.14 (1.06) ^{a}	0.13 (1.06) ^{a}
T_8	AAVYA 4 gm/lit	2.09 (1.74)	1.54 (1.59) ^{e}	1.94 (1.69) ^{h}	0.80 (1.33) ^{e}	0.77 (1.33)	0.25 (1.12) ^{de}	0.26 (1.12) ^{def}	0.32 (1.14) ^{de}
T_9	Untreated check	2.14 (1.77)	2.18 (1.78) ^{i}	2.58 (1.88) ^{i}	1.53 (1.58) ^{i}	0.73 (1.31)	1.23 (1.49) ^{i}	0.46 (1.20) ^{h}	0.57 (1.24) ^{h}
	Mean	1.93	1.34	1.15	0.76	0.88	0.35	0.25	0.28
	CD (p=0.05)	NS	0.20	0.27	0.12	NS	0.10	0.074	0.09
	SE(m) ±	0.07	0.071	0.09	0.041	0.03	0.03	0.025	0.03
	CV (%)	8.19	9.331	12.95	6.22	5.76	6.31	4.50	5.45

*Values in the parentheses of damage score are square root transformation values, *Mixed leaves (A= Andrographus, C =Calotropis, D =Datura, N=Neem, L=Lantana, C= Cascabela , P= Pongamia , I=Ipomoea)*

Table 3.19 : Efficacy of different botanicals on incidence of shoot tip caterpillar and leaf miner of cashew at Jagdalpur during 2019-20

Treatment		Mean % damage of pests							
		**Shoot tip caterpillar				**Leaf miner			
		Pre treatment D (%)	15 DAS after 1st spray	30 DAS after 1st spray	30 DAS after 2nd spray	Pre treatment D (%)	15 DAS after 1st spray	30 DAS after 1st spray	30 DAS after 2nd spray
T_1	*Andrographus* decoction 3 %	5.53 (8.87)	4.54 (12.28) efgh	4.45 (12.10) b	3.23 (10.30) ab	2.38 (8.87)	0.95 (5.57) de	0.74 (4.91) abcde	0.80 (5.13) cdef
T_2	*Andrographus* decoction 5 %	6.91 (9.14)	3.18 (10.27) bc	4.73 (12.52) b	3.08 (9.93) ab	2.54 (9.14)	0.27 (2.97) ab	1.02 (5.77) bcdefg	0.63 (4.56) abcdf
T_3	*Calotropis* decoction 3 %	5.15 (8.89)	3.51 (10.79) bcd	3.18 (10.16) ab	2.08 (8.29) ab	2.40 (8.89)	1.26 (6.43) ef	0.62 (4.49) abcd	0.60 (4.42) abcde
T_4	*Datura* decoction 3 %	7.11 (8.80)	4.29 (11.88) e	3.60 (10.91) ab	2.92 (9.83) ab	2.38 (8.80)	0.53 (4.16) abcd	0.25 (2.82) ab	0.35 (3.39) ab
T_5	Cow urine+ Mixed leaves putrefaction 3 %	8.92 (8.66)	4.50 (12.24) efg	4.59 (12.35) b	2.49 (9.06) ab	2.28 (8.66)	0.73 (4.87) bcd	0.61 (4.46) abc	0.41 (3.63) abcd
T_6	Mixed leaves decoction 3 %	7.06 (8.59)	5.36 (13.37) fg	4.18 (11.59) b	3.00 (9.91) ab	2.25 (8.59)	0.42 (3.68) abc	0.77 (5.03) abcdef	0.39 (3.56) abc
T_7	L-cyhalothrin 5EC (0.6ml/l)	6.38 (8.71)	0.63 (4.15) a	2.14 (4.19) a	1.64 (7.25) a	2.30 (8.71)	0.10 (1.79) a	0.18 (2.40) a	0.28 (3.02) a
T_8	AAVYA 4 gm/lit	5.42 (9.39)	2.93 (9.84) b	4.03 (11.57) ab	3.55 (10.84) b	2.67 (9.39)	2.51 (9.10) g	1.53 (7.09) fgh	0.99 (5.70) ef
T_9	Untreated check	5.86 (8.60)	6.55 (14.81) i	4.45 (12.14) b	3.22 (10.29) ab	2.25 (8.60)	2.73 (9.49) gh	1.83 (7.76) i	1.28 (5.87) f
	Mean	6.48	3.94	3.93	2.80	2.38	1.05	0.84	0.64
	CD (p=0.05)	NS	0.87	1.91	1.70	NS	0.50	0.77	0.43
	SE(m) ±	0.31	0.29	0.65	0.58	0.31	0.17	0.26	0.14
	CV (%)	7.14	5.38	12.06	12.18	7.14	6.45	10.65	6.76

**Values in the parentheses of damage score are angular transformation values, *Mixed leaves (A= Andrographus, C =Calotropis, D =Datura, N=Neem, L=Lantana, C= Cascabela , P= Pongamia , I=Ipomoea)*

Table 3.20 : Efficacy of different botanicals on insect pests of cashew at Jagdalpur centre

Treatment		Mean % damage and damage score of pests									Yield (kg/ tree)
		**Leaf folder				Mean of 2 spray					
		Pre treatment D (%)	15 DAS after 1st spray	30 DAS after 1st spray	30 DAS after 2nd spray	TMB D S (0-4)	Thrips D S (0-4)	Shoot tip caterpillar (%)	Leaf miner (%)	Leaf folder (%)	
T_1	*Andrographus* decoction 3 %	2.51 (9.08)	1.43 (6.86) d	1.91 (7.92) bcdef	1.47 (6.97) cdef	1.33 (1.50) de	0.60 (1.12) de	4.07 (11.56) bc	0.83 (5.20) bcdef	1.60 (7.25) bcdef	3.76
T_2	*Andrographus* decoction 5 %	2.75 (9.45)	1.08 (5.95) bcde	1.47 (6.92) bc	0.87 (5.35) ab	0.79 (1.32) c	0.36 (1.08) c	3.66 (10.91) bc	0.64 (4.43) abcde	1.14 (6.07) ab	3.94

Treatment		Mean % damage and damage score of pests									Yield (kg/ tree)
		**Leaf folder				Mean of 2 spray					
		Pre treatment D (%)	15 DAS after 1st spray	30 DAS after 1st spray	30 DAS after 2nd spray	TMB D S (0-4)	Thrips D S (0-4)	Shoot tip caterpillar (%)	Leaf miner (%)	Leaf folder (%)	
T_3	*Calotropis* decoction 3 %	2.23 (8.59)	2.31 (8.72) h	2.33 (8.77) defg	1.36 (6.69) bcde	1.51 (1.57) efg	0.74 (1.15) f	2.92 (9.75) ab	0.83 (5.11) bcdef	2.00 (8.06) f	3.77
T_4	*Datura* decoction 3 %	2.33 (8.74)	0.77 (5.02) abc	1.82 (7.74) bcde	1.27 (6.45) abc	0.41 (1.18) ab	0.26 (1.08) ab	3.60 (10.87) bc	0.38 (3.46) ab	1.29 (6.40) abc	3.81
T_5	Cow urine+ Mixed leaves putrefaction 3 %	2.20 (8.46)	1.09 (5.97) bcdef	1.64 (7.32) bcd	1.31 (6.56) abcd	0.60 (1.25) bc	0.36 (1.09) c	3.86 (11.22) bc	0.58 (4.32) abcd	1.35 (6.62) bcde	3.67
T_6	Mixed leaves decoction 3 %	2.04 (8.13)	0.57 (4.30) a	1.30 (6.54) ab	2.15 (8.42) g	1.24 (1.48) d	0.56 (1.14) d	4.18 (11.62) bc	0.53 (4.09) abc	1.34 (6.42) bcd	3.56
T_7	L-cyhalothrin 5EC (0.6ml/l)	2.27 (8.62)	0.63 (4.55) abc	0.65 (4.60) a	0.80 (5.12) a	0.35 (1.16) a	0.17 (1.05) a	1.47 (5.20) a	0.19 (2.40) a	0.69 (4.76) a	4.19
T_8	AAVYA 4 gm/ lit	2.52 (9.09)	1.02 (5.78) abcd	2.38 (8.85) def	1.67 (7.40) cde	1.43 (1.54) def	0.84 (1.13) g	3.50 (10.75) bc	1.68 (7.30) g	1.69 (7.34) bcde	3.61
T_9	Untreated check	2.25 (8.49)	1.35 (6.64) defg	2.63 (9.31) fgh	1.36 (6.67) bcde	2.10 (1.75) h	1.46 (1.31) h	4.74 (12.41) c	1.95 (7.71) h	1.78 (7.54) cde	2.91
	Mean	2.34	1.14	1.79	1.36	1.08	0.59	3.56	0.84	1.43	3.76
	CD (p=0.05)	NS	0.53	0.77	0.511	0.20	0.09	1.49	0.55	0.60	0.32
	SE(m) ±	0.54	0.18	0.26	0.17	0.07	0.03	0.51	0.19	0.20	0.11
	CV (%)	12.40	6.03	6.97	5.25	9.50	5.42	9.87	7.95	6.08	13.91

**Values in the parentheses of damage score are angular transformation values, *Mixed leaves (A= Andrographus, C =Calotropis, D =Datura, N=Neem, L=Lantana, C= Cascabela , P= Pongamia , I=Ipomoea)*

MADAKKATHARA

Treatment details

Sl. No.	Treatments
T_1	Neem Seed Kernel Extract 5%
T_2	Desi cow urine 10%
T_3	Pongamia oil 5%
T_4	Cinnamon leaf extract 2%
T_5	Cinnamon leaf extract 5%
T_6	*Acorus calamus* rhizome powder extract 2%
T_7	*Acorus calamus* rhizome powder extract 5%

Sl. No.	Treatments
T_8	*Andrographis paniculata* leaf extract 2%
T_9	*Andrographis paniculata* leaf extract 5%
T_{10}	'Aavya' botanical formulation 4g/l
T_{11}	POP, KAU
T_{12}	Untreated check

Influence of insecticides on tea mosquito bug damage

The trial was conducted in the mid season variety Dhana. One spray is given during the flowering season. The TMB damage score recorded before spray, and seven and 15 days after spray is presented in Table 3.21.

Before spraying of botanical products, the average TMB damage was 2.810 and 3.079 respectively on laterals and panicles. After 7 and 15 days of spray, T_{11} (POP, KAU) recorded least damage score on laterals (1.319 & 0.859) as well as panicles (1.021 & 1.083). At the same time, T_7 (*Acorus calamus* rhizome powder extract 5%) also recorded less damage score of 2.121 on laterals after 7 days of spray and 2.233 on panicles after 15 days of spray and was on par to that of T_{11}. There was no phytotoxicity symptom on plants after application of botanical products.

Nut yield per tree was the highest in T_{11} (POP, KAU) and was significantly different from remaining treatments.

Table 3.21 : Efficacy of different botanical products against TMB incidence in cashew at Madakkathara Centre during 2019-20

Treatments	TMB incidence on 30 leader shoots/panicles at different days after spray (DAS)						Nut yield (kg/ tree)
	On laterals			On panicles			
	Before spray	7 days after spray	15 days after spray	Before spray	7 days after spray	15 days after spray	
T_1	2.840 (1.902)	4.000 (2.236)^{a}	4.000 (2.236)^{a}	2.947 (1.943)	4.000 (2.236)^{a}	4.000 (2.236)^{a}	2.43^{b}
T_2	2.533 (1.835)	2.502 (1.959)^{ab}	2.825 (1.943)^{a}	2.691 (1.887)	2.899 (1.959)^{ab}	2.844 (1.943)^{ab}	2.21^{b}
T_3	3.250 (2.058)^{b}	3.617 (2.236)^{a}	3.175 (2.020)^{a}	3.441 (2.105)	4.000 (2.236)^{a}	4.000 (2.236)^{a}	2.70^{b}
T_4	4.000 (2.236)	4.000 (2.236)^{a}	4.000 (2.236)^{a}	4.000 (2.236)	4.000 (2.236)^{a}	4.000 (2.236)^{a}	1.79^{b}
T_5	2.973 (1.953)	2.799 (1.932)^{ab}	3.168 (2.018)^{a}	2.949 (1.944)	2.917 (1.932)^{ab}	3.179 (2.022)^{ab}	1.50^{c}
T_6	2.419 (1.793)	3.275 (2.079)^{ab}	3.170 (2.019)^{a}	2.577 (1.846)	3.370 (2.079)^{ab}	3.189 (2.025)^{ab}	1.73^{c}
T_7	2.117 (1.739)	2.121 (1.758)^{b}	2.753 (1.920)^{a}	2.043 (1.727)	2.225 (1.758)^{ab}	2.233 (1.761)^{b}	2.92^{b}
T_8	3.223 (2.035)	4.000 (2.236)^{a}	4.000 (2.236)^{a}	3.365 (2.077)	4.000 (2.236)^{a}	3.271 (2.050)^{ab}	1.68^{c}
T_9	2.407 (1.796)	3.267 (2.081)^{ab}	3.212 (2.032)^{a}	2.919 (1.967)	3.377 (2.081)^{ab}	3.279 (2.052)^{ab}	1.46^{c}
T_{10}	3.298 (2.058)	2.837 (2.169)^{a}	2.809 (1.889)^{a}	3.295 (2.057)	3.714 (2.169)^{a}	2.975 (1.953)^{ab}	2.09^{b}
T_{11}	2.127 (1.762)	1.319 (1.422)^{b}	0.859 (1.364)^{b}	2.728 (1.900)	1.021 (1.422)^{b}	1.083 (1.442)^{b}	3.92^{a}

Treatments	TMB incidence on 30 leader shoots/panicles at different days after spray (DAS)						Nut yield (kg/ tree)
	On laterals			On panicles			
	Before spray	7 days after spray	15 days after spray	Before spray	7 days after spray	15 days after spray	
T_{12}	2.537 (1.877)	4.000 (2.236)[a]	4.000 (2.236)[a]	4.000 (2.236)	4.000 (2.236)[a]	4.000 (2.236)[a]	1.59[c]
Mean	2.81	3.13	3.16	3.07	3.29	3.17	2.17
SEm±	0.16	0.11	0.15	0.17	0.11	0.13	0.31
CD @ 5 %	NS	0.34	0.46	NS	0.34	0.40	0.91
CV (%)	14.73	10.00	13.60	15.18	10.00	11.86	24.78

The trees under this experiment are being monitored for tea mosquito bug infestation in order to impose the spray before attaining economic threshold level.

PARIA

The population of Tea Mosquito Bug (TMB) on shoots ranged between 1.48 to 1.71 before spraying of treatments. The TMB damage score at 7 days and 15 days after the spray ranged from 0.27 to 1.77 and 0.15 to 1.88 on shoots. After 15 days of spray, treatment L-cyhalothrin 6ml/10 lit was observed to be superior for the management of TMB on shoots while NAU Product 10% recorded least number of TMB damage score and it was at par with Kalmagh 10%.

Table 3.22 : Efficacy of different botanicles against tea mosquito bug incidence in cashew at Paria centre during the year 2019-20

Treatments		On shoots (%)		
		BS	7 DAS	15 DAS
T1	Custard apple 10%**a10d apple**	1.71	1.43	1.37
T2	NAU Product 10%	1.56	0.58	0.38
T3	Akdo 1%	1.59	1.08	0.96
T4	Tulsi 10%	1.67	1.22	1.10
T5	Nirgudi 5%	1.61	1.39	1.25
T6	Kalmagh 10%	1.55	0.64	0.46
T7	Mr.Ajit Paul Botanical formulation 40gm/10 lit	1.63	0.89	0.75
T8	Cow urine 10%	1.57	1.35	1.32
T9	L- cyhalothrin 6ml/10 lit	1.48	0.27	0.15
T10	Untreated control	1.64	1.77	1.88
	SEm ±	0.07	0.06	0.06
	CD at 5%	NS	0.19	0.17
	CV%	6.97	10.43	10.19

PILICODE

The trial was started during the year 2019. The variety included in the trial was Madakkathara 1. The treatment details are as follows.

1. Neem seed kernel extract 5 ml/litre (5% solution - 50 gram kernels/litre and dilute to 5% and spray)
2. Kasaragod dwarf cow urine – 100ml/litre (10%)
3. Vitex *negundo* extract – 7.5 ml/litre
4. Bougainvillea leaf extract - 5ml/litre (5 % solution has been prepared)
5. *Hyptis suaveolens* extract – 5ml/litre (5 % solution has been prepared)
6. Standard check – Lamda cyhalothrin – 0.6 ml/litre as per POP recommendation
7. Untreated control

8. 'Aavya' by Ajith Paul

Number of replications : 4

Time of spray : at Flushing, flowering and nut setting stage

Damage scoring was done as per the directions of AICRP on Cashew experiment on TMB control using chemicals, by counting the damage score from 0 to 4 from 52 tagged leader shoots from a tree. Aqueous extract of leaves was prepared by grinding 10g of leaves and grinding using mortar and pestle.

Before spraying of the treatments, all the trees had statistically similar damage score and population of insects. Spraying was undertaken at three stages viz. flushing, flowering and nut setting stages. At flushing stage, lowest damage score was observed with Lamda cyhalothrin (2.16) and Kasaragod dwarf cow urine treatments (2.10). The population of Nymph and Adult was lowest in Lamda cyhalothrin (17.67) followed by Neem seed kernel extract treatment (19.48). Similar results were observed during flowering and nut setting stage also. When the mean of all three post treatments damage scores were compared, Lamda cyhalothrin (2.11) and Kasaragod dwarf cow urine treatments (2.08) had the least damage score among the treatments. Also, the mean of all three post treatments damage scores were compared with the pretreatment damage scores using paired test (Table3.23) and was found that the treatments could effectively bring down the damage score. Hence, from this experiment, it could be concluded that Kasaragod dwarf cow urine spray @10% could effectively manage TMB and could be a possible organic alternative to chemical control. However, this needs to be repeated and observed in the ensuing seasons.

Table 3.23 : Effect of botanicals on the incidence of TMB at Pilicode (2019-20)

Treatment	Before spray		Flushing		Flowering		Nut setting		Post treatment mean damage score (0-4)* (Mean of three sprays)
	Pre treatment mean damage score (0-4)	Average Population (Nymph + Adult)**	Post treatment mean damage score (0-4)*	Average Population (Nymph + Adult)**	Post treatment mean damage score (0-4)*	Average Population (Nymph + Adult)**	Post treatment mean damage score (0-4)*	Average Population (Nymph + Adult)**	
Neem seed kernel extract	2.30 (1.52)	24.31 (4.93)	2.34 (1.53)	19.48 (4.41)	2.30 (1.52)	19.36 (4.40)	2.28 (1.51)	19.56 (4.42)	2.31 (1.52)
Kasaragod dwarf cow urine	2.21 (1.49)	25.03 (5.00)	2.10 (1.45)	20.94 (4.58)	2.08 (1.44)	20.64 (4.54)	2.06 (1.44)	20.57 (4.54)	2.08 (1.44)
Vitex negundo	2.35 (1.53)	25.45 (5.05)	2.39 (1.55)	24.36 (4.94)	2.36 (1.54)	24.78 (4.98)	2.36 (1.536)	24.34 (4.93)	2.37 (1.54)
Bougainvillea leaf extract	2.29 (1.51)	24.13 (4.91)	2.31 (1.52)	22.67 (4.76)	2.28 (1.51)	22.46 (4.74)	2.23 (1.49)	22.84 (4.78)	2.27 (1.51)
Hyptis suaveolens	2.36 (1.53)	24.23 (4.92)	2.40 (1.55)	24.65 (4.96)	2.39 (1.55)	24.68 (4.97)	2.39 (1.55)	24.42 (4.94)	2.39 (1.55)
Lamda-cyhalothrin	2.27 (1.51)	24.63 (4.96)	2.16 (1.47)	17.67 (4.20)	2.14 (1.46)	17.06 (4.13)	2.03 (1.425)	17.36 (4.17)	2.11 (1.44)
'Aavya' by Ajith Paul	2.31 (1.52)	23.29 (4.82)	2.38 (1.54)	21.98 (4.69)	2.30 (1.52)	21.45 (4.63)	2.35 (1.532)	21.42 (4.63)	2.34 (1.53)
Untreated control	2.28 (1.51)	25.25 (5.02)	2.33 (1.54)	25.75 (5.07)	2.33 (1.54)	25.75 (5.07)	2.33 (1.53)	25.75 (5.01)	2.33 (1.53)
F Test	**NS**	**NS**	**	**	**	**	**	**	**
SEm ±	-	-	0.007	0.022	0.006	0.013	0.006	0.021	0.004
CD	-	-	0.02	0.07	0.02	0.04	0.02	0.06	0.01
CV %	1.71	2.38	0.97	0.94	0.81	0.54	0.86	0.89	0.49

*Figures in paratheses are square root transformed values

** Average population of Nymph + Adult observed in each treatment

Table 3.24 : Effect of botanicals on the incidence of TMB at Pilicode (2019-20)

Treatment	Mean	Std Deviation	SEm	CV	Mean difference	T value
Pretreatment mean damage score (0-4)	2.32 (1.52)	0.096 (0.032)	0.017 (0.006)	0.042 (0.021)	-0.044 (-0.015)	-4.985** (-4.972**)
Post treatment mean damage score (0-4)* (Mean of three sprays)	2.28 (1.51)	0.114 (0.038)	0.020 (0.007)	0.050 (0.025)		

*Figures in paratheses are square root transformed values

VENGURLA

Design : RBD

Replication : Three

Spray schedule : 15 days interval

The data presented in Table 3.25 showed that the treatment T_9 Standard check Lambda cyhalothrin was found to be the best for the management of tea mosquito bug followed by the treatment T_7, Neem seed (*Azadirachta indica*) kernel extract 5 % after first spray and treatment T_4, Dhatura (*Datura stramonium*) seed extract 5 % after second and third spray.

From the mean of three sprays, it was observed that the treatment, T_9, Standard check Lambda cyhalothrin was found to be the best for the management of tea mosquito bug as it reduced the incidence of tea mosquito bug up to (0.098) followed by the treatment T_4, Dhatura (*Datura stramonium*) seed extract 5 % (0.155).

Table 3.25 : Incidence of tea mosquito bug after spraying of botanical

Treatments		Incidence of tea mosquito bug			Mean
		After first spray	After second spray	After third spray	
T_1:	Nirgudi (*Vitex negundo*) plant extract 5%	0.173	0.243	0.217	0.211
T_2:	Kalmagh (*Andrographis paniculata*) plant extract 5%	0.153	0.218	0.217	0.194
T_3:	Tiriphal (*Zanthoxylum piperitum*) seed extract 5%	0.166	0.224	0.205	0.198
T_4:	Dhatura (*Datura stramonium*) seed extract 5 %	0.128	0.153	0.186	0.155
T_5:	Custard apple leaves + Bael leaves + Ruhi leaves + Tulsi leaves + Drumstick leaves+ Hibiscus leaves + Bitter gourd juice - 5 % extract (on the basis of farmers feedback)	0.160	0.205	0.230	0.198
T_6:	Satvin (*Alstonia scholaris*) bark extract 5%	0.166	0.224	0.230	0.207
T_7:	Neem seed (*Azadirachta indica*) kernel extract 5 %	0.121	0.198	0.198	0.172
T_8:	Deshi cow urine 10%	0.153	0.192	0.198	0.181
T_9:	Standard check Lambda cyhalothrin/ Recommended spray	0.057	0.102	0.134	0.098
T_{10}:	Untreated control	0.269	0.346	0.320	0.312
	SEm ±	0.01	0.01	0.01	0.00
	CD at 5%	0.03	0.03	0.03	0.02
	CV%	11.61	9.03	9.69	7.15

VRIDHACHALAM

Experimental details

Design	:	RBD	No. of trees/treatment	:	Two
Treatment	:	Ten	Replication	:	Four
Variety	:	VRI-3	Year of Planting	:	2005

Treatments

The following treatments were imposed as per the approved technical programme.

T-1 : Leaf extracts of each of 500 grams of Adathoda, Datura, Vitex, Calotropis, Neem fermented for 15-20 days.

T-2 : NSKE 5%

T-3 : Deshi Cow urine 100 ml/litre of water.

T-4 : Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 g), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.

T-5 : Rhizomes of Acorus 5% soaked overnight.

T-6 : Pongam oil 5 %

T-7 : Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.

T-8 : Botanical formulation by Mr. Ajith Paul

T-9 : Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water)

T-10 : Untreated check

As per the technical Programme, botanicals were sprayed during flushing, flowering and fruit formation stage at the fortnight intervals before reaching ETL. Totally five round of sprays were imposed with maximum spray suspension used per tree was 10 lit./each spray.

Botanicals preparation methodology

T1 - 500 grams leaves each of Adathoda, Datura, Vitex, Calotropis and Neem were grinded and leaf extracts of Adathoda, Datura, Vitex, Calotropis, Neem were soaked in 10 litres of water and fermented for 15-20 days, and the supernatant was used for spraying; T2- Neem Seed Kernal Extract (5%) was prepared and used; T3- Deshi Cow urine (100 ml/litre) of water; T4- Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 g), Lime - 250 g, Cow urine - 5 lit., soaked in mud pot with 10 litres of water for seven days, and supernatant was used for spraying; T5 - Rhizomes of Acorus 5% soaked overnight and supernatant was used for spraying; T6-Pongam oil 5 %; T7-Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit. soaked in mud pot with 10 litres of water for seven days; T8- Botanical formulation @ 64 grams in 16 litres of water; T9- Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water); T10-Untreated check. For all the treatments, khadhi soap@ 1g/litre of water was added for spraying.

Observations recorded

The data on the pest incidence for each treatment was recorded from randomly selected tagged 52 leader shoots of each tree at four sides (East, West, North, South) on 7, and 15 days after each spray and pest infestations data were also taken. Observations were recorded on the infestation of TMB (damage in 0-4 scale) on flushes, TMB population (adults and nymphs), leaf miner (% infestation), leaf folder (% infestation), Leaf and blossom webber (% infestation), apple and nut borer damage (% infestation). Natural enemies population *viz.*, Spiders, ants, coccinellids and cotesia were also recorded.

Evaluation of phytotoxicity of botanicals on cashew

As per the technical Programme, in Botanicals field experiments, symptoms like leaf injury, wilting, vein

clearing, necrosis, epinasty and hyponasty were observed in each trees at 1,3,5,7,10 and 14 days after spraying as per the protocol of Central Insecticide Board and Registration Committee (C.I.B and R.C).

Method of assessment

Leaf injury was assessed by visual rating in a 0-10 scale

Rating	Phytotoxicity (%)
0	No phytotoxicity
1	0-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

The per cent leaf injury was calculated using the formula,

$$\text{Per cent leaf injury} = \frac{\text{Total grade points}}{\text{Maximum grade x Number of leaves observed}} \times 100$$

The results of evaluation of Botanical pesticides against TMB revealed that 15 days after the third, fourth and fifth spraying, the efficacy of botanicals was low when compared to the standard insecticides treated check. All the botanical pesticides were sprayed in the field before reaching ETL. During the flushing period, the first and second spray was carried out prior to the TMB incidence.TMB incidence was not observed in botanical pesticides sprayed when compared to the Untreated check (the damage score observed was 2.5). The pre-treatment damage score of TMB was non-significant in all the treatments but not in the untreated check. Reduction of fresh infestation was observed 7 days after each round of spray. Standard insecticide check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6ml/lit.of water) is effective in controlling the TMB incidence. Among all the botanical pesticides sprayed, spraying of combined leaf extracts of Adathoda, Datura, Vitex, Calotropis and neem was very effective in controlling the TMB incidence (0.175 and 0.124 scale), followed by Pongam oil 5% (0.225 and 0.150 scale), Botanical formulation by Mr. Ajith Paul (0.175 and 0.124 scale) followed by Rhizomes of Acorus 5% (0.463 and 0.363 scale), followed by NSKE 5% (0.625 and 0.550 scale). The same was also observed in 7 DAS and 15 DAS of fourth and fifth spraying also. After the fourth spray, the damage score ranged between 0.003 and 0.764 in different treatments as against an increased damage score of 3.725 in untreated control. Fifteen days after fifth spray, the damage score was low and ranged between 0.0016 and 0.6385 in various treatments as against an increased score of 3.825 in control (Table 3.26 and 3.27).

The overall efficacy ranked in the order against the incidence of TMB and its population at Vridhachalam are as follows: T9 - Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water) > T1-spraying of combined Leaf extracts of Adathoda, Datura, Vitex, Calotropis and neem > T6- Pongam oil 5 %> T8-Botanical formulation by Mr. Ajith Paul> T5-Rhizomes of Acorus 5%> T2-NSKE 5% >T3 Deshi Cow urine 100 ml/litre of water>T4- Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 kg), Lime - 250 g, Cow urine - 5 lit. > T7-Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit.

The population trend of TMB and other foliar feeding insects was recorded (Table 3.28). Fifteen days after 5th spray, all the botanical pesticides were found to be effective in controlling TMB populations (0.1) as against 2.6 bugs/ 52 leader shoots observed in untreated control. Furthermore, the per cent damage of leaf miner, leaf folder, leaf and blossom webber and nut borer was very low in all the insecticides treated trees as compared to untreated trees.

Phytotoxic effect of botanicals on cashew

The results on the investigations of the phytotoxic effect of botanicals sprayed at fortnight intervals during flushing, flowering and fruit formation stage on cashew variety VRI-3 are furnished in the Table. The observations showed that none of the botanical treatments caused any phytotoxic symptoms such as injury to leaf tip and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty. Hence, it was concluded that these botanical treatments did not inflict any phytotoxic effect on cashew.

The population trends of various natural enemies in respect of all the insecticides treatment gradually decimated the population of spiders, coccinellids, ants and braconid wasp after each round of insecticidal spray. In unprotected trees, the activity of weaver ants and *Cotesia* wasps were predominant among different forms of natural enemies (Table 3.29).

Table 3.26 : Effect of Botanicals on the incidence of TMB at Vridhachalam

(Mean of four replications)

Treatment		Pre-treatment damage score (0-4)	Post treatment mean damage score (0-4)		Pre - treatment damage score (0-4)	Post treatment- mean damage score (0-4)		Pre - treatment damage score (0-4)	Post treatment mean damage score (0-4)	
			III Spray			IV Spray			V Spray	
			7 DAS	15 DAS		7 DAS	15 DAS		7 DAS	15 DAS
T1	Leaf extracts of each of 500 grams of Adathoda, Datura, Vitex, Calotropis, Neem fermented for 15-20 days. Soaked in Mud pot with 10 litres of water.	1.703 (1.644)	0.175 (1.084)	0.124 (1.060)	3.598 (2.144)	0.007 (1.004)	0.007 (1.004)	3.550 (2.133)	0.007 (1.004)	0.0054 (1.003)
T2	NSKE 5%	1.650 (1.627)	0.625 (1.275)	0.550 (1.245)	3.553 (2.134)	0.550 (1.245)	0.525 (1.235)	3.625 (2.150)	0.525 (1.235)	0.4750 (1.214)
T3	Deshi Cow urine 100 ml/litre of water.	1.548 (1.595)	0.650 (1.284)	0.525 (1.235)	3.553 (2.134)	0.563 (1.250)	0.538 (1.240)	3.525 (2.126)	0.538 (1.240)	0.4625 (1.209)
T4	Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 kg), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	1.600 (1.612)	0.850 (1.339)	0.775 (1.332)	3.525 (2.127)	0.814 (1.346)	0.764 (1.327)	3.550 (2.132)	0.789 (1.337)	0.6385 (1.277)
T5	Rhizomes of Acorus 5% soaked overnight.	1.500 (1.581)	0.463 (1.209)	0.363 (1.167)	3.425 (2.103)	0.418 (1.191)	0.393 (1.180)	3.575 (2.139)	0.443 (1.201)	0.3933 (1.180)
T6	Pongam oil 5 %	1.525 (1.589)	0.225 (1.107)	0.150 (1.072)	3.505 (2.122)	0.114 (1.055)	0.089 (1.044)	3.500 (2.121)	0.105 (1.051)	0.0803 (1.039)

Treatment		Pre-treatment damage score (0-4)	Post treatment mean damage score (0-4)		Pre - treatment damage score (0-4)	Post treatment- mean damage score (0-4)		Pre - treatment damage score (0-4)	Post treatment mean damage score (0-4)	
			III Spray			IV Spray			V Spray	
			7 DAS	15 DAS		7 DAS	15 DAS		7 DAS	15 DAS
T7	Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit. soaked in Mud pot with 10 litres of water for seven days.	1.550 (1.596)	0.875 (1.369)	0.725 (1.313)	3.523 (2.127)	0.683 (1.296)	0.658 (1.286)	3.500 (2.121)	0.658 (1.287)	0.5830 (1.255)
T8	Botanical formulation by Mr. Ajith Paul	1.500 (1.581)	0.350 (1.162)	0.275 (1.129)	3.325 (2.079)	0.225 (1.107)	0.200 (1.095)	3.650 (2.156)	0.200 (1.095)	0.1500 (1.072)
T9	Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water)	1.325 (1.524)	0.010 (1.005)	0.005 (1.003)	3.548 (2.132)	0.004 (1.002)	0.003 (1.002)	3.525 (2.127)	0.002 (1.001)	0.0016 (1.001)
T10	Untreated check	3.250 (2.061)	3.550 (2.133)	3.600 (2.145)	3.600 (2.145)	3.650 (2.156)	3.725 (2.174)	3.775 (2.185)	3.800 (2.191)	3.8250 (2.197)
C.D.		NS	0.032	0.032	NS	0.044	0.044	NS	0.046	0.072
SE(m)		0.022	0.011	0.011	0.015	0.015	0.015	0.020	0.016	0.025
SE(d)		0.031	0.016	0.016	0.022	0.021	0.021	0.028	0.022	0.035
C.V.		2.675	1.704	1.738	1.447	2.398	2.411	1.843	2.504	3.950

DAS – Days After Spraying; Values in the parentheses are $\sqrt{x+0.5}$ transformed values

Table 3.27 : Efficacy of Botanicals on TMB population / 52 leader shoot at Vridhachalam

(Mean of four replications)

Treatment		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots))	
			III Spray			IV Spray			VSpray	
			7 DAS	15 DAS		7 DAS	15 DAS		7 DAS	15 DAS
T1	Leaf extracts of each of 500 grams of Adathoda, Datura, Vitex, Calotropis, Neem fermented for 15-20 days. Soaked in Mud pot with 10 litres of water.	1.680 (1.637)	0.237 (1.111)	0.187 (1.089)	2.448 (1.856)	0.335 (1.155)	0.285 (1.133)	2.706 (1.925)	0.235 (1.111)	0.123 (1.060)

Treatment		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots)		Pre-Treatment Count /52 leader shoots	Post-treatment count (Mean TMB population/52 leader shoots))	
			III Spray			IV Spray			VSpray	
			7 DAS	15 DAS		7 DAS	15 DAS		7 DAS	15 DAS
T2	NSKE 5%	1.800 (1.673)	0.822 (1.350)	0.722 (1.312)	2.325 (1.823)	1.148 (1.466)	1.098 (1.448)	2.750 (1.936)	1.048 (1.431)	0.543 (1.242)
T3	Deshi Cow urine 100 ml/litre of water.	1.725 (1.651)	0.857 (1.363)	0.757 (1.325)	2.250 (1.802)	1.401 (1.549)	1.351 (1.533)	2.632 (1.905)	1.301 (1.517)	0.952 (1.397)
T4	Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 kg), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	1.750 (1.658)	0.865 (1.366)	0.765 (1.328)	2.285 (1.812)	1.430 (1.559)	1.355 (1.534)	2.529 (1.879)	1.305 (1.518)	0.971 (1.404)
T5	Rhizomes of Acorus 5% soaked overnight.	1.703 (1.644)	0.779 (1.333)	0.679 (1.295)	2.273 (1.809)	0.958 (1.399)	0.908 (1.381)	2.700 (1.923)	0.858 (1.363)	0.446 (1.202)
T6	Pongam oil 5 %	1.725 (1.650)	0.555 (1.247)	0.505 (1.226)	2.308 (1.818)	0.455 (1.206)	0.405 (1.185)	2.805 (1.950)	0.355 (1.164)	0.199 (1.095)
T7	Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	1.675 (1.635)	0.928 (1.387)	0.706 (1.302)	2.343 (1.828)	1.796 (1.672)	1.746 (1.657)	2.699 (1.923)	1.671 (1.634)	0.834 (1.354)
T8	Botanical formulation by Mr. Ajith Paul	1.653 (1.628)	0.621 (1.272)	0.521 (1.231)	2.425 (1.850)	0.862 (1.365)	0.812 (1.346)	2.660 (1.912)	0.762 (1.327)	0.428 (1.195)
T9	Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water)	1.698 (1.642)	0.036 (1.018)	0.026 (1.013)	2.295 (1.815)	0.141 (1.068)	0.091 (1.044)	2.652 (1.911)	0.041 (1.020)	0.004 (1.002)
T10	Untreated check	1.800 (1.673)	1.950 (1.717)	2.575 (1.889)	2.550 (1.884)	3.300 (2.073)	3.550 (2.133)	3.550 (2.133)	3.675 (2.162)	3.750 (2.179)
C.D.		NS	0.052	0.089	NS	0.030	0.033	NS	0.028	0.018
SE(m)		0.018	0.018	0.031	0.023	0.010	0.011	0.017	0.010	0.006
SE(d)		0.025	0.025	0.043	0.032	0.015	0.016	0.025	0.014	0.009
C.V.		2.164	2.726	4.705	2.474	1.423	1.574	1.795	1.352	0.920

DAS – Days After Spraying; Values in the parentheses are $\sqrt{x+0.5}$ transformed values

Table 3.28 : Efficacy of Botanicals against foliar pests at Vridhachalam

(Mean of four replications)

Treatment		Mean damage after 5th spray										Yield (Kg per tree)
		TMB Damage %		Leaf Miner %		Leaf and Blossom Webber %		Apple and Nut Borer %		Leaf Thrips Population (Nos.)		
		PTC	15 DAS	PTC	15 DAS	PTC	15 DAS	PTC	15 DAS	PTC	15 DAS	
T1	Leaf extracts of each of 500 grams of Adathoda, Datura, Vitex, Calotropis, Neem fermented for 15-20 days. Soaked in Mud pot with 10 litres of water.	3.750 (11.159)	0.225 (2.706)	5.202 (13.179)	2.750 (9.535)	4.183 (11.796)	2.513 (9.104)	1.525 (7.088)	0.045 (1.213)	9.150 (3.186)	2.863 (1.965)	6.525
T2	NSKE 5%	3.750 (11.159)	0.750 (4.963)	5.410 (13.438)	2.625 (9.317)	4.295 (11.956)	3.363 (10.560)	1.500 (7.028)	0.650 (4.619)	9.210 (3.195)	3.750 (2.179)	5.700
T3	Deshi Cow urine 100 ml/litre of water.	3.675 (11.045)	0.775 (5.046)	5.125 (13.079)	2.675 (9.405)	4.365 (12.050)	3.213 (10.315)	1.575 (7.199)	0.750 (4.957)	9.260 (3.203)	3.875 (2.208)	5.725
T4	Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 kg), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	3.750 (11.160)	0.863 (5.325)	5.153 (13.115)	3.138 (10.198)	4.247 (11.888)	3.413 (10.636)	1.650 (7.370)	0.940 (5.561)	9.173 (3.189)	3.775 (2.185)	5.425
T5	Rhizomes of Acorus 5% soaked overnight.	3.775 (11.192)	0.688 (4.748)	5.140 (13.098)	2.525 (9.138)	4.395 (12.093)	3.350 (10.531)	1.525 (7.088)	0.525 (4.150)	9.203 (3.194)	3.528 (2.128)	5.550
T6	Pongam oil 5 %	3.725 (11.122)	0.475 (3.936)	5.265 (13.259)	3.150 (10.219)	4.377 (12.071)	0.783 (5.060)	1.750 (7.596)	0.065 (1.457)	9.155 (3.187)	3.275 (2.067)	6.325
T7	Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	3.725 (11.121)	1.238 (6.373)	5.243 (13.230)	3.300 (10.461)	4.239 (11.876)	3.760 (11.175)	1.575 (7.199)	1.150 (6.151)	9.173 (3.189)	3.850 (2.202)	5.275
T8	Botanical formulation by Mr. Ajith Paul	3.675 (11.046)	0.675 (4.702)	5.145 (13.105)	2.663 (9.383)	4.263 (11.909)	2.250 (8.621)	1.575 (7.202)	0.425 (3.732)	9.260 (3.203)	3.313 (2.077)	6.025
T9	Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water)	3.800 (11.235)	0.005 (0.413)	5.268 (13.262)	2.735 (9.511)	4.215 (11.842)	3.450 (10.697)	1.675 (7.421)	0.115 (1.500)	9.215 (3.196)	2.475 (1.864)	6.625
T10	Untreated check	3.910 (11.400)	4.210 (11.835)	5.340 (13.354)	6.179 (14.387)	4.283 (11.938)	4.653 (12.451)	1.775 (7.650)	2.100 (8.328)	9.153 (3.186)	12.208 (3.634)	2.650
C.D.		NS	0.367	NS	0.369	NS	0.577	0.390	0.681	NS	0.039	
SE(m)		0.126	0.126	0.086	0.127	0.104	0.198	0.134	0.233	0.006	0.013	
SE(d)		0.179	0.178	0.122	0.179	0.148	0.280	0.189	0.330	0.009	0.019	
C.V.		2.265	5.030	1.308	2.494	1.747	3.992	3.673	11.204	0.405	1.183	

PTC- Pre Treatment Count; DAS: Days After Spraying ; Values in the parentheses are arc sine $\sqrt{\text{per cent}}$ transformed values for per cent damage and $\sqrt{x+0.5}$ transformed values for population numbers.

Table 3.29 : Effect of Botanical sprays on natural enemies at Vridhachalam

T. No.	Treatments	Mean number of natural enemies / pollinators in 52 inflorescence 15 days after 5th spray			
		Spiders	Ants	Coccinellids	*Cotesia*
		15 DAS	15 DAS	15 DAS	15 DAS
T1	Leaf extracts of each of 500 grams of Adathoda, Datura, Vitex, Calotropis, Neem fermented for 15-20 days. Soaked in Mud pot with 10 litres of water.	6.671 (2.769)	6.709 (2.776)	5.803 (2.608)	4.575 (2.361)
T2	NSKE 5%	7.936 (2.989)	6.639 (2.763)	5.474 (2.544)	5.828 (2.613)
T3	Deshi Cow urine 100 ml/litre of water.	10.281 (3.359)	12.634 (3.692)	5.550 (2.559)	5.850 (2.617)
T4	Seeds of Nerium, Pongam, Tobacco waste and Pods of Datura (Each 500 kg), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	8.455 (3.075)	9.233 (3.198)	5.550 (2.559)	5.903 (2.627)
T5	Rhizomes of Acorus 5% soaked overnight.	7.792 (2.965)	6.793 (2.791)	6.760 (2.786)	5.958 (2.638)
T6	Pongam oil 5 %	6.848 (2.801)	6.913 (2.813)	5.813 (2.610)	4.825 (2.413)
T7	Citrus peel extract and Leaf extracts of Tulsi, Custard apple and Chrysanthemum flowers (Each 250 grams), Lime - 250 g, Cow urine - 5 lit. Soaked in Mud pot with 10 litres of water for seven days.	8.760 (3.124)	9.756 (3.280)	5.625 (2.573)	5.865 (2.620)
T8	Botanical formulation by Mr. Ajith Paul	7.678 (2.946)	7.208 (2.865)	5.930 (2.631)	4.750 (2.398)
T9	Standard treated check (Spraying of Lambda Cyhalothrin 5% EC @ 0.6 ml/lit of water)	3.598 (2.144)	5.450 (2.540)	4.536 (2.353)	3.629 (2.151)
T10	Untreated check	14.602 (3.950)	12.556 (3.682)	7.250 (2.872)	6.600 (2.757)
	C.D.	0.047	0.072	0.077	0.042
	SE(m)	0.016	0.025	0.026	0.014
	SE(d)	0.023	0.035	0.037	0.020
	C.V.	1.078	1.621	2.028	1.131

Values in the parentheses are $\sqrt{x+0.5}$ transformed values

Ent. 2: Control of cashew stem and root borer

Expt. 2. Curative control trial

Centres: East Coast : Bapatla, Bhubaneshwar, Jhargram and Vridhachalam

West Coast : Madakkathara and Vengurla

Plains / others: Hogalagere and Jagdalpur

The objective of this trial is to evaluate different pesticides and neem products for their efficacy in curative control of the cashew stem and root borer incidence after extraction of pest stages.

BAPATLA

The treatments 1-5 indicated above were applied sequentially as and when infested trees were available. The treatments are applied on the tree trunk and exposed roots after removal of the grubs and cocoons from the infested trees to the extent possible and observation on re-infestation were recorded at monthly intervals.

Table 3.30 : Efficacy of insecticides as Post extraction prophylaxies (PEP) against cashew stem and root borer at Bapatla centre

Trt No	Treatment	Total No. of trees treated	No. of trees re-infested	% trees with Reinfestation	% trees without Re-infestation
1	Fipronil Swabbing (2 ml/l)	20	8	40.0	60.0
2	Neem oil Swabbing (5%)	20	11	55.0	45.0
3	Imidacloprid (2 ml/l) (Swabbing and Drenching)	20	5	25.0	75.0
4	Chlorpyriphos (10 ml/l) (Treated Check)	20	9	45.0	55.0
5	Untreated check (only removal of CSRB grubs)	20	13	65.0	35.0

Table 3.31 :Physical parameters of treated cashew trees under post extraction prophylaxis (PEP) trial at Bapatla

Physical parameters		Total trees treated	No. of trees infested after PEP	% out of total trees	No. of trees not reinfested after PEP	% out of total trees
Stem girth	< 60 cm	4	0	0.0	4	100.0
	60-80cm	18	5	27.8	13	72.2
	80-100 cm	49	22	44.9	27	55.1
	>100 cm	29	19	65.5	10	34.5
Total		**100**	**46**	**46.0**	**54**	**54.0**
Age of the tree	< 10 years	12	2	16.7	10	83.3
	10-15 years	39	18	46.2	21	53.8
	>15years	49	26	53.1	23	46.9
Total		**100**	**46**	**46.0**	**54**	**54.0**
Zone of attack	C + R	28	14	50.0	14	50.0
	C + S	16	6	37.5	10	62.5

Physical parameters		Total trees treated	No. of trees infested after PEP	% out of total trees	No. of trees not reinfested after PEP	% out of total trees
	R	7	2	28.6	5	55.6
	S	17	2	11.8	15	88.2
	C	9	4	44.4	5	55.6
	C + S + R	23	18	78.3	5	21.7
Total		**100**	**46**	**46.0**	**54**	**54.0**
Yellowing of canopy	Canopy yellowing	21	19	90.5	2	09.5
	Canopy not yellowing	79	27	34.2	52	65.8
Total		**100**	**46**	**46.0**	**54**	**54.0**
% of bark circumference damaged	<25	40	2	05.0	38	95.0
	26-50	27	12	44.4	15	55.6
	51-75	17	16	94.1	01	05.9
	>75	16	16	100.0	0	0.0
Total		**100**	**46**	**46.0**	**54**	**54.0**

Table 3.32 : Stem girth vs Age of the tree

Stem Girth Age of the tree	<60 cm	60-80 cm	80-100 cm	>100 cm	Total
<10 years	3	5	3	1	12
10-15 Years	1	12	20	6	39
>15 Years	0	1	26	22	49
Total	4	18	49	29	100

During 2019-20, among the insecticides evaluated as post extraction prophylaxis, Imidacloprid (Swabbing and drenching) @ 2ml/l have offered protection to the tune of 75.00 % trees without re-infestation followed by Fipronil Swabbing 2 ml/l with 60.00 % trees without re-infestation. The other treatments Chlorpyriphos 10 ml/l (Treated Check) and neem oil 5% (Swabbing) have offered 55.00 and 45.00 percent protection without re-infestation and are superior over the control treatment which recorded 35.00 % trees without re-infestation. Preferential zone of attack is Collar + Root in 28.00 percent of trees (28/100) followed by stem+collor+root in 23.00 percent of trees.

HOGALAGERE

The results on infestation and re-infestation of the CSRB in different treatments applied during Oct.-Nov., Jan - Feb and April - May months revealed that Fipronil (2ml/l) and Chlorpyriphos (0.2%) treatments were found to be the most effective against grubs of CSRB with 80 % and 67% trees without reinfestation, respectively (Table). In treated check, where only grubs extraction was adopted which indicated that only 47% of treated trees could recover from reinfestation. However, the other treatments also maintained their superiority in suppressing the population over control (Table 3.33).

Table 3.33 : Efficacy of insecticides as post extraction prophylaxis (PEP) against cashew stem and root borer (CSRB) at Hogalagere during 2019-20

Sl. No.	Treatment	No. of trees treated	No. of trees without reinfestation	% Recovery from reinfestation
1	Fipronil swabbing @ 2ml/l (during Oct.-Nov., Jan.- Feb. and April - May)	15	12	80

Sl. No.	Treatment	No. of trees treated	No. of trees without reinfestation	% Recovery from reinfestation
2	Neem oil swabbing 5% suspension	15	4	26
3	Imidacloprid 17.8 SL @ 2ml/l as swabbing and drenching	15	9	60
4	Chlorpyriphos 20 EC(0.2%) @ 10ml/l	15	10	67
5	Treated check - only removal of CSRB grubs	15	7	47
6	Untreated control	15	5	33
	Total	**90**	**47**	-

The incidence of cashew stem and root borer was monitored randomly at fortnightly interval in old and neglected cashew gardens. Trees with 60-100 cm stem girth showed maximum damage (83% preference for infestation) and with respect to age of trees. More than 15 years old trees were highly prone to CSRB damage (63%) which might be due to maximum availability of dead, cracks & crevices and loose bark for CSRB oviposition. The zone of CSRB attack was noticed maximum at collar + stem (60%) and 67 per cent of infested trees showed yellowing canopy. The trees with less than 25% bark circumference damage recorded 80.00 per cent recovery of the infested trees (Table 3.34) compared to severely bark damaged plants.

Table 3.34 : Physical parameters of treated cashew trees under post extraction prophylaxis (PEP) trial at HREC, Hogalagere during 2019-20

Physical parameters		No. plants observed after PEP	No. plants reinfested after PEP	% CSRB Preference
Stem girth	< 60 cm	8	5	63
	60-100 cm	12	10	83
	> 100 cm	8	6	75
Total		**N=28**	**N=21**	-
Age of the tree	<10 years	6	0	0
	10-15 years	6	0	0
	>15 years	8	5	63
Total		**N=20**	**N=5**	-
Zone of attack	C + R	5	1	20
	C + S	5	3	60
	C + S + R	5	1	20
Total		**N=15**	**N=5**	-
Yellowing of canopy	Canopy yellowing	6	4	67%
	Canopy not yellowing	6	3	50%
Total		**N=12**	**N=7**	-
% of bark circumference damaged	< 25	5	4	80
	26-50	5	3	60
	51-75	5	1	20
	>75	5	0	0
Total		**N=20**	**N=8**	-

JAGDALPUR

Experiment details

Year of experimentation	: 2019-20	No of tree	: 108
Location	: Ghatkawali, District Bastar	Treatments	: 6
Crop stage	: Flushing to fruit maturity	Design	: CRD
Age of trees	: Varied between 15 to 40 years		

The post extraction prophylaxis treatment was carried out in 108 trees of forest plantation in Ghatkawali village of Bastar District during 2019-20. The insecticide treatments were swabbed on the trunk, stem and exposed roots and drenching of the insecticides in the root region after the removal of grubs and cocoons from the infested trees.

Table 3.35 : Efficacy of insecticides as post extraction prophylaxis (PEP) against cashew stem and root borer (CSRB) at Jagdalpur centre during the year 2018-19

Treatment	Total number of trees treated	No. of trees without reinfestation	No. of trees re-infested	% trees without reinfestation (Recovery %)	% of trees re-infested
T_1 : Fipronil swabbing (2ml/l)	18	15	3	83.33	16.67
T_2 : Neem oil swabbing (5%)	18	11	7	61.11	38.89
T_3 : Imidacloprid (2 ml/l)	18	14	4	77.78	22.22
T_4 : Chlorpyriphos (10 ml/l)	18	16	2	88.89	11.11
T_5: Treated check (only removal of CSRB grubs)	18	6	12	33.33	66.67
T_6 : Untreated check	18	2	16	11.11	88.89
Total	108	36	-	54	-

Data presented in table 3.35 showed that the maximum recovery of 88.89 per cent was observed in T_4 (Chlorpyriphos @ 10 ml/l) of water as swabbing and drenching of CSRB infested tree followed by T_1 (Fipronil @ 2ml/l) swabbing lead to 83.33% and T_3 (Imidacloprid @ 2 ml/l) swabbing and drenching lead to 77.78% recovery whereas, minimum recovery of 11.11 per cent was observed in T_5 (treated check : only removal of CSRB grubs) as against nil recovery in untreated check. The overall results indicate that chlorpyriphos recorded maximum recovery, followed by Fipronil and Imidacloprid in reducing the CSRB infestation.

Table 3.36 : Physical parameters of treated cashew trees under post extraction prophylaxis (PEP) trial at Jagdalpur centre during the year 2018-19

Physical parameters		No. of trees treated	No. of trees reinfested after PEP	% of trees reinfested after PEP	No. of trees Without re-infestation	% of trees Without re-infestation
Stem diameter	< 19 cm	0.0	0.00	0.00	0.00	0.00
	19-32 cm	0.0	0.0	0.00	0.00	0.00
	> 32 cm	108	24	22.22	84.00	77.78
Total		**108**				

Physical parameters		No. of trees treated	No. of trees reinfested after PEP	% of trees reinfested after PEP	No. of trees Without re-infestation	% of trees Without re-infestation
Age of the tree	<10 years	0.0	0.0	0.0	0.00	0.00
	10-15 years	0.0	0.0	0.0	0.00	0.00
	>15 years	108	24	22.22	84.00	77.78
Total		**108**				
Zone of attack	C	31	5	16.13	26.00	83.87
	S	13	4	30.77	9.00	69.23
	R	2	0	0.00	2.00	100.00
	C+S	16	3	18.75	13.00	81.25
	C+R	34	8	23.53	26.00	76.47
	R+S	1	0	0.00	1.00	100.00
	C+S+R	11	5	**45.45**	6.00	54.55
Total		**108**				
Yellowing of canopy	Canopy yellowing	11	3.00	27.27	8.00	72.73
	Canopy not yellowing	97	21.00	21.65	76.00	78.35
Total		**108**				
% of bark circumference damaged	< 25	33	05	15.15	28	84.85
	26-50	34	12	35.29	22	64.71
	51-75	12	05	**41.67**	07	58.33
	>75	11	02	18.18	09	81.82
Total		**90**	**24**		**66**	

Observations recorded in the physical parameters of treated cashew trees under post extraction prophylaxis (PEP) curative trial and details are presented in table 3.36. The data revealed that the cashew trees having more than 32 cm of diameter were more prone to the attack of CSRB (22.22%). With respect to the age of the cashew infested trees, more than 15 years old cashew trees (22.22%) were more susceptible to the attack of CSRB. Preferential zone of re-infestation by CSRB in the trees were Collar + Stem + Root zone followed by stem zone and Collar + Root with 45.45, 30.77 and 23.53 per cent re-infested trees respectively. Yellowing of canopy was observed in 27.27 per cent re-infested trees. Trees with more than 50-75 per cent bark circumference damage had maximum re-infestation of 41.67 per cent followed by 15.15% in less than 25 per cent bark circumference damage. The data presented in two way table between age of tree and stem diameter revealed that all the trees having stem diameter below 19 cm, 19-32 have zero year age plants. In stem diameter more than 32 cm were reported in all trees which are more than 15 years old.

Table 3.37 : Two way table (Stem diameter vs Age of Tree)

Age of Tree / Stem diameter	<10 years	10-15 years	>15 years	Total
< 19 cm	0	0	0	0
19 - 32 cm	0	0	0	0

Age of Tree / Stem diameter	<10 years	10-15 years	>15 years	Total
> 32 cm	0	0	108	108
Total	0	0	108	108

MADAKKATHARA

Treatments: 5

Sl. No.	Treatment	Dose
1.	Fipronil (swabbing)	2 ml/l
2.	Imidachloprid (swabbing and drenching)	2ml/l
3.	Chlorpyrifos (treated check)	10 ml/l
4.	Neem oil (swabbing)	50 ml/l
5.	Untreated check (only removal of CSRB grubs)	-

The treatments were applied sequentially as and when the infestation was noticed. The treatments were applied on the tree trunk and exposed roots after removal of the grubs from the infested trees, at the maximum possible. Observation on reinfestation was recorded at fortnightly intervals.

Efficacy of different insecticides imposed as Post Extraction Prophylaxis (PEP), against cashew stem and root borer (CSRB) during 2019-20 is presented in Table 3.38. Among the insecticides evaluated as PEP, swabbing of chlorpyriphos @ 10m/l offered highest recovery with 82 per cent trees without reinfestation followed by swabbing of fipronil@ 2ml/l (80%). Control treatment with mere extraction of the grubs recorded recovery of 55 per cent.

Table 3.38 : Efficacy of insecticides as post extraction prophylaxis (PEP) against cashew stem and root borer (CSRB) at Madakkathara centre (2019-20)

Treatments	Total number of trees treated	No. of trees without reinfestation / persistent attack	% trees without reinfestation / persistent attack
T_1	20	16	80
T_2	20	15	75
T_3	20	17	82
T_4	20	15	75
T_5	20	11	55

The physical parameters of treated trees under PEP trial is presented in Table 3.39. The maximum infestation was observed in trees with stem girth of more than 100 cm (71 trees) and diameter of 30-45 cm (59 trees) and age more than 15 years (81 trees). In most of the trees, infestation was noticed on collar and root zone. Yellowing of the canopy was observed only in 6 out of 100 infested trees.

Table 3.39 : Physical parameters of treated cashew trees under post extraction prophylaxis trial at Madakkathara centre during the year 2019-20

Physical parameters		Total trees treated	No. of trees infested after PEP	% out of total trees	No. of trees not reinfested after PEP	% out of total trees
Stem girth (cm)	< 60	-	-	-	-	-
	60-80	5	1	20	4	80

Physical parameters		Total trees treated	No. of trees infested after PEP	% out of total trees	No. of trees not reinfested after PEP	% out of total trees
	80-100	24	6	25	18	75
	>100	71	19	27	52	73
Total		**100**	**26**		**74**	
Diameter (cm)	5-15	0	0	0	0	0
	15-30	20	4	20	16	80
	30-45	59	17	29	42	71
	45-60	21	5	24	16	76
Total		**100**	**26**		**74**	
Age of the tree (Years)	<10	-	-	-	-	-
	10-15	19	3	16	16	84
	>15	81	23	28	58	72
Total		**100**	**26**		**74**	
Zone of attack	C + R	75	15	20	60	80
	C	1	0	0	1	100
	C + S + R	13	10	77	3	23
	R	11	1	10	10	90
Total		**100**	**26**		**74**	
Yellowing of canopy	Yellowing	6	5	83	1	17
	no yellowing	94	21	22	73	78
Total		**100**	**26**		**74**	
% of bark circumference damaged	< 25	3	0	0	3	100
	25-50	70	6	9	64	91
	50-75	26	19	73	7	27
	>75	1	1	100	0	0
Total		**100**	**26**		**74**	

A Chi-square table was constructed to study the association of physical parameters with respect to recovery after PEP and presented in Table 3.40. The recovery of trees after PEP is closely associated with per cent bark circumference damage as well as zone of attack. With increase in per cent damage to bark circumference, there will be gradual reduction in the per cent of trees recovered after PEP. Similarly, the per cent recovery was less in trees with damage on collar, stem and root together compared to those trees with attack only on collar or root region.

Table 3.40 : Two way table showing association of physical parameters and damage characteristics with respect to recovery after PEP at Madakkathara

Physical parameters		Recovery category					Chi square value
		Re-infested		Recovered			
		No.	(%)	No.	(%)	Total	
Stem girth (cm)	< 60	-		-		-	-
	60-80	1	20	4	80	5	0.127
	80-100	6	25	18	75	24	
	>100	19	27	52	73	71	
Diameter	5-15	-		-		-	-
	15-30	4	0	16	0	20	1.525
	30-45	17	20	41	80	59	
	45-60	5	29	17	71	21	
Age of the tree (Years)	<10	-		-		-	-
	10-15	3	16	16	84	19	0.298
	>15	23	28	58	72	81	
Zone of attack	C	0	0	1	100	1	20.911*
	R	1	10	10	90	11	
	C + R	15	20	60	80	75	
	R+ S + R	10	77	3	23	13	
Yellowing of canopy	Yellowing	5	83	1	17	6	10.905*
	No yellowing	21	22	73	78	94	
Bark circumference damaged (%)	< 25%	0	0	3	100	3	44.901*
	25-50%	6	9	64	91	70	
	50-75%	19	73	7	27	26	
	>75%	1	100	0	0	1	

The trees are being regularly monitored and application of plaster of paris will be followed after cessation of North-East Monsoon.

VENGURLE

Year of experimentation : 2019-20

Design : CRD

The results (Table 3.41) indicated that the treatment T_1 (Fipronil swabbing 2ml/lit) recorded 95.00 per cent trees without reinfestation followed by treatment T_4 Chlorpyriphos (0.2%) 85.00 per cent trees without reinfestation. Reinfestation was more in Control (T_6) 75.00 percent trees.

Table 3.41 : Efficacy of insecticides as post extraction prophylaxis (PEP) against cashew stem and root borer (CSRB) at Vengurla centre during the year 2019-20

Treatments		Total number of trees treated	No. of trees without reinfestation/ persistent attack	% trees without reinfestation/ persistent attack	No. of trees reinfestation/ persistent attack	% trees re-infestation/ persistent attack
T_1	Fipronil swabbing 2ml/lit	20	19	95	1	5
T_2	Neem oil swabbing 5%	20	11	55	9	45
T_3	Imidachloprid swabbing and drenching 2ml/lit	20	14	70	6	30
T_4	Chlorpyriphos 10ml/ lit	20	17	85	3	15
T_5	Treated check (only removal of grub)	20	6	30	14	70
T_6	Untreated check	20	5	25	15	75

During the year 2019-20, a total of 120 trees were treated for cashew stem and root borer management. The data on the physical parameter of infested tree and not infested tree was recorded and presented in Table 3.42.

The tree having the stem girth >100 cm were more prone to CSRB damage. Regarding age of the tree, more than 15 years old were prone to CSRB infestation. Whereas, the tree having the age of 10 years recorded less infestation of cashew stem and root borer. In case of zone of attack, the collar+ stem recorded more infestation whereas, it was minimum in collar + stem + root. In case of bark circumference, removal of >75 percent bark showed more number of tree infested whereas, the removal of >25 percent bark showed more infested tree without re-infestation after the removal of grub.

Table 3.42 : Physical parameters of treated cashew trees under post extraction prophylaxis (PEP) trial at Vengurla Centre during the year 2019-20.

Physical parameters		No. of trees infested after PEP	% out of total trees	No. of trees not reinfested after PEP	% out of total trees
Stem girth	< 60 cm	5	4.16	12	10.00
	60-100 cm	18	15.00	50	41.67
	> 100 cm	**25**	20.83	10	8.33
Total		**48**	**40.00**	**72**	**60.00**
Age of the tree	<10 years	5	4.17	**40**	33.33
	10-15 years	15	12.50	12	10.00
	>15 years	**28**	23.33	20	16.67
Total		**48**	**40.00**	**72**	**60.00**
Zone of attack	C + R	13	10.83	17	14.17
	C + S	**25**	20.83	15	12.50
	C + S + R	10	8.33	**40**	33.33

Physical parameters		No. of trees infested after PEP	% out of total trees	No. of trees not reinfested after PEP	% out of total trees
Total		**48**	**40.00**	**72**	**60.00**
Yellowing of canopy	Canopy yellowing	2	1.67	-	-
	Canopy not yellowing	46	38.33	72	60.00
Total		**48**	**40.00**	**72**	**60.00**
% of bark circumference damaged	< 25	4	3.33	**31**	25.83
	26-50	10	8.33	12	10.00
	51-75	12	10.00	19	15.83
	>75	**22**	18.33	10	8.33
Total		**48**	**40.00**	**72**	**60.00**

VRIDHACHALAM

As per the technical programme, the treatments were applied sequentially as and when infested trees are available. The treatments were swabbed on the trunk, stem and exposed roots and drenching of the insecticides in the root region after the removal of grubs (Post Extraction Prophylaxis) and cocoons from the infested trees to the extent possible and observation on re-infestation and persistent infestation were recorded at monthly intervals.

Maximum recovery of 76.00% was observed in chlorpyriphos 20 EC @10 ml/lit. of water as swabbing and drenching of CSRB infested trees as against mere recovery of 10.00 in treated check (only removal of CSRB grubs). Treatments with Fipronil 5% SC swabbing @ 2ml/lit. and Imidachloprid 17.8 SL Swabbing and Drenching @ 2ml/lit. lead to 55.55 and 44.44% recovery respectively as against nil recovery in untreated check. The overall results indicated that chlorpyriphos recorded maximum recovery, followed by Fipronil and Imidachloprid which were at par in reducing the CSRB infestation, with an average cost of protection of Rs.90/-, Rs.98/- and Rs. 101/- respectively (Table 3.43).

Table 3.43 : Efficacy of certain insecticides as curative control against CSRB at Vridhachalam

Treatment		No. of trees treated	No. of trees without reinfestation from CSRB	Mean % recovery of trees from CSRB	Frequency of treatment	Cost of treatment /tree
T_1	Fipronil 5% SC Swabbing@ 2ml/lit.	18	10	55.55[b]	3	98.00
T_2	Neem Oil suspension 5% Swabbing and Drenching	16	5	31.25[c]	3	82.00
T_3	Imidachloprid 17.8 SL Swabbing and Drenching @ 2ml/lit.	18	8	44.44[b]	3	101.00
T_4	Chlorpyriphos 20 EC @ 10ml / lit. Swabbing and Drenching	25	19	76.00[a]	3	90.00
T_5	Treated check (only removal of CSRB grubs followed).	10	01	10.00[d]	3	55.00
T_6	Untreated check.	15	-	-	-	-
	Total	**101**	**43**			

Observations recorded in the physical parameters of treated cashew trees under Post Extraction Prophylaxis (PEP) curative trial revealed that the cashew trees having 80-100 cm of stem girth (76.19%) were more prone to the attack of CSRB infestation (Table 3.44). When the age of the cashew infested trees was compared, more than 15-year-old cashew trees (62.50%) were more susceptible to attack of CSRB. Preferential zone of attack of re-infestations by CSRB in the trees were Collar+Stem+Root zone followed by Collar + Root and Collar + Stem with 70.97, 65.52 and 59.09 per cent re-infested trees respectively. Yellowing of canopy showed 88.89 per cent re-infestation. Trees with less than 25 per cent bark circumference damage had maximum re-infestation with 70.37 per cent followed by 51-75 per cent bark circumference damage (66.67% re-infestation). This implied that early detection of borer infestation and simultaneous prophylaxis treatment on a community basis is very important to mitigate persistent attack of cashew stem and root borer.

Table 3.44 : Physical parameters of treated cashew trees under post extraction prophylaxis (PEP) curative trial observed at Vridhachalam

Physical Parameters		Total no. of trees treated	No.of trees reinfested	% of trees reinfested	No. of trees not reinfested	% of trees not reinfested
Stem girth	< 60 cm	8	2	25.00	6	75.00
	60-80 cm	47	32	68.08	15	31.91
	80-100 cm	21	16	76.19	5	23.81
	> 100 cm	26	9	34.62	17	65.38
Total		102	59		43	
Age of the tree	< 10 years	0	0			
	10-15 years	54	29	53.70	25	46.30
	> 15 years	48	30	62.50	18	37.50
Total		102	59		43	
Zone of attack	Collar+Root	29	19	65.52	10	34.48
	Collar+Stem	22	13	59.09	9	40.91
	Root	5	0	0	5	100.00
	Stem	6	2	33.33	4	66.67
	Collar	7	3	42.86	4	57.14
	Stem+Root	2	0	0	2	100.00
	Collar+Stem+Root	31	21	70.97	9	29.03
Total		102	59		43	
Yellowing of canopy	Canopy yellowing	45	40	88.89	5	11.11
	Canopy not yellowing	57	19	33.33	38	66.67
Total		102	59		43	
% of bark circumference damaged	< 25	54	38	70.37	16	29.63
	26-50	36	11	30.56	25	69.44
	51-75	12	8	66.67	4	33.33
	> 75	0	0	0	0	0
Total		**102**	**59**		**43**	

Ent.3: Influence of biotic and abiotic factors on the incidence of pest complex of cashew

Centres: East Coast :	Bapatla, Bhubaneshwar, Jhargram and Vridhachalam
West Coast :	Madakkathara, Paria and Vengurla
Plains / others :	Hogalagere, Kanabargi and Jagdalpur

The objective of the project is to investigate the population dynamics of pests of regional importance and to correlate it to prevalent weather parameters.

BAPATLA

Trees were selected randomly in the cashew plantations in the surrounding areas of Bapatla and in certain villages of Prakasam and the different pests occurring and their intensities were recorded. Pest infested samples were collected at weekly intervals and were maintained in the laboratory for observation of emergence of parasitoids. The data on pest incidence from 12 selected and unprotected trees in Cashew Research Station, Bapatla was recorded at weekly intervals from 52 tagged leader shoots from all the four sides of a tree.

Table 3.45 : Influence of abiotic factors on the activity of pest complex of cashew

Variable	Leaf and blossom webber	Leaf miner	Leaf Folder	Shoot Tip Caterpillar	Apple and Nut borer	Spiders
X_1-Maximum Temp	0.04	-0.69*	-0.08	0.04	0.18	0.10
X_2-Minimum Temp	-0.19	0.52*	-0.23	-0.13	0.41	0.12
X_3-RH (m)	0.02	0.09	-0.04	0.06	0.17	0.04
X_4-RH (e)	-0.003	-0.14	0.03	-0.06	-0.07	-0.01
X_5-Rain fall	-0.01	0.003	-0.003	-0.003	-0.02	0.002
R^2 Value	0.284	0.236	0.248	0.383	0.218	0.150
% Variation	28.4	23.6	24.8	38.3	21.8	15.0

***= r at 5% level of significance**

Table 3.46 : Regression analysis between pests and natural enemies of cashew and weather parameters during 1st Jan, 2020 to 26th Oct, 2020

S.No.	Biotic factor	Regression equation	R^2
1.	LBW	3.44 + 0.04 (X_1) -0.19 (X_2) +0.02 (X_3) -0.003 (X_4) -0.01 (X_5)	0.284
2.	LM	14.54 – 0.69* (X_1) + 0.52* (X_2) + 0.09 (X_3) -0.14 (X_4) + 0.003 (X_5)	0.236
3.	LF	10.56 – 0.08 (X_1) – 0.23 (X_2) - 0.04 (X_3) + 0.03 (X_4) - 0.003 (X_5)	0.248
4.	STC	1.86 + 0.04 (X_1) -0.13 (X_2) + 0.06 (X_3) -0.06 (X_4) - 0.003 (X_5)	0.383
5.	ANB	-22.81 + 0.18 (X_1) + 0.41 (X_2) + 0.17 (X_3) -0.07 (X_4) - 0.02 (X_5)	0.218
6.	Spiders	-6.10 +0.10 (X_1) + 0.12 (X_2) + 0.04 (X_3) -0.01 (X_4) + 0.002 (X_5)	0.150

LBW: Leaf and blossom webber; LM: Leaf miner; LF: Leaf folder; STC: Shoot tip caterpillar; ANB: Apple and nut borer
X_1-Maximum Temperature; X_2-Minimum Temperature; X_3-Relative Humidity (m); X_4-Relative Humidity (e); X_5-Rain fall

During the year 2020 (1st January, 2020 to 26th October, 2020) the relationship between the percent pest damage (Y) and weather variables such as max. temp (X_1), min. temp.(X_2), relative humidity (m) (X_3), relative humidity (e) (X_4) and rainfall (X_5) was worked out by subjecting the data collected over 43 standard weeks by Multiple Linear Regression Analysis.

Leaf miner population showed significantly positive correlation with maximum temperature (X_1) and significantly negative correlation with minimum temperature (X_2). The other weather variables were found to influence the damage by leaf miner independently and all the weather parameters accounted for 23.6 percent of total variation in percent leaf damage by leaf miner (R^2=0.236).

However, for leaf folder, leaf and blossom webber, shoot tip caterpillar and apple and nut borer, the data indicated that none of the weather variables were found to independently influence the damage by each pest.

HOGALAGERE

Nine insect pests species belonging to insect order *Hemiptera* (4 species), *Thysanoptera* (1 species), *Coleoptera* (2 species) and *Lepidoptera* (2 species) infesting cashew at different crop phenological stages, and four species of their natural enemies each belonging to order *Arenae*, *Coleoptera*, *Neuroptera* and *Diptera* were recorded at varied intensity in maidan parts of Karnataka. Among them, tea mosquito bug with intensity of 5-12% infestation, cashew stem and root borer with intensity of 5-15% infestation and apple and nut borer with intensity of 5 - 8% infestation were emerged as the major pests in the region (Table 3.47).

Table 3.47 : Influence of abiotic factors on the activity of pest complex of cashew during 2019-20

Sl No.	Common Name	Scientific Name	Family	Plant part affected	Period of occurrence	Intensity
Order : Hemiptera						
1	Tea mosquito bug	*Helopeltis antonii* Signoret	Miridae : Hemiptera	Tender shoots, panicles, young apples & nuts	Oct - Mar	Low to moderate (5-12%)
2	Cotton mealy bug	*Planococcus* sp.	Pseudococcidae Hemiptera	Leaf, panicle, apples & nuts	Nov -Jan	Low (<5%)
3	Aphid	*Toxoptera odinae*	Aphididae : Hemiptera	Tender shoots, panicles and young apples & nuts	Nov-May	Low (<5%)
4	Wiptail mealy bug	*Ferrisia virgata*	Pseudococcidae Hemiptera	Tender shoots, panicles, young apples & nuts	Feb-May	Low (<5%)
Order : Thysanoptera						
5	Thrips	*Rhipiphorothrips cruentatus*	Thripidae : Thysanoptera	Leaf, apple & nuts	Jul-Feb	Low to moderate (5-8%)
Order: Coleoptera						
6	Cashew stem and root borer	*Plocederus ferrugenius*	Cerambycidae : Coleoptera	stem and root	Throughout the year	Low to moderate (5-15%)
7	Ash weevil	*Myllocerus discolor*	Curculionidae : Coleoptera	Young leaf	Throughout the year	Low (<5%)
Order: Lepidoptera						
8	Leaf miner	*Acrocercops syngramma*	Gracillaridae: Lepidoptera	Young leaf	May-Sep	Low (<5%)
9	Apple and nut borer	Thylacoptila panerosema	Pyralidae: Lepidoptera	Apple and nuts	Jan-Mar Feb-Jun	Low to moderate Low (5-8%)

Table 3.48 : Incidence of natural enemies in cashew ecosystem during 2019-20

	Predators	Host pest	Month of occurrence	Intensity
1	*Oxypes sweta* Order: Arenae	*Helopeltis antonii*	Oct - Mar.	Low to moderate (5-10%)
2	*Menochilus sexmaculatus* (Coccinellidae: Coleoptera)	*Toxoptera odinae Ferrisia virgata*	Feb.-May	Low to moderate (5-7%)
3	*Chrysoperla zastrowi* (Chrysopidae: Neuroptera)	*Toxoptera odinae Ferrisia virgata*	Jan.-May	Low (<5%)
4	*Paragens yerburiensis* (Syrphidae: Diptera)	*Toxoptera odinae Ferrisia virgata*	Jan.-May	Low (<5%)

The correlation between the pest incidence and weather parameters revealed that minimum temp (+0.88), evening relative humidity (+0.55), rainfall (+0.78) and number of rainy days (+0.75) had highly significant positive correlation with the activity of TMB. Whereas negative correlation was established with maximum temperature (-0.09) and morning relative humidity (-0.39). The activity of CSRB was observed throughout the year but its peak activity was noticed during December, April and May. The minimum temperature (+0.55), rainfall (+0.73) and number of rainy days (+0.71) had highly significant positive correlation with the incidence of CSRB and negative correlation was noticed with maximum temperature (-0.01), morning & evening relative humidity (-0.62 & -0.45), respectively (Table 3.49).

Apple and nut borer (ANB) had significant positive correlation with maximum temperature (+0.53). The highly significantly negative correlation was found with evening relative humidity (-0.80), minimum temperature (-0.47), morning relative humidity (-0.66), rainfall (-0.63) and number of rainy days (-0.64) with activity of ANB. The infestation of thrips showed significantly positive correlation with maximum temperature (+0.60) and number of rainy days (+0.14). The negative correlation was obtained with rest of the weather parameters. The aphid infestation had significantly positive correlation with maximum temperature (+0.39), and significantly negative correlation was observed with evening RH (-0.65), rainfall (-0.54), and number of rainy days (-0.58).

Table 3.49 : Correlation of weather parameters and different insect pests recorded on cashew during 2019-20

Weather Parameters	TMB (% damage)	CSRB (% damage)	ANB (% damage)	Thrips (No./shoot or panicle)	Aphids (No. affected shoots/plant)
X1 - Maximum Temp	(-)0.09	(-)0.01	(+)0.53*	(+)0.60*	(+)0.39
X2 - Minimum Temp	(+)0.88**	(+)0.55*	(-)0.47*	(-)0.51*	(-)0.26
X3 - RH (m)	(-)0.39	(-)0.62*	(-)0.66	(-)0.26	(-)0.40
X4 - RH (e)	(+)0.55*	(-)0.45	(-)0.80**	(+)0.23	(-)0.65*
X5 - Rain fall	(+)0.78**	(+)0.73**	(-)0.63*	(-)0.24	(-)0.54*
X6 - No. of rainy days	(+)0.75**	(+)0.71**	(-)0.64*	(+)0.14	(-)0.58*

* Significant at 0.05% & ** highly significant at 0.01%

Where TMB -Tea mosquito bug; CSRB - Cashew stem & root borer; ANB - Apple & nut borer

Table 3.50 : Incidence of different cashew pests during different months during 2020-21

	2020					2021				
	TMB (% damage)	CSRB (% damage)	ANB (% damage)	Thrips (No./ shoot or panicle)	Aphids (No. affected shoots/ plant)	TMB (% damage)	CSRB (% damage)	ANB (% damage)	Thrips (No./shoot or panicle)	Aphids (No. affected shoots/ plant)
Jan	-	-	-	-	-	1.22	0.64	0.66	0.68	0.00
Feb	-	-	-	-	-	0.94	1.00	2.20	1.94	2.66
Mar	-	-	-	-	-	1.06	1.63	2.05	2.16	1.72
Apr	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-
Jun	-	-	-	-	-	0.00	0.00	0.00	3.75	0.00
Jul	-	-	-	-	-	0.00	0.00	0.00	2.34	0.00
Aug	1.33	0.00	0.00	0.00	0.92	-	-	-	-	-
Sep	1.37	0.00	0.00	0.00	0.00	-	-	-	-	-
Oct	1.98	0.98	0.49	0.28	0.29	-	-	-	-	-
Nov	2.01	0.76	0.64	0.96	0.17	-	-	-	-	-
Dec	2.02	1.05	0.49	1.70	0.82	-	-	-	-	-

JAGDALPUR

The study was conducted at weekly intervals from ten randomly selected cashew trees of variety Vengurle-4 which were of 21 years of age. 52 leader shoots were tagged from each tree from all the four sides for observation. The crop observation were taken throughout the year.

Table 3.51 : Records of major cashew insect-pest in Jagdalpur during 2019-20

S. No.	Common name	Scientific name	Family	Order
1.	Thrips	*Rhipiphorothrips sp.*	Thripidae	Thysanoptera
2.	Tea mosquito bug	*Helpeltis antonii*	Miridae	Hemiptera
3.	Shoot tip caterpillar	*Hypotima heligramma*	Gelichiidae	Lepidoptera
4.	Leaf miner	*Acrocercops syngramma*	Gracillariidae	Lepidoptera
5.	Leaf folder	*Caloptilia tiselaea*	Gracillariidae	Lepidoptera
6.	Bark eating caterpillar	*Inderbela spp.*	Metarbedelidae	Lepidoptera
7	Apple and nut borer	*Thylocoptila paurosema*	Pyralidae	Lepidoptera

The data from Table 3.51 revealed that TMB incidence showed highly significant negative correlations with maximum temperature (r= - 0.883**), minimum temperature (r = - 0.941**) and wind velocity (r= - 0.564**) whereas, highly significantly positive correlation was observed with morning relative humidity (r= 0.915**) at 1 per cent level of significance. The damage score of thrips was highly influenced by temperature and morning relative humidity. The incidence of thrips showed highly significant negative correlation with maximum temperature (r= - 0.570**) while, significantly positive correlation was found with morning relative humidity (r= 0.449*). Per cent incidence of leaf caterpillar showed non-significant negative correlation with maximum temperature, minimum temperature, rainfall and wind velocity, while, non-significant positive correlation was with morning and evening relative humidity. The per cent incidence of leaf folder and leaf miner was statistically not influenced by weather factors.

Table 3.52 : Influence of weather parameters on the activity of pest complex of cashew at Jagdalpur during the year 2019-20

Weather Parameters	Y_1 - TMB	Y_2 - Thrips	Y_3 - Shoot tip caterpillar	Y_4 - Leaf miner	Y_5 - Leaf folder
X_1 - Maximum Temp	-0.883**	-0.570**	-0.151	0.071	-0.036
X_2 - Minimum Temp	-0.941**	-0.477*	-0.128	0.030	0.020
X_3 - Rainfall	-0.306	0.039	-0.118	-0.176	-0.143
X_4 - RH (m)	0.915**	0.449*	0.117	0.047	0.085
X_5 - RH (e)	0.061	0.199	0.245	0.039	0.210
X_6 - Wind velocity	-0.564**	-0.291	-0.030	0.131	0.025
X_7 - Sun shine hours	-0.142	-0.076	0.001	0.084	-0.141
X_8 - Rainy days	-0.500*	-0.181	-0.198	-0.149	-0.171

* Significant at 5 % level (2.074), ** significant at 1% level (2.819)

The population of natural enemies was also recorded during 2019-20. The mean population of lady bird beetle was highly positively correlated with morning relative humidity while, highly negatively correlated with maximum temperature (r= -0.883**), minimum temperature (r = -0.941**) and wind velocity (r= -0.564**) at 1 per cent level of significance. Similarly, ants population were negatively correlated with wind velocity (r = -0.448*) at 5 per cent level of significance. Natural enemies viz., ants, spiders, lady bird beetle and *Brumus* were non-significantly and negatively correlated with rainfall, while, non-significant positive correlation was found with morning relative humidity.

Table 3.53 : Influence of abiotic factors on the activity of natural enemies of cashew at Jagdalpur centre during the year 2019-20

Weather Parameters	Y_6 - Ant	Y_7 - Spiders	Y_8 - Lady bird beetle	Y_9 - Brumus
X_1 - Maximum Temp (°C)	-0.260	-0.788	-0.813**	-0.157
X_2 - Minimum Temp (°C)	-0.271	-0.692	-0.809**	-0.287
X_3 - Rainfall (mm)	-0.140	-0.236	-0.292	-0.107
X_4 - RH (m)	0.330	0.748	0.832**	0.094
X_5 - RH (e)	-0.042	0.253	0.096	-0.158
X_6 - Wind velocity (kmph)	-0.448*	-0.412	-0.564**	-0.070
X_7 - Sun shine hours	0.176	-0.350	-0.173	-0.053
X_8 - Rainy days	0.026	-0.266	-0.372	-0.205

* Significant at 5 % level (2.074), ** significant at 1% level (2.819)

The impact of weather parameters on insect pests and natural enemies were presented in the form of multiple linear regression equation (Table). Multiple regression analysis was done by taking pest incidence, damage per cent and population of natural enemies (Y) as a dependent variable and weather parameters (X) as independent variables for the season December 2019 to June 2020. The regression equation indicated that an increase in 1 °C of minimum temperature reduced the thrips and TMB damage score by 0.027 and 0.107 respectively, per tagged 52 leader shoots. Similarly, increase in 1% morning relative humidity increased the TMB damage score by 0.006 per 52 leader shoots. The mean per cent damage of the shoot tip caterpillar (0.154) and leaf miner (0.056) increased, if 1% of evening relative humidity increases. An increase in 1 °C of maximum temperature, the mean population (0.053) of ants decrease whereas if 1 per cent morning humidity increases accordingly 0.039 mean population of ant increases. Based on the regression equation (2018-

19 and 2019-20) it is opined that for sucking insects, minimum temperature was very crucial factor which meant that they prefer optimum low temperature while for leaf chewing insects, evening relative humidity (%) was important influencing factor.

The multiple regression equations were developed for predicting the pests and natural enemies of cashew by using regression models. By using regression models and coefficient of determination means goodness of fit (R^2) indicated that pests observed *viz.*, TMB damage score (Y_1), thrips damage score (Y_2), shoot tip caterpillar per cent damage (Y_3), leaf miner per cent damage (Y_4), leaf folder per cent damage (Y_5) were predicted to an extent of 94, 58, 42, 32 and 19 per cent respectively. Similarly, for the natural enemies *viz.*, population of ants (Y6), spider (Y7), lady bird beetle (Y8), Brumus (Y9) were predicted to an extent of 38, 73, 79 and 34 per cent respectively.

The equation fitted for TMB can predict the 94.6 % chances of incidence of TMB due to variations in weather parameters and can be used in Bastar conditions.

Table 3.54 : Regression analysis between pest-natural enemies of cashew and weather parameters during December 2019 to June 2020

S.No.	Biotic factors	Regression equation	R^2 (goodness of fit)	Adjusted R^2
1	TMB (Y_1)	$Y_1 = 0.406 + 0.131*(X_1) - \mathbf{0.107*(X_2)} + 0.008(X_3) + \mathbf{0.006*(X_4)} - 0.009(X_5) + 0.124(X_6) + 0.040(X_7) - \mathbf{0.148(X_8)}$	0.946**	0.911
2	Thrips (Y_5)	$Y_2 = 6.750 + 0.092(X_1) - \mathbf{0.027*(X_2)} + \mathbf{0.018(X_3)} - 0.060(X_4) - 0.016(X_5) + 0.073(X_6) + 0.016(X_7) - 0.245(X_8)$	0.580	0.309
3	Shoot tip caterpillar (Y_2)	$Y_3 = -2.902 + 0.911(X_1) - 0.594(X_2) + 0.021(X_3) - 0.144(X_4) + \mathbf{0.154(X_5)} + 0.139(X_6) + 0.064(X_7) - 0.493(X_8)$	0.420	0.048
4	Leaf miner (Y_4)	$Y_4 = -11.614 - 0.121(X_1) - 126(X_2) - \mathbf{0.039(X_3)} + \mathbf{0.108(X_4)} + \mathbf{0.056(X_5)} + \mathbf{0.196(X_6)} + \mathbf{0.168(X_7)} + 0.338(X_8)$	0.324	-0.110
5	Leaf folder % damage (Y_3)	$Y_5 = -3.431 - \mathbf{0.041(X_1)} - 0.033(X_2) - \mathbf{0.012(X_3)} + 0.043(X_4) + 0.050(X_5) - 0.112(X_6) - 0.068(X_7) - 0.091(X_8)$	0.190	-0.330
6	Ant (Y_6)	$Y_6 = -1.405 - \mathbf{0.053(X_1)} + 0.098(X_2) + 0.002(X_3) + \mathbf{0.039(X_4)} - 0.023(X_5) - \mathbf{0.094(X_6)} + 0.068(X_7) + 0.120(X_8)$	0.385	-0.011
7	Spider (Y_7)	$Y_7 = 4.060 - \mathbf{0.122(X_1)} + 0.101(X_2) - \mathbf{0.001(X_3)} + \mathbf{0.006(X_4)} - 0.028(X_5) + 0.069(X_6) - \mathbf{0.016(X7)} - \mathbf{0.019(X_8)}$	0.736*	0.566
8	Lady bird beetle (Y_8)	$Y_8 = 0.531 - \mathbf{0.014(X_1)} + 0.018(X_2) + 0.001(X_3) + \mathbf{0.003(X_4)} - 0.007(X_5) + 0.012(X_6) + 0.002(X_7) - \mathbf{0.010(X_8)}$	0.795*	0.664
9	Brumus (Y_9)	$Y_9 = 49.280 - \mathbf{0.472(X_1)} - \mathbf{3.074(X_2)} - \mathbf{0.129(X_3)} - 0.393(X_4) - \mathbf{0.517(X_5)} - \mathbf{0.500(X_6)} - \mathbf{0.179(X_7)} + 0.799(X_8)$	0.347	-0.073

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

X_1 - Maximum Temperature (°C), X_2 - Minimum Temperature (°C), X_3 - Rainfall (mm), X_4 - Relative Humidity (Morning %), X_5 Relative Humidity (Evening %), X_6 - Wind velocity (Kmph), X_7 - Sunshine (Hours), X_8 - Rainy days

MADAKKATHARA

The insect pests and natural enemies of cashew were monitored throughout the year from April 2019 to March 2020. The commonly found insect pests were tea mosquito bug, leaf miner, apple and nut borer and thrips. The damage by these insect pests were observed and presented in Table 3.55. The damage by tea mosquito bug was observed from August but was negligible. Severe damage was observed during January – March, coinciding with flowering and nut set stage. Damage on panicle was comparatively high during peak period of infestation. On comparison with previous season incidence, tea mosquito bug damage was high during 2019-20.

During the season, the peak infestation of leaf miner was noticed during October to January with per

cent shoot infestation ranging from 10.9 to 13.7. The per cent leaf damage during these months ranged from 11.0 to 15.1 per cent. Leaf miner infestation was comparatively low during current season compared to previous season, which ranged from 19.53 to 24.71 during peak incidence.

A mild damage of apple and nut borer was recorded during the season with less than two per cent infestation. The thrips were present only during January-March with a maximum damage score of 1.56 in the month of February, whereas, a less damage score 0.172 was recorded during the previous season.

Table 3.55 : Seasonal occurrence of insect pests at Madakkathara centre during 2019-20

Season	Tea mosquito bug			Leaf miner infestation (%)		Apple and nut borer infestation (%)	Thrips (damage score)
	lateral	panicle	mean	Shoot infestation	Leaf damage		
April	0.000	0.000	0.000	0.60	7.20	0.00	0.00
May	0.000	0.000	0.000	0.70	2.70	0.00	0.00
June	0.000	0.000	0.000	0.00	0.00	0.00	0.00
July	0.000	0.000	0.000	3.40	9.30	0.00	0.00
August	0.016	0.004	0.010	5.70	13.30	0.00	0.00
September	0.000	0.000	0.000	1.80	8.50	0.00	0.00
October	0.004	0.000	0.002	2.80	11.00	0.00	0.00
November	0.003	0.004	0.004	10.90	11.80	0.00	0.00
December	0.043	0.004	0.024	13.70	15.10	0.00	031
January	0.132	0.350	0.241	11.80	12.20	0.433	1.27
February	0.129	0.343	0.236	2.90	4.90	1.275	1.56
March	0.110	0.106	0.108	0.60	2.10	0.808	0.50
Mean	**0.036**	**0.067**	**0.052**	**4.58**	**8.18**	**0.21**	**2.86**

Seasonal occurrence of natural enemies like red ant, black ant and spiders were also recorded and presented in Table 3.56. Natural enemy population was observed througout the season with fluctuation in population.

Table 3.56 : Seasonal occurrence of natural enemies at Madakkathara centre during 2019-20

Season	Red ant	Black ant	Spider
April	0.63	1.44	0.54
May	1.32	1.79	0.44
June	0.94	2.00	0.47
July	1.10	2.94	0.57
August	0.25	0.53	0.66
September	0.28	1.04	0.63
October	0.47	0.66	0.54
November	0.47	0.72	0.26
December	0.10	0.41	0.54
January	0.94	0.63	0.41
February	0.94	0.69	0.38
March	0.63	0.44	0.31
Mean	**0.67**	**1.11**	**0.48**

Correlation between abiotic factors and different insect pests

The population dynamics of all these regional pests were investigated and the damage score of these insect pests were correleated with the average weather variables of first and second previous weeks. The correlation detail is given in Table 3.57. The correlation between TMB and weather parameters revealed significant negative correlation with minimum temperature, morning and evening relative humidity, and rainfall. Strong positive correlation was established with sunshine hours. A strong negative correlation between tea mosquito bug damage and minimum temperature and evening relative humidity was established in the previous season also. In the case of leaf miner, no significant correlation was established with any of the weather parameters. Only the phenophase of the crop influenced the build up of leaf miner.

The correlation study indicated that the incidence of apple and nut borer showed positive and significant correlation with maximum temperature.

The incidence of thrips showed negative and significant correlation with morning and evening humidity, and strong positive correlation with sunshine hours.

Table 3.57 : Correlation of weather parameters and different insect pests recorded at Madakkathara centre during 2019-20

Weather variables	TMB	Leaf miner	Apple and nut borer	Thrips
$Tmax_1$	0.416	-0.095	0.613*	0.401
$Tmax_2$	0.438	-0.093	0.599*	0.465
$Tmin_1$	-0.535*	-0.214	0.471	-0.400
$Tmin_2$	-0.730**	-0.105	0.266	-0.343
RHm_1	-0.869**	-0.095	-0.250	-0.621*
RHm_2	-0.750**	-0.059	-0.385	-0.244*
RHe_1	-0.787**	-0.109	-0.285	-0.615*
RHe_2	-0.736**	-0.043	-0.424	-0.610*
SSH_1	0.574*	-0.126	0.258	0.542*
SSH_2	0.574*	-0.103	0.422	0.532*
RF_1	-0.307	-0.146	-0.190	-0.275
RF_2	-0.362	-0.134	-0.225	-0.325
RD_1	-0.478	-0.034	-0.297	-0.429
RD_2	-0.543*	-0.042	-0.338	-0.488

T_{max}=Maximum temperature, T_{min}=Minimum temperature, RH_m=Morning relative humidity,
RH_e=Evening relative humidity, SSH= Sunshine hours, RF=Rainfall, RD=Rainy days
The subscripts $_1$ & $_2$ indicate weather variables of the first and second previous weeks respectively.

Regression analysis

0Regression analysis was done to develop prediction models (Table 3.58) to forecast the infestation of tea mosquito bug and other insect pests in cashew. The models developed predicted the damage with 75 per cent accuracy with respect to the average morning relative humidity for the previous week. While 84 per cent variance was explained in the prediction equation developed with average relative humidity and minimum temperature for the two lag weeks.

The prediction model developed for apple and nut borer infestation explained 66 per cent variance with average relative humidity and minimum temperature for the two lag weeks. The models developed for thrips predicted the infestation level to an extent of 63 and 74 per cent with morning and evening relative humidity respectively.

Table 3.58 : Regression analysis between insect pests of cashew and weather variables of the first and second lag weeks at Madakkathara centre during 2019-20

Sl. No.	Insect pest	Weather variables	Regression equation	R^2 value (%)
1	Tea mosquito bug	Morning relative humidity	$0.848-0.009*RHm_1$	75
		Minimum temperature and relative humidity	$1.890-0.005*RH_{average2}-0.064*T_{min2}$	84
2	Apple and nut borer	Minimum temperature and relative humidity	$12.24-0.037*RH_{average2}-0.408*T_{min2}$	66
3	Thrips	Morning relative humidity	$6.551-0.071*RHm_1$	74
			$6.629-0.072*RHm_2$	63

Correlation between pest and biotic factors

A positive and significant correlation was established in the case of infestation by tea mosquito bug, apple and nut borer, and thrips with the population of red ants (Table 3.59). During the previous season, a positive and significant correlation was established between tea mosquito bug and spider population.

Table 3.59 : Correlation of biotic factors and different insect pests recorded at Madakkathara during 2019-20

Biotic factors	Tea mosquito bug	Leaf miner	Apple and nut borer	Thrips
Red ant	0.700**	0.171	0.675**	0.701**
Black ant	-0.175	-0.058	-0.290	-0.030
Spider	-0.11	0.057	-0.082	0.695

The trees were being monitored regularly for seasonal occurrence of insect pests and natural enemies.

PARIA

The correlation studies showed that TMB incidence was negatively correlated with temperature, wind velocity, humidity and evaporation while it showed positive correlation with sunshine hours. However, the thrips incidence showed negative correlation with all weather parameters.

Table 3.60 : Influence of abiotic factors on the activity of pest complex of cashew at Paria centre during the year 2018-19

Weather Parameters	TMB	Thrips
X1 - Maximum Temp	-0.55	-0.62
X2 - Minimum Temp	-0.88	-0.72
X3 - RH (m)	-0.07	-0.10
X4 - RH (e)	-0.37	-0.17
X5 - Bright sunshine hours	0.00	-0.20
X6 - Wind velocity	-0.14	-0.30
X7 -Evaporation	-0.26	-0.38
Intercept	3.84	2.22
R^2	0.85	0.74
Standard Error	0.28	0.12

***= significant at 5%**

VENGURLE

The data from Table 3.61 revealed that during the year 2019-20 the incidence TMB, Thrips and ABN showed negative significant correlation with minimum temperature (r= -0.887), (r= -0.830) and (r= -0.826), respectively.

The regression analysis of pest damage (Y) as dependent variable and weather parameter (X) as independent variable was done for the year 2019-20. The regression equation indicated that increase in 1°C minimum temperature decreases the TMB incidence by (0.036) and in case of thrips increase in 1°C minimum temperature decrease in thrips population by (0.034). The multiple regression equation was developed for predicting the pest of cashew and presented in Table 3.62. The incidence of TMB, Thrips and ABN were predicted to an extent of 86, 86 and 96 percent, respectively.

Table 3.61 : Influence of abiotic factors on the activity of pest complex of cashew at Vengurla centre during the year 2019-20

Weather Parameters	TMB	THRIPS	ABN
X_1 - Maximum Temp	0.35	0.35	0.24
X_2 - Minimum Temp	-0.88*	-0.83*	-0.82*
X_3 - RH (m)	-0.08	-0.22	0.05
X_4 - RH (e)	-0.51	-0.53	-0.34
X_5 - Rain fall	-0.47	-0.46	-0.40

Table 3.62 : Regression analysis Equation for insect pest of cashew

S. No.	Biotic factor	Regression Equation	R^2	Adjusted R^2
1	TMB (Y_1)	$Y_1=1.111+0.001(x_1)-0.036(x_2)-0.005(x_3)+0.003(x_4)+0.001(x_5)$	0.865	0.703
2	Thrips (Y_2)	$Y_2= 1.306-0.002(x_1)-0.034(x_2)-0.007(x_3)+0.002(x_4)+0·001(x_5)$	0.866	0.755
3	ABN (Y_3)	$Y_3=10.994-0.1534906(x_1)-0.1180843(x_2)+0.0238557(x_3)-0.0766296(x_4)+0.00050\ (x_5)$	0.935	0.882

* X_1 - Maximum Temp, X_2 - Minimum Temp, X_3 - RH (m), X_4 - RH (e) and X_5 - Rain fall

Table 3.63 : Seasonal incidence of pest at Vengurla

Month	TMB for the year 2017-18	TMB for the year 2018-19	TMB incidence for the year 2019-20	Inflo. Thrips for the year 2017-18	Inflo. Thrips for the year 2018-19	Inflo. Thrips for the year 2019-20	Apple & Nut borer for the year 2017-18	Apple & Nut borer for the year 2018-19	Apple & Nut borer for the year 2019-20
April	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0
Aug.	0	0	0	0	0	0	0	0	0
Sep.	0	0	0	0	0	0	0	0	0
Oct.	0	0		0	0	0	0	0	0
Nov.	0	0	0	0	0	0	0	0	0
Dec.	0.08	0.09	0.134	0.076	0.076	0	0	0	0
Jan.	0.102	0.134	0.135	0.078	0.171	0.103	**1.36**	1.30	1.02

Month	TMB for the year 2017-18	TMB for the year 2018-19	TMB incidence for the year 2019-20	Inflo. Thrips for the year 2017-18	Inflo. Thrips for the year 2018-19	Inflo. Thrips for the year 2019-20	Apple & Nut borer for the year 2017-18	Apple & Nut borer for the year 2018-19	Apple & Nut borer for the year 2019-20
Feb.	**0.114**	**0.195**	**0.168**	**0.136**	0.260	0.146	0.081	**2.10**	**1.48**
March 19	0.091	0.139	0.131	0.069	**0.349**	**0.161**	0.038	2.0	0.384

VRIDHACHALAM

The incidence of cashew pests and natural enemies were recorded at weekly intervals from ten randomly selected cashew trees. 52 leader shoots were tagged from each tree from all the four sides for observation. These cashew trees were grown under unprotected condition.

The incidence of TMB was confined to flushing through fruiting season. Its activity was observed from the first week of February 2020 to the third week of April 2020. The same observation on TMB activity was recorded during first week of February 2018 to third week of April 2019 also. Maximum TMB damage was observed during the second week of March with mean damage score ranging between 1.75 and 2.46. Nut borer activity during non-bearing periods could not be traced out. Cashew leaf miner was found from August to March with a maximum of 2.43% leaf damage during first fortnight of February 2020. Cashew leaf folder was also observed from August 2019 - March 2020 with 5.3 % to 8.2% leaf damage observed in young plantations. Maximum damage was noticed during August 2019 and also in August 2020. Whereas, Leaf and blossom webber damage was observed maximum during June 2019 and 2020. Cashew Leaf thrips population (9.19) was noticed in April 2020. However, shoot tip caterpillar was observed during January to February - 2020. During 2018 to 2019 CSRB incidence was observed as 30%. The CSRB damage (34%) was prevailing throughout the season but maximum was recorded during August 2020.

Table 3.64 : Correlation coefficient (r) for abiotic factors and insect pests of cashew at Vridhachalam

Weather Parameters	TMB Population (Y1)	Leaf and blossom webber (% damage) (Y2)	Leaf miner (% damage) (Y3)	Leaf thrips Population (Y4)	Apple and nut borer (%damage) (Y5)	Leaf folder (%damage) (Y6)	Shoot tip caterpillar (%damage) (Y7)	CSRB (% damage) (Y8)
Minimum temperature (°C) (X1)	-0.421	0.366	0.359	-0.084	-0.292	0.189	-0.197	0.350
Maximum temperature (°C) (X2)	0.638**	0.787**	0.864**	-0.035	-0.149	0.639**	-0.125	0.377
Relative Humidity (Morning%) (X3)	-0.859**	-0.656**	-0.910**	-0.308	0.055	-0.657**	-0.021	-0.193
Relative Humidity (Evening%) (X4)	0.745**	-0.458	-0.673**	-0.745**	0.036	-0.461	0.121	-0.126
Rainfall (X5)	-0.579*	-0.154	0.470	-0.671**	-0.575**	0.084	0.060	0.460
Rainy days (X6)	-0.616*	0.850**	-0.154	-0.645**	-0.626**	-0.027	0.012	0.540*
Wind speed(Km/hr.) (X7)	0.445	-0.314	-0.433	0.135	0.120	-0.187	-0.422	-0.452
Sunshine (hours) (X8)	0.668**	-0.040	0.145	0.852**	0.634**	-0.181	-0.225	-0.400

*significant at 1% level; **significant at 5% level.

Table 3.65 : Correlation coefficient (r) for abiotic factors and population of natural enemies on cashew at Vridhachalam

Weather Parameters	Spiders (Y9)	Ants (Y10)	Coccinellids (Y11)	Braconids (Y12)	Wasp (Y13)
Minimum temperature (°C) (X1)	0.089	-0.579*	0.079	-0.081	-0.669**
Maximum temperature (°C) (X2)	0.197	-0.611*	0.212	-0.372	-0.398
Relative Humidity (Morning%) (X3)	-0.228	0.375	-0.204	0.493	0.107
Relative Humidity (Evening%) (X4)	-0.192	0.384	-0.007	0.373	0.323
Rainfall (X5)	0.153	-0.878*	0.310	0.314	-0.106
Rainy days (X6)	-0.063	-0.701*	0.228	0.358	-0.345
Wind speed(Km/hr.) (X7)	0-.592*	0.489	-0.486	-0.115	0.429
sunshine (hours) (X8)	0-.285	0.433	-0.466	-0.183	-0.003

*significant at 1% level; **significant at 5% level

Based on the regression analysis (Table 3.66) by taking pest population, damage per cent and population of natural enemies (Y) as a dependent variable and weather parameters (X) as independent variable following equations were fitted for season June 2019 to September 2020.

Results of multiple linear regression analysis between weather parameters and abundance of TMB population revealed that the maximum temperature (T_{max}) and minimum temperature (T_{min}) had significant contribution towards the TMB population with the R^2 value of 0.94. When the maximum temperature (T_{max}) increased by 1 °C, number of TMB population increased by 0.1 percent and 1 °C of minimum temperature (T_{min}) decreased the population by 0.1 per cent as well. A similar trend was noticed in leaf and blossom webber damage with the R^2 value of 0.79 and 1°C increase in temperature increased per cent damage by leaf and blossom webber by 1.0 percent and 1°C of minimum temperature (T_{min}) decreased the incidence of the pest by 1.0 per cent as well.

With regard to leaf miner damage, maximum (T_{max}) and minimum (T_{min}) temperature had significant contribution towards their abundance with the R^2 value of 0.89 and a 1°C increase in maximum temperature (T_{max}), 0.1 percent increase and with 1°C decrease in minimum temperature (T_{min}) 0.2 per cent decrease in leaf miner damage could be predicted. The same trend was noticed in leaf thrips population where maximum (T_{max}) and minimum temperature (T_{min}) contributed to budworm incidence with R^2 value of 0.97 and with 1°C increase in maximum temperature (T_{min}) 0.1 percent increase and with 1°C decrease in minimum temperature 0.2 per cent decrease in the leaf thrip population could be predicted.

Maximum temperature (T_{max}) and minimum temperature (T_{min}) had noteworthy contribution towards the abundance of apple and borer damage with the R^2 value of 0.86 with 1°C increase in maximum temperature (T_{min}), the borer damage increased by 0.3 percent whereas, with 1°C decrease in minimum temperature (T_{min}), it decreased by 1 per cent respectively.

Results of multiple linear regression analysis between weather parameters and leaf folder per cent damage revealed that the maximum temperature (T_{max}) and minimum temperature (T_{min}) had significant contribution towards the leaf folder damage with the R^2 value of 0.70 with 1°C increase in maximum temperature (T_{min}), damage increased by 0.5 percent whereas, with 1°C decrease in minimum temperature (T_{min}), damage decreased by 0.1 respectively. A similar trend was noticed in shoot tip caterpillar damage with the R^2 value of 0.49 and 1°C increase in temperature increased per cent damage by 0.1 percent and 1°C of minimum temperature (T_{min}) decreased the incidence of the pest by 0.5 per cent as well. With regard to CSRB per cent damage, maximum (T_{max}) and minimum (T_{min}) temperature had significant contribution towards their per cent damage with the R^2 value of 0.65 and a 1°C increase in maximum temperature (T_{max}), 0.2 percent increase and with 1°C decrease in minimum temperature (T_{min}), 0.4 per cent decrease in CSRB damage could be predicted.

Results of multiple linear regression analysis between weather parameters and abundance of spider population revealed that the maximum temperature (T_{max}) and minimum temperature (T_{min}) had significant contribution towards the spider population with the R^2 value 0.72. When the maximum temperature (T_{max}) increased by 1 °C, spider population increased by 0.1 percent and 1 °C of minimum temperature (T_{min}) decreased population by 0.3 per cent as well. A similar trend was noticed in ant population with the R^2 value of 0.83 and 1°C increase in temperature increased ant population by 0.1 percent and 1°C of minimum temperature (T_{min}) decreased population by 1.0 per cent as well. With regard coccinellid population maximum (T_{max}) and minimum (T_{min}) temperature had significant contribution towards coccinellid population with the R^2 value 0.70 and a 1°C increase in maximum temperature (T_{max}), 0.1 percent in coccinellid population and with 1°C decrease in minimum temperature (T_{min}) 0.01 per cent in the coccinellid population could be predicted. The same trend was noticed in braconid population also that maximum (T_{max}) and minimum temperature (T_{min}) have contributed to braconid population with R^2 value 0.4 and with 1°C increase in maximum temperature (T_{min}) 0.1 percent increase in population and with 1°C decrease in minimum temperature 0.2 per cent decrease in population could be predicted.

Maximum temperature (T_{max}) and minimum temperature (T_{min}) had noteworthy contribution towards the wasp population with the R^2 value 0.63 with 1°C increase in maximum temperature (T_{min}), the wasp population increased by 0.1 percent whereas, with 1°C decrease in minimum temperature (T_{min}), the wasp population decreased by 0.03 per cent respectively.

Table 3.66 : Regression analysis between pests of cashew and weather parameters during June - 2019 and September - 2020 at Vridhachalam

Sl. No.	Biotic factors	Regression equation	R^2
1.	TMB Population(Y1)	Y1= (-3.587)+(-0.1)(X1)+(0.1)(X2)+0.1(X3)+(-0.03) (X4)+0.001(X5)+(-0.2)(X6)+0.1 (X7)+1(X8)	0.94**
2.	Leaf and blossom webber (% damage) (Y2)	Y2= (-38.112)+(-1)(X1)+2(X2)+(-0.03) (X3)+0.1(X4)+0.001(X5)+0.2(X6)+(-0.5)X7+(-0.2)X8	0.79
3.	Leaf miner (% damage) (Y3)	Y3=7.658+(0.1)(X1)+0.2(X2)+(-0.1) (X3)+0.002(X4)+0.002(X5)+(-0.04)(X6)+0.1(X7)+(-0.1)	0.89**
4.	Leaf thrips Population(Y4)	Y4 = (-20.933)+0.1(X1)+(-0.2)(X2)+0.3(X3)+(-0.1) X4+0.03(X5)+(-1)(X6)+(-1) (X7)+2(X8)	0.97**
5.	Apple and nut borer (% damage) (Y5)	Y5 = (-46.285=(-0.3)(X1)+1(X2)+1(X3)+(-0.2)(X4)+(0.01)(X5)+(-1) X6+(0.3) X7 + 1(X8)	0.86**
6.	Leaf folder (% damage) (Y6)	Y6 = 1.035+(-0.5)(X1)+1(X2)+(-0.2)X3+0.02(X$)+(-0.001) X5+0.1(X6)+(-0.3) X7+(-1)(X8)	0.70
7.	Shoot tip caterpillar (% damage) (Y7)	Y7=49.445+(-0.1)(X1)+(0.5)(X2)+(-0.3)X3+0.2(X4)+(-0.03) X5+0.04(X6)+(-2)(X7)+(-1)X8	0.49
8.	CSRB (% damage) (Y8)	Y8=103.478+0.2(X1)+(-0.4)X2+(-2)(X3)+1(X4)+(-0.04) X5+2(X6)+(-2)X7+(1)X8	0.65

*significant at 1% level; **significant at 5% level.

Minimum temperature (°C) (X1),
Maximum temperature (°C) (X2),
Relative Humidity (Morning%) (X3),
Relative Humidity (Evening%) (X4),
Rainfall (X5),
Rainy days (X6),
Wind speed(Km/hr.) (X7) and sunshine (hours) (X8).

Table 3.67 : Regression analysis between natural enemies of cashew and weather parameters during June - 2019 and September 2020 at Vridhachalam

Sl. No.	Biotic factors	Regression equation	R^2
1.	Spiders (Y9)	Y9=1.402+(-0.1)(X1)+(0.3)(X2)+0.1(X3)+(-0.02)X4+(-0.004)X5+(-0.5)X6+X7+(-1)X8	0.72
2.	Ants (Y10)	Y10=22.190+(-0.1)X1+(-1)X2+0.2(X3)+(-0.1)X4+0.02(X5)+(-1)(X6)+1(X7)+1(X8)	0.83*
3.	Coccinellids (Y11)	Y11=15.078+0.01(X1)+(-0.1)(X2)+(-0.2)(X3)+0.1(X4)+(-0.01)X5+(0.1)X6+(-0.4)X7+(-0.5)X8	0.70
4.	Braconids (Y12)	Y12=6.238+0.1(X1)+(-0.2)X2+(-0.1)X3+0.04(X4)+(-0.003)X5+0.03(X6)+(-0.01)(X7)+0.2(X8)	0.40
5.	Wasp (Y13)	Y13+4.514+(-0.1)(x1)+(-0.03)(X2)+(-0.02)(X3)+0.01(X4)+0.004(X5)+(-0.1)(X6)+0.1(X7)+0.03(X8)	0.63

*significant at 1% level; **significant at 5% level.

Minimum temperature (°C) (X1),
Maximum temperature (°C) (X2),
Relative Humidity (Morning%) (X3),
Relative Humidity (Evening%) (X4),
Rainfall (X5),
Rainy days (X6),
Wind speed(Km/hr.) (X7) and
sunshine (hours) (X8).

Ent.4 : Screening of germplasm to locate tolerant / resistant types to major pests of the region

Centres: East Coast :	Bapatla, Bhubaneshwar, Jhargram and Vridhachalam
West Coast :	Madakkathara and Vengurla
Plains / others:	Hogalagere and Jagdalpur

The objective of this project is to identify germplasm accessions tolerant / resistant to the major pests of the region.

BAPATLA

Experimental details:

Germplasm entries existing in the gene bank of Cashew Research Station, Bapatla were screened for resistance/susceptibility to major pest(s) of cashew *viz*,.

1) Leaf and blossom webber (*Lamida moncusalis*)
2) Shoot tip caterpillar (*Cheleria haligramma)*
3) Leaf miner (*Acrocercops syngramme)*
4) Apple and nut borer *(Thylocoptila panrosema)*

The data on pest incidence from 2 trees per each entry from 52 leader shoots of each tree from all the four sides was recorded under unprotected conditions in respect of Leaf and blossom webber and Shoot tip caterpillar.

During the year 2019-20, among the 37 accessions screened to identify the tolerant lines against the pests of cashew, all entries recorded almost negligible incidence of leaf and blossom webber and shoot tip caterpillar. The accession **ABT-3** has recorded the highest incidence of leaf miner (3.99%) and **Vetapalem** has recorded the lowest incidence (0.32%). With regard to the incidence of leaf folder, the **ABT-2** has recorded with the highest incidence **(**2.04%**)** and remaining entries recorded the lowest incidence (0.00-1.81%). The accession line **T.No. 8/7** has recorded with highest incidence of apple and nut borer (8.46 %) and **T.No. 7/12** observed nil incidence during this season (0.00**%**).

Infestation by	Min. damage recorded (range)	Germplasm	Max. damage recorded (range)	Germplasm
Leaf and blossom webber	0-5%	T.No.129, T.No.274, T.No.12/1, T.No.12/8, ABT-3, ABT-2, T.No.3/7, T.No.8/7,T.No.4/3, T.No.4/5, T.No.30/1, T.No.233, T.No.244, T.No.268, BLA 139-1, T.No.5/1, T.No.7/12, T.No.71, T.No.277, T.No.40/1, Hy 94-T3, T.No.2/5, Hy 95-T4, Priyanka, T.No.275, T.No.18/3, T.No.3/4, T.No.1/1, T.No.228, BLA 39/4, T.No.2/3, T.No.10/2, T.No.2/14, Ch.gudem, ASRPT, T.No.6/14, Hy 94-T4, Vetapalem	5.1-10%	-
Leaf miner	0-5%	T.No.129, T.No.12/8, ABT-2, T.No.1/1, T.No.228, T.No.244, M 15/4, BLA 139-1, T.No.2/3, T.No.7/12, T.No.40/1, Hy 94-T3, Hy 94-T4, Hy 95-T4, Vetapalem, Priyanka, T.No.275, T.No.12/1, T.No.18/3, T.No.3/4, T.No.8/7, T.No.30/1, T.No.233, T.No.268, T.No.17/5, BLA 39/4, T.No.5/1, T.No.10/2, T.No.71, T.No.277, T.No.2/14, Ch.gudem, ASRPT, T.No.6/14, T.No.274, T.No.2/5, ABT-3, T.No.3/7, T.No.4/3, T.No.4/5	5.1 -10%	
Leaf folder	0-5%	Priyanka, T.No.129, T.No.275, T.No.274 , T.No.12/1, T.No.12/8, T.No.18/3, ABT-3, ABT-2, T.No.3/7, T.No.3/4, T.No.1/1, T.No.8/7, T.No.4/3, T.No.4/5, T.No.30/1, T.No.228, T.No.233, T.No.244, T.No.268, M 15/4, BLA 139-1, T.No.17/5, BLA 39/4, T.No.5/1, T.No.10/2, T.No.7/12, T.No.71, T.No.277, T.No.2/14, Ch.gudem, ASRPT, T.No.40/1, T.No.6/14, Hy 94-T3, T.No.2/5, Hy 94-T4, Hy 95-T4, Vetapalem, T.No.2/3	5.1-10%	-

Infestation by	Min. damage recorded (range)	Germplasm	Max. damage recorded (range)	Germplasm
Shoot tip caterpillar	0-5%	Priyanka, T.No.129, T.No.12/8, T.No.30/1, T.No.268, M 15/4, BLA 139-1, BLA 39/4, T.No.5/1, T.No.2/3, T.No.10/2, T.No.7/12, T.No.71, T.No.2/14, T.No.40/1, Hy 94-T3, T.No.2/5, Hy 95-T4, T.No.275, T.No.274 , T.No.12/1, T.No.18/3, ABT-3, ABT-2, T.No.3/7, T.No.3/4, T.No.1/1, T.No.8/7, T.No.4/3, T.No.4/5, T.No.228, T.No.233, T.No.244, T.No.17/5, T.No.277, Ch.gudem, ASRPT, T.No.6/14, Hy 94-T4, Vetapalem	5.1-10%	-
Apple and nut borer	0-5%	T.No.12/1, T.No.18/3, T.No.30/1, T.No.7/12, T.No.6/14, Vetapalem, T.No.274, T.No.2/14, T.No.2/3, T.No.277, Hy 94-T4, T.No.275, T.No.12/8, T.No.3/7, T.No.4/3, T.No.4/5, BLA 39/4, T.No.129, T.No.228, T.No.233, T.No.244, T.No.268, BLA 139-1, Hy 95-T3, T.No.5/1, ASRPT,	5.1-10%	Priyanka, ABT-3, ABT-2, T.No.71, Ch.gudem, T.No.2/5, T.No.40/1, T.No.1/1, T.No.10/2, T.No.3/4, T.No.8/7, Hy 94-T3

HOGALAGERE

The reactions of MLT-1992 and MLT-2002 entries maintained at HREC, Hogalagere and ARS, Chintamani were observed to identify the susceptibility/resistant or tolerance to infestation of TMB and other major pests. The data indicated that none of the yielding accessions have shown resistant or tolerance to TMB infestation.

Table 3.68 : Screening of MLT-II (MLT-1992) entries for tolerant/resistant to the major pests of the region at HREC, Hogalagere during 2019-20

Sl. No.	Centre	Entry	Mean damage on shoots			Thrips (% damage)
			TMB (% damage)	Leaf miner (No. blotches/shoot)	Apple & nut borer (% damage)	
1	Vengurla	H-68	0.90	0.98	1.02	1.00
		H-367	1.00	0.96	1.01	0.95
		H-303 (V-9)	1.09	0.88	0.82	0.84
		H-255	0.88	0.91	0.98	0.92
		H-320	1.01	0.86	0.87	1.04
2	Vridhachalam	M-4/3	0.82	0.97	0.89	0.92
		M-15/4	0.97	0.86	1.00	0.88
3	NRCC, Puttur	NRCC-1	0.85	0.88	0.86	1.04
		NRCC-2	0.89	0.91	0.89	0.87
4	Bapatla	TN-30/1	0.82	0.97	0.85	1.03
		TN-3/33	1.08	0.97	0.86	1.04
		TN-10/19	0.97	0.85	0.98	0.92
		TN-3/28	1.02	1.04	0.88	1.06
5	Ullal	Ullal-1	0.92	0.99	1.01	0.90

Table 3.69 : Screening of MLT-III (MLT-2002) entries for tolerant/resistant to the major pests of the region at HREC, Hogalagere during 2019-20

Sl. No.	Centre	Entry	Mean damage on shoots		
			TMB (% damage)	Leaf miner (No. blotches/shoot)	Apple & nut borer (% damage)
1	Bhubaneshwar	BH-6	0.99	0.92	1.00
		BH-85	0.93	1.00	0.87
2	Madakathara	H-1593	0.96	0.90	0.86
		K-22-1	0.84	1.03	0.98
3	Vengurla	H-662	0.84	1.00	1.07
		H-675	0.89	0.92	0.92
4	Puttur	H-32/4	1.01	0.96	1.03
		Goa-11/6	0.89	0.91	0.98
5	Vridhachalam	H-11	0.87	1.07	1.05
		H-14	1.04	0.95	1.05
6	Chintamani	Chintamani-1	0.91	1.02	1.08

JAGDALPUR

Among twelve promising DCR entries planted during 1997 in SG CARS Jagdalpur, which were 22 years old, all the germplasm recorded low score for thrips and TMB. The lowest score for thrips was recorded in NRC-190 (0.07), whereas, germplasm NRC-131 had minimum score for TMB (0.04). The experimental data presented in Table 3.70 revealed that the shoot tip caterpillar infestation ranged from 2.56 to 7.39 per cent, minimum percentage of leaf damage was reported in NRC-130. The lowest damage with respect to leaf miner and leaf folder was recorded in NRC-130 (0.11 %) and NRC-130 (0.83 %) respectively.

Table 3.70 : Screening of promising ICAR-DCR entries for tolerance/ resistance to the major pests at Jagdalpur during the year 2019-20

Germplasm	TMB (mean damage score 0-4 scale)	Thrips (mean damage score 0-4 scale)	Shoot tip caterpillar (% of damaged leaves)	Leaf miner (% of mined leaves)	Leaf folder (% of damaged leaves)
NRC-130	0.33	0.43	2.56	0.11	0.83
NRC-131	0.04	0.54	3.46	0.79	1.53
NRC-136	1.15	0.90	3.67	0.13	1.92
NRC-137	0.09	0.31	5.18	2.84	2.46
NRC-138	0.13	0.27	5.71	0.81	1.69
NRC-140	0.18	0.47	3.69	4.15	1.93
NRC-190	0.12	0.07	2.78	1.33	2.05
NRC-191	0.35	0.51	5.50	1.53	1.62
NRC-192	0.12	0.54	4.06	0.38	2.04
NRC-193	0.13	0.70	2.63	0.35	3.34
VTH 711/4	0.64	0.78	7.39	0.82	2.01
Aakhane	0.88	0.88	3.99	0.76	1.10

Locally collected germplasm were studied for tolerance to pests which were 07- 11 years old, maintained in the gene bank of SGCARS, Jagdalpur. Screening of local germplasm revealed that all germplasm recorded low score for thrips and TMB. Lowest score for thrips was recorded in CARS-6 (0.32) whereas, the same was maximum in CARS-9 (1.28). The lowest TMB infestation was reported in CARS-7 (0.03) germplasm during 2019-20 however, maximum TMB score was reported in CARS-1 (2.61). From these results it could not be concluded that CARS-6 was immune to leaf folder while maximum in CARS-9 (4.43%). The minimum damage of leaf caterpillar (3.15%) was recorded in germplasm CARS-1 and leaf miner (0.08%) in CARS-3 during 2019-20.

Table 3.71 : Screening of local germplasm for tolerance/ resistance to the major pests at Jagdalpur during the year 2019-20

Germplasm	TMB (mean damage score 0-4 scale)	Thrips (mean damage score 0-4 scale)	Shoot tip caterpillar (% of damaged leaves)	Leaf miner (% of mined leaves)	Leaf folder (% of damaged leaves)
CARS-1	2.61	0.45	**3.15**	1.97	0.97
CARS-2	0.55	0.43	9.28	0.34	2.93
CARS-3	2.16	1.13	3.76	**0.08**	1.30
CARS-4	2.03	0.69	4.72	3.60	1.54
CARS-5	0.11	0.58	10.45	0.87	2.44
CARS-6	0.06	0.32	3.36	0.22	**0.00**
CARS-7	**0.03**	0.83	9.50	3.07	0.88
CARS-8	1.58	0.97	6.72	0.28	1.54
CARS-9	0.13	1.28	14.13	13.57	4.43
CARS-10	0.31	0.53	5.95	2.90	2.00

The data recorded in other varieties/genotypes for tolerance /resistance to the major pests revealed that, TMB and thrips incidence were very low in germplasm H-15181 with 0.0 and 0.13 respectively, similarly the minimum per cent damage for shoot tip caterpillar, leaf miner and leaf folder was recorded in germplasm Ullal-1 (1.57 %), BPP-5 (0.0 %) and VRI-3 (0.16 %). The damage of leaf miner was recorded lower in NRCC Sel. 1 which had only 2.67 per cent infestation.

The results for the year 2019-20 (Table 3.72) revealed that the zero damage were recorded in H-1598, BPP-5 and CARS-6 for TMB, Leaf miner and Leaf folder respectively but it cannot be opined that this is immune because previous year they have varied range of infestation.

Table 3.72 : Screening of germplasm accession maintained at germplasm block for tolerance/ resistance to the major pests at Jagdalpur during the year 2019-20

Germplasm	Thrips (mean damage score 0-4 scale)	TMB (mean damage score 0-4 scale)	Shoot tip caterpillar (% of damaged leaves)	Leaf miner (% of mined leaves)	Leaf folder (% of damaged leaves)
NRCC Sel. 1	0.19	0.19	5.33	2.67	1.83
NRCC Sel. 2	0.13	0.35	3.05	1.02	1.22
3/28	0.10	0.33	6.02	1.13	3.38
3/33	1.08	0.70	6.48	0.32	3.32
30/1	1.52	0.27	4.81	8.29	1.60
10/19	1.46	1.08	7.03	0.51	2.23
VRI-1	**3.21**	0.90	5.44	7.86	0.85

Germplasm	Thrips (mean damage score 0-4 scale)	TMB (mean damage score 0-4 scale)	Shoot tip caterpillar (% of damaged leaves)	Leaf miner (% of mined leaves)	Leaf folder (% of damaged leaves)
VRI-2	1.05	**1.63**	4.33	4.33	5.07
VRI-3	2.90	0.15	3.87	0.32	**0.16**
Vengurla-4	0.78	1.00	3.38	0.36	2.05
Ullal-1	0.80	0.30	**1.57**	1.91	4.00
Ullal-2	0.22	0.31	2.77	0.92	0.31
H-1598	**0.00**	**0.13**	3.82	4.01	2.67
H-1608	0.94	0.18	4.74	0.62	1.65
Chintamani-1	1.41	0.59	8.41	5.28	3.52
Bhubaneswar-1	1.03	1.00	4.38	3.90	4.63
H-1591	1.22	0.89	3.78	2.72	3.02
MAD-2	0.03	0.23	6.78	1.22	1.22
MAD-1	0.69	0.64	5.73	3.44	1.58
K-22-1	0.72	0.47	1.63	1.02	2.04
M-15/4	1.63	1.60	10.28	**13.62**	**9.35**
BPP-1	1.21	1.39	3.96	1.28	2.45
BPP-2	2.74	0.90	8.65	9.38	1.32
BPP-4	1.58	0.95	7.38	3.09	2.57
BPP-5	0.64	0.68	**18.34**	**0.00**	0.69
BPP-6	0.68	0.88	8.62	5.75	4.60
BPP-8	3.36	0.36	5.59	3.26	2.64

Table 3.73 : Minimum and maximum damage scores recorded in germplasm during 2019-20

Infestation by	Minimum damage	Germplasm	Maximum damage recorded	Germplasm
Thrips (0-4 scale)	0	-	1.63	VRI-2
TMB (0-4 scale)	0	H-1598	3.36	BPP-8
Shoot tip caterpillar	0	-	18.34	BPP-5
Leaf miner	0	BPP-5	13.62	M15/4
Leaf folder	0	CARS-6	9.35	M15/4

VENGURLE

During the year 2019-20, the variety V-7 recorded lowest TMB incidence (0.084) whereas, it was maximum in the H-992 (0.198). In case of thrips, the variety V-5 (0.089) recorded lowest Thrips infestation whereas it was maximum in H-1306 (0.153).

Table 3.74 : Screening of cashew germplasm to locate tolerance/resistance to major pests of the region at Vengurla centre during the year 2019-20

Infestation by	Min. damage recorded (range)	Germplasm	Max. damage recorded (range)	Germplasm
Tea Mosquito Bug	0.084	V-7	0.198	H-992
Flower thrips	0.089	V-5	0.153	H-1306

VRIDHACHALAM

The data pertaining to reaction of different accessions indicate that all the MLT entries and hybrids were prone for TMB infestation in varying degree of susceptibility. The damage score for TMB infestations in various MLT entries ranged from 2.2-3.4 (Table 3.75). The score was low in ME 20/1 with mean damage score of 2.2. In other cashew entries, the mean damage score ranged between 2.3 and 3.4. So, none of the cashew entries showed immune or resistant reactions to TMB infestation under field condition.

Table 3.75 : Screening of MLT entries against major pests of cashew at Vridhachalam

MLT entries	TMB (mean damage score 0-4 scale in 52 leader shoots)	Leaf & blossom webber (% shoot damaged / 52 leader shoots)	Leaf miner (% of mined leaves on five laterals)	Inflorescence caterpillars (% of damaged panicle out of 52 panicles)	Leaf thrips (Population No./52 leader shoots)	Apple & Nut borer (% of apples damaged /52 panicles)
H 1598	2.8	3.2	1.2	0.0	0.5	0.0
H 1600	2.4	3.6	1.0	0.0	0.5	0.0
H 1608	2.6	3.4	1.3	0.0	0.6	0.0
H 1610	2.8	3.6	2.0	0.0	0.6	0.0
H 129	2.8	3.8	2.0	0.0	0.7	0.0
H 40	3.2	3.2	2.6	0.0	0.5	0.0
H 2/15	2.8	3.5	1.0	0.0	0.5	0.0
H 2/16	3.4	2.8	2.0	0.0	0.5	0.0
H 33/3	2.3	2.8	2.8	0.0	0.6	0.0
H 44/3	2.3	2.8	1.3	0.0	0.6	0.0
M 26/2	2.6	3.2	3.3	0.0	0.6	0.0
ME 20/1	2.2	2.8	1.3	0.0	0.6	0.0
VTH 30/4	3.0	3.5	1.3	0.0	0.5	0.0
VTH 59/2	3.2	3.5	1.0	0.0	0.6	0.0
V 2	3.0	2.8	1.0	0.0	0.5	0.0
V 3	3.0	2.8	3.0	0.0	0.6	0.0
V 4	3.0	3.2	2.3	0.0	0.5	0.0
V 5	2.5	3.4	2.6	0.0	0.6	0.0

Screening of F_1 hybrids revealed that all the cross combinations were susceptible to TMB infestation. However, the damage score was low (2.4) in H 10, H14 and H 16 followed by H 13 and H15, H17 with a mean damage score of 2.6 and 2.8 respectively (Table 3.76).

Table 3.76 : Screening of F_1 hybrids for tolerance to cashew pests at Vridhachalam

Hybrid Number	Cross combination	TMB mean damage score 0-4 scale in 52 leader shoots	Leaf & blossom webber % shoot damaged / 52 leader shoots	Inflorescence caterpillars (% of damaged panicle out of 52 panicles)	Leaf miner (% of mined leaves) on five laterals	Apple & Nut borer (% of apples damaged /52 panicles)
H 10	M 10/4 x M 26/1	2.4	4.5	2.0	2.0	0.0
H 11	M 10/4 x M 45/4	3.2	4.0	1.8	1.8	0.0

Hybrid Number	Cross combination	TMB mean damage score 0-4 scale in 52 leader shoots	Leaf & blossom webber % shoot damaged / 52 leader shoots	Inflorescence caterpillars (% of damaged panicle out of 52 panicles)	Leaf miner (% of mined leaves) on five laterals	Apple & Nut borer (% of apples damaged /52 panicles)
H 12	M 10/4 x M 75/3	2.9	4.0	1.9	1.4	0.0
H 13	M 26/2 x M 26/1	2.6	4.0	2.0	1.4	0.0
H 14	M 26/2 x M 45/4	2.4	5.2	1.5	1.6	0.0
H 15	M 26/2 x M 75/3	2.8	5.2	1.6	2.4	0.0
H 16	M 44/3 x M 26/1	2.4	5.2	1.5	2.6	0.0
H 17	M 44/3 x M 45/1	2.6	5.0	1.8	2.8	0.0

However, none of the cashew entries showed immune or resistant reaction to TMB and other foliar feeding insects.

CHAPTER II
ORGANISATION

1. GENERAL CHARACTERISTICS OF CENTRES OF AICRP ON CASHEW

The AICRP-Cashew has eleven coordinating centres and three co-operating centres which are located in the East Coast, West Coast and Plain Regions (plateau region) of the country. The general characteristic of the centre is given in the below Table.

Centers	Average Rainfall (mm)	Temperature (° C)	Soil	Climate
East Coast Centers				
Bapatla, Andhra Pradesh	1167	17.3 to 37.8	Sandy soil with low organic matter, medium N, low P_2O_5 and K_2O. Average Water Holding Capacity (AWC) 100 mm	Sub humid (dry).
Bhubaneshwar, Orissa	1550	14.3 to 37.1	Red soil, red loamy and laterite; AWC 100 mm	Sub humid (dry)
Jhargram, West Bengal	1622	11.3 to 39.4	Red, laterite, shallow depth gravels, low in organic matter, N and high in P_2O_5 and K_2O. AWC 200 mm	Sub humid (dry
Vridhachalam, Tamil Nadu	1215	18.7 to 35.7	Red laterite, low in organic matter and N, medium in P_2O_5 and high in K_2O; semi arid (dry)	Semi arid (dry)
West Coast centers				
Madakkathara, Kerala	3550	22.0 to 36.2	Laterite (oxisol), medium in N, low in P and medium in K contents. AWC is 150 mm.	Humid
Pilicode, Kerala	3550	22.0 to 36.2	Laterite (oxisol), medium in N, medium in P and low in K contents. AWC is 150 mm.	Humid
Vengurla, Maharastra	2916	17.4 to 32.9	Sandy loam to sandy clay loam with high organic matter, N, K and low in P. AWC 150 mm	Humid
Paria, Gujarath	2200	18.5 to 33.0	Black loamy soil	Mean RH of 70.22 percent
Centers in Maidan tract				
Hogalagere (Eastern Dry zone of Karnataka)	789	13.9 to 34.5	Red sandy loam, deficient in N, medium in P_2O_5 and high in K_2O. AWC 150 mm.	The climate is semi arid (dry), 300 MSL
Darisai, Jharkhand	1200		Well drained loamy soil	-
Jagdalpur, Chattisgarh	1200 - 1400	6 to 41	Sandy loam to silty loam, very poor moisture retaining capacity having shallow depth with poor organic matter (0.05%) and pH value (5.5 - 6.5)	Cold and dry
Cooperating centers				
Kanabargi, Karnataka	1200	20.5 to 30.16	Texturally red sandy loams and medium to deep soil depth.	Northern transitional zone
Tura, Meghalaya	2500 - 4000	9 to 21	Hilly terrain and deep black loamy soils	Subtropical hill Zone
Goa	2800 - 3800	21.0 to 32.20	Lateritic soils with shallow to medium depth	25-40m above the MSL

2. TRANSFER OF TECHNOLOGY

BAPATLA

The scientists of the centre participated in the training programme under SCSP at Gangavaram village, Rajavaram Panchayat, Koyyalagudem Mandal in West Godavari District from 20.11.2020 to 21.11.2020. The total area covered under SCSP programme is 25 acres covering 26 beneficiaries. The centre organized the three days farmers training programme on "Advanced Cashew Production Technology" at Cashew Research Station, Bapatla from 06.03.2020 to 08.03.2020 sponsored by Directorate of Cashewnut and Cocoa Development, Kochi, Kerala. A total of 50 farmers from Srikakulam, Vizianagaram, Visakhapatnam, Krishna, Guntur and Prakasam Districts were participated in the programme.

Dr. K. Dhanumjaya Rao, Principal Scientist (Hort) & Head, Dr. K. Umamaheswara Rao Scientist (Hort) and Dr. B. Nagendra Reddy, Scientist (Ento.) were invited as resource persons for Virtual Training Programme on Cashew organized by Dept. of Horticulture, Vizianagaram for Srungavarapukota and Mentada Cashew clusters on 31.12.2020.

Cashew farmers from Srikakulam, Vizianagaram, Visakhapatnam, Krishna, Guntur and Prakasam Districts were taken on a field visit by Cashew Research Station, Bapatla on 07.03.2020 and on 08.3.2020 visited cashew field and Cashew processing unit at Vetapalem, Cheerala of Prakasam. During their visit, they were explained about advanced production technology in cashew, Integrated Pest management of Cashew and Processing in Cashew.

Programme	Date
Programme on Cultivation of Cashew at Dooradarsan Kendra, Vijayawada	4.6.2020
Programme on Integrated Pest Management on Cashew at Doordarshan Kendra, Vijayawada	17.12.2020
Integrated Pest Management on Cashew, telecasted in DD Saptagiri Channel.	22.12.2020

The centre had organized Rythu Sadassu at Bethapudi village of Bapatla Mandal, Guntur Dist on 29.02.2020 under RHWE Programme. Around 100 Farmers attended the Rythu Sadassu and they observed the specimens, charts and models displayed by the RHWEP students.

The centre had organized state level webinar on "Cashew – a white gold for the future" in which scientists of CRS, Bapatla delivered lecturers on management practices in cashew. Officials of Department of Horticulture, FPO members, representatives of NGOs working with cashew and farmers had attended the webinar.

BHUBANESWAR

The scientists of the centre have participated and acted as resource person in the following programmes.

Programme	Date and Venue	Organised by
District Level Seminar on Cashew	Chittri, Jajpur district on 4th February, 2020 Lahanga, Khordha Disrtrict on 12th February, 2020.	Odisha State Cashew Development Corporation Ltd, Bhubaneswar
Training for entrepreneurship development on "Orchard management" and "Fruit Crops Nursery Management"	8th January and 28th February, 2020	Directorate of Horticulture, Government of Odisha under Rashtriya Krishi Vikash Yojana (RKVY)
Replanting and rejuvenation programme of cashew	11th to 13th February, 2020.	Odisha State Cashew Development Corporation Ltd., Bhubaneswar

25 farmers from Andhra Pradesh had visited Cashew Research Station, OUAT, Bhubaneswar on 24.11.2020. They were taken to the research plots and interacted with the scientists of the project. Four field visits/discussions were made on various aspects of cashew cultivation i.e. production technology, crop management and plant protection measures and suitable suggestions were provided to the farmers.

The scientist of the centre had participated in Pallishree Programme at Doordarshan Kendra, Bhubaneswar on the topic "*Kaju Phasalara Jatna*" on 23rd January, 2020 and attended Doordarshan "Live-Phone-in Programme" on Krishi Darshan on the topic "*Amba O Kaju Phasalara Jatna*" on 6th March, 2020. The scientist has also participated in discussion programme on the topic "*Barsha Dine Kaju Bagichara Jatna O Parichalana*" and "*Kaju Bagicharu Adhika Amala Paibe Kipar*" 'in Kisanvani Programme broadcasted by All India Radio, Puri on 27.08.2020 and 07.12.2020 respectively.

HOGALAGERE

The scientists of the centre gave consultancy on various aspects of cashew viz., cultivation aspects of cashew, nursery grafts availability for planting, pruning, fertilization, rejuvenation practices and intercropping in cashew. Scientists also recommended farmers to grow annual pulse crops or Amla in the interspace between the cashew and clarified the queries on cashew stem and root borer problem raised by 7 farmers of the region.

The Scientists of the centre exhibited cashew production technologies at National Horticulture Fair-2020, held at IIHR, Bangalore between 05-02-2020 to 08-02-2020 and gave consultancy services to diverse group of participants. Information regarding cashew cultivation and related aspects were also extended to around 200 of farmers and students through RAWE programme.

JAGDALPUR

Three training programs on cashew production technology, plant protection and processing was organized at Papanpal, Rajnagar and Mongrapal villages under SCSP scheme in which more than 50 farmers participated in each training program. The scientists have also acted as resource person for the Training-cum-exposure visit on "Advance in Production and Processing of Cashewnut" organized by Chhattisgarh Govt. A training programme was organized for unemployed women on cashew apple utilization on 29th March 2020 in which 100 women members had participated.

JHARGRAM

Three training programmes were organized under Scheduled caste sub plan project during 2019 – 20. First training programme was organized on 10.01.2020 at Sankrail block of Jhargram district, second one on 28.01.2020 at aranya Sundari Mahila Mahasangha, Jhargram district and third one on 07.02.2020 at the regional research station, Bidhan Chandra Krishi Viswavidyalaya, Jhargram. About 60, 60 and 80 farmers attended the first, second and third training respectively. The farmers were trained on various aspects of cashew cultivation such as propagation methods, planting technique, maintenance of cashew orchards, management of pest and diseases of cashew crops, processing of cashew apple and nut.

Apart from trainings under SCSP project 6.62 ha cashew plantation was developed at the Godbeta block of Paschim Medinipur district of West Bengal and 1 ha

at the Gopiballavpur – I block of Jhargram district. 17 scheduled caste farmers were identified as beneficiaries for the area expansion programme. 20 scheduled caste cashew farmers were supported with small implements such as sprayers, water cans, pruning loopers, secateurs, measuring tapes. 5 Scheduled cast farmers were identified for area expansion programme of SCSP for the year 2020 – 21. The total area will be 2 ha. Sprayers were purchased for distribution to scheduled cast farmers during the training. For Tribal Sub plan project area has been identified and small implements have been purchased for distribution.

MADAKKATHARA

The scientists of the centre had provided training on "Cashew apple processing for unemployed women" on 7.2.2020, 14.2.2020, 17.2.2020 and 22.2.2020 at CRS, Madakkathara in which around 100 trainees were present. Cashew Vigyan Mela funded by DCCD was conducted at CRS, Madakkathara on 15.2.2020 in which there were 391 participants and District level seminar on cashew was also conducted at CRS, Madakkathara on 17.2.2020 in which around 154 trainees had participated. Online training programme was conducted on "Pre-flowering management of cashew" on 20.8.2020 and "Management of cashew plantation in flowering season" on 11.11.2020 for the farmers at CRS, Madakkathara.

Under SCSP Programme, the centre had conducted training on "Cashew production management and cashew apple processing" on 6th Feb, 2020 at Kottassery in which 139 trainees had participated and on cashew cultivation on 15.2.2020 at CRS, Madakkathara in which around 55 trainees had participated.

Other Extension activities

- Malayalam version of "Cashew India"Android Mobile app developed by ICAR-DCR Puttur was launched on 7.8.2020.
- Commercial scale of traditional cashew sprout was launched on 7.8.2020.
- KAU-RAISE-KAU PACE2020 - Product development and operational aspects value added products from cashew apple and nut on 12th October 2020.
- A class handled on Production technology of cashew - DAESI (Diploma in Agriculture Extension) programme implemented at Krishi Vigyan Kendra, Palakkad on 14.11.2020.
- Facebook live on 'Cashew cultivation" – RATTC Vytilla, Agriculture Department, Kerala.
- Handled a session on 'diversified cashew products' to farmers in a training conducted by Post Harvest Department of College of Agriculture Vellayani, Kerala

PARIA

The scientist of the centre had conducted training for farmers on "scientific cultivation of cashew" and "Control of pest and disease in fruit crops" on 1-3-2020 at Umergam in which about 35 trainees (32 male and 3 female) had participated and on 13-3-2020 at Surat in which around 32 trainees (15male and 17 female) had participated.

PILICODE

The Scientist of the centre were invited as resource person in two trainings on "Cashew and its importance as a commercial crop, budding and grafting" on 10.1.2020 at GVHSS, Bellikkoth in which around 55 farmers had participated and online training on "Management of Cashew Plantation- Pre-flowering stage" on 28.8.2020 wherein 35 farmers had participated.

The Centre has been maintaining two cashew demonstration plots in farmer's field for about fourteen years. Further, 28 demonstration plots established under TSP is under 5th year of maintenance. 45 demonstration plots established under TSP in under 4th year of maintenance. Under SCSP programme around 50 plots have been established during 2019-20.

TURA

The centre had organised Four numbers of one day training and awareness programme in the villages of Garo Hills *viz*. Chongpotre, Skorimrim, Badek and Nengja Bolchugre on 17th October (Calendar of operations for cashew), 24th October (Nutrient management in cashew), 3rd November (Intercropping in cashew) and 4th November (Nutrient management in cashew) respectively. A total of 73 (39 male and 34 female) cashew growers had participated.

VENGURLE

The centre had organized two "District Level Seminar on Cashew" on 28th Jan. 2020 at Hirlok, Tal. Kudal, Dist. Sindhudurg and on 11th Feb. 2020 at Kunde, Tal. Kudal, Dist. Sindhudurg wherein around 150 members had participated. The centre had organized four training programmes on "Cashew Apple Utilization for Unemployed Women" for 100 participants from 4th March to 11th March 2020 sponsored by DCCD. On 1st July 2020, the centre had taken up three demonstrations on "cashew grafts planting and their maintenance" "Integrated nutrient management in cashew" and "CSRB management" wherein in each around 25 members had participated.

VRIDHACHALAM

The scientists of the centre have conducted SCSP training programme on "Cashew production, management and cashew apple processing" on 19.2.2020 at RRS, Vridhachalam.

3. RESEARCH PUBLICATIONS

BAPATLA

Umamaheswara Rao K., Venkata Ramana K.T., Yuvaraj K.M., Vimala B. and Nagendra Reddy B. 2020. Growing of intercrops in cashew based cropping system under coastal sandy soils of Andhra Pradesh. *The Andhra agricultural Journal*, 67(2): 9-12.

Umamaheswara Rao K., Prasanna Kumar B., Swami D.V., Salomi Suneetha D.R., Smith D.D. and Uma Krishna K. 2021. Effect of packaging and storage on physico-chemical characters of powder prepared by spray drying of blended juices of cashew apple 2021. *International Journal of Chemical Studies*; 9(1): 1259-1264

Umamaheswara Rao K., Prasanna Kumar B., Swami D.V., Salomi Sunnetha D.R., Uma Krishna K. and Smith D.D. 2020. " Studies on Physico-chemical characters and storage behavior of blended cashew apple juice powder for RTS beverage". *International Journal of Current Microbiology and Applied Sciences.*

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Panda, P.K., Sethi, K. and Mukherjee, S.K. 2020. Evaluation of cashew genotypes for Nut yield and yield attributing characters under Bhubaneswar condition. *The Pharma Innovation,* 9(7):231-2333.

Sahoo,S., Sethi,K., Dash,M. and Tripathy, P. 2020. Evaluation of F_1 hybrids of Cashew (*Anacardium occidentale* L.). *International Journal of Agricultural Sciences*, 16(1):79-85.

Sharma, Sakhi, Sethi, K. and Dash Manasi. 2020. Evaluation of cashew (*Anacardium occidentale* L.) genotypes under Bhubaneswar condition. *The Pharma Innovation,* 9(9):552-556.

Sethi, K., Dash, M. and Tripathy, P. 2020. Character Association and Multivariate Analysis in Cashew (*Anacardium occidentale* L.). *International Journal of Bio-resource and Stress Management*, 11(1):64-72.

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Panda, P.K., Patnaik, R. K. and Sethi, K. 2020. Economics of Cashew (*Anacardium occidentale* L.) nut yield cv.BPP-8 on different organic sources of nutrients. In: *Regional Seminar on Perspectives of Horti-business in Development of North Eastern Region*, 24-25 Feb. 2020, CHF, Pasighat, Arunachal Pradesh. Pp.102-103.

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Popular Articles :

- Panda P.K. and Sethi K. 2020. Saghana Pranalire Kajubadam Chasa. *Chasirara Sansara*, 55(2-3):13-15.
- Panda P.K. and Sethi K. 2020. Unnatta Kisamara Kajukalami Chara.In: *Basudha Prameya*, *Bhubaneswar*, pp-22 (30.06.2020).

DARISAI

Jha,P.K. 2019. Performance of released Cashew nut (*Anacardium occidentale* L.) genotypes under Jharkhand condition. *J. Pharmacog. & phytochem*. Part v 4 (8) : 1254-1256

Jha,P.K and Dash, S.P. 2019. Interaction Effect of Plant Density and Nutrient Management in Cashew (*Anacardium occidentale* L.) under Jharkhand Condition. *Int.J.Curr.Microbiol.App.Sci*. 8(12): 2376-2382. https://doi.org/10.20546/ijcmas.2019.812.280

JAGDALPUR

Nirala, Y. S., Ramteke, V., Madawi, N. C., Nanda H. C. and Roy, S. 2019. Influence of weather factors on the incidence of pest complex in cashew. *Int. J. Chem. Studies*, 7(5): 961-963.

Ramteke, V., Nirala, Y. S., Nayak, M. G. and Mohana, G. S. 2020. Evaluation of apple and nut characters of cashew germplasm from Bastar region, Chhattisgarh, India. *J. Plantation Crops, 48(2): 142-145.*

Ramteke, V., Nirala, Y. S., Kumar, H., Thakur P. and Kashyap, S. K. 2020. Study on sensory evaluation of cashew varieties for preparation of ready to serve beverage and Jam. *J. Soils and Crops*, 30(2): 23-25.

MADAKKATHARA

Conference proceedings/ Abstracts

Dr. Jalaja S. Menon, Dr. Asna A.C., Dr. Smitha M.S., Ms Irine Chacko. 2020. Role of women in cashew farm and processing sector and their constraints at work place - A case study. Proceedings of National workshop on Gender Issues and Atmanirbhar Bharat, 15 October 2020 (Online platform)

Books/Book Chapter/ Reports/Technical Bulletin/ Leaflets

Smitha M.S. & Sudhikumar. A.V. 2020. A diversity of spiders (Arachinda: Araneae) from a cashew ecosystem in Kerala, India, Journal of Threatened taxa 12(13) : 16879-16884

Jalaja S. Menon, Asna A.C., Hariprasad C., Manoj M.K. Cashew hybrids from Kerala for better yield and quality. The Cashew and Cocoa Journal, October-December 2019.

A news letter "KAU-Cashew News 2019" and brochure on CRS, Madakkathara.

Leaflet on cashew hybrids (Malayalam)

VENGURLA

Gajbhiye R. C., Bhingarde R. T., Pawar S. N., Zote V. K., Salvi S. P. and Sawant B. N. 2020. Evaluation of cashew (*Anacardium occidentale* l.) genotypes under south Konkan conditions. *Multilogic in Science J. (International Peer Reviewed Journal)* IX(XXXII) : 380-384.

Gajbhiye R.C., Pawar S.N., Zote V.K. and Sawant. B.N. 2020. Long term effect of application of organic manures on growth, yield and soil nutrient status of cashew. *International Journal of Chemical Studies.* 8(3): 310-317.

Gajbhiye R.C., Pawar S.N., Zote V.K., Talha P.M. and Sawant. B.N. 2020. Effect of application of

organic manures on growth, yield and quality of Cashew. *Journal of Pharmacognosy and Phytochemistry* 2278-4136. April, 2020; 9(3): 676-679.

Gajbhiye R.C., Pawar S.N., Zote V.K. and Sawant B.N. Intercropping of different vegetable crops in new cashew plantation under Konkan Conditions of Maharashtra, India. *International Journal of Current Microbiology and Applied Sciences* 2319-7706. June, 2020 9(6): 448-455

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Khapare L.S., Kadam J.H and Shirke G.D. 2020. Garcinia a medicinally potential genus in Western Ghat- Review. *Journal of Pharmacognosy and Phytochemistry* 2278-4136. Sept., 2020 9(5):2750-2752

Kadam J.H., Khapare L.S. and Shirke G.D. 2020. Variability in turmeric as sources of secondary metabolites. *Journal of Pharmacognosy and Phytochemistry* 2278-4136. Sept., 2020 9(5):2740-2744

Book published

Dr. R. C. Gajbhiye, Dr. P. C. Haldawanekar, Smt. Vaishali Zote, Dr. R. G. Khandekar, Dr. B. R. Salvi, Dr. S. G. Bhave, Dr. P.M. Haldandankar, Dr. S. R. Torane and Dr. B. N. Sawant. Book published in Local Marathi Language on "Caju Lagwad Tantradhyan Aani Prakria" March, 2020 and Publication No.डॉबासाकोकृवि/विस्तार/पुस्तिका/२/२०२०. Directorate of Cashewnut and Cocoa Development, Kochi, Kerala.

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5. BUDGETARY PROVISION AND ACTUAL EXPENDITURE DURING THE YEAR 2020-21

Allocation

(Rs. in lakhs)

Centre	Details of sanctioned provision					ICAR share
	Pay and Allowances	TA	Recurring contingency	Non- Recurring contingency	Grand Total	
Bapatla	58.85	1.50	16.00	0.00	76.35	57.26
Bhubaneshwar	46.25	1.00	17.84	0.00	65.09	48.82
Hogalagere	40.38	1.00	23.00	0.00	64.38	48.28
Darisai	20.96	0.50	4.00	0.00	25.46	19.10
Jagdalpur	23.85	1.00	9.00	1.83	35.68	26.76
Jhargram	17.25	0.80	10.00	0.00	28.05	21.04
Madakkathara	44.19	1.50	16.33	0.00	62.02	46.51
Paria	27.05	1.00	5.00	0.00	33.05	24.79
Pilicode	12.14	0.50	4.00	0.00	16.64	12.48
Vengurla	58.04	1.50	15.00	1.91	76.45	57.33
Vridhachalam	47.25	1.50	17.97	0.00	66.72	50.03
KRCCH, Arabhavi	0.00	0.50	6.00	0.00	6.50	4.88
ICAR Res. Compl. For NEH Region, Barapani	0.00	0.00	7.33	0.00	7.33	5.50
Provision for RC for PC Cell	0.00	0.00	2.89	0.00	2.89	2.17
Total	**396.21**	**12.30**	**154.36**	**3.74**	**566.61**	**424.95**
ICAR Share	**297.16**	**9.22**	**115.77**	**2.80**	**424.95**	
Provision for SCSP						41.73
Provision for TSP						18.00
Provision for NEH						28.42
					GRAND TOTAL	**513.10**

Actual Expenditure

(Rs. in lakhs)

Centre	Pay and Allowances	TA	Recurring contingency	Non-recurring contingency	Total	ICAR Share
Bapatla	70.60	0.56	10.85	0.00	82.01	61.50
Bhubaneshwar	48.89	0.27	17.84	0.00	67.00	50.25
Hogalagere	36.00	0.84	14.93	0.00	51.77	38.83
Darisai	16.94	0	3.75	0.0	20.69	15.52
Jagdalpur	25.93	0.65	9.00	1.80	37.38	28.03
Jhargram	19.00	0.55	5.58	0.0	25.13	18.85
Madakkathara	43.47	0.22	14.32	0.0	58.01	43.51

Centre	Pay and Allowances	TA	Recurring contingency	Non-recurring contingency	Total	ICAR Share
Paria	29.06	0.00	4.40	0.0	33.46	25.10
Pilicode	12.28	0.12	2.65	0.0	15.05	11.29
Vengurla	52.87	0.11	14.28	1.74	69.00	51.75
Vridhachalam	61.59	0.50	17.96	0.00	80.05	60.04
KRCCH, Arabhavi	0	0.16	4.84	0	5.00	3.75
ICAR Res. Compl. For Goa, Goa	0.00	0.00	0.00	0.00	0.00	0.00
ICAR Res. Compl. For NEH Region, Barapani	0.00	0.00	1.47	0.00	1.47	1.10
Provision for RC for PC Cell	0.00	0.00	2.79	0.00	2.79	2.09
Total	**416.63**	**3.98**	**124.66**	**3.54**	**548.81**	**411.61**
ICAR Share	**312.47**	**2.98**	**93.50**	**2.66**	**411.61**	
Provision for SCSP						38.46
Provision for TSP						16.22
Provision for NEH						28.42
					GRAND TOTAL	**494.71**

6. METEOROLOGICAL DATA OF DIFFERENT CENTRES FOR THE YEAR

BAPATLA

Month & Year	Max. temp (°C)	Min. Temp (°C)	RH (%)		Rainfall (mm)	Rainy days (No)
			(m)	(e)		
Jan - 20	29.8	20.4	85.4	66.7	79.8	2
Feb - 20	30.7	20.6	81.6	61.5	10.7	3
Mar - 20	34.2	23.1	84.5	53.2	0	0
Apr - 20	34.6	25.6	80.0	68.0	4.9	1
May - 20	37.2	28.2	75.0	65.0	10.2	1
June - 20	36.4	27.0	71.0	62.0	95	12
July - 20	33.4	25.5	84.0	75.0	180.1	16
Aug - 20	32.1	25.3	82.0	71.0	139.9	14
Sep - 20	32.7	25.5	80.0	72.0	338.8	18
Oct - 20	32.0	25.0	83.0	71.0	66.3	8
Nov - 20	30.4	22.0	83.5	68.7	222.8	8
Dec - 20	29.7	18.7	85.6	58.5	0.4	1
Total					**1148.9**	**84**

BHUBANESWAR

Months	Temperature (°C)		Relative Humidity (%)		BSH	Rainfall (mm)	No. of rainy days
	Max.	Min.	Max.	Min.			
Jan - 20	27.9	16.1	94.0	50.7	5.8	12.7	1
Feb - 20	28.5	16.2	91.2	48.2	5.2	94.2	4
Mar - 20	34.2	22.1	95.2	49.5	7.5	56.5	5
Apr - 20	36.9	24.7	93.0	50.4	7.7	107.9	5
May - 20	36.0	25.9	89.2	59.9	7.8	157.1	5
June - 20	34.9	26.7	92.7	68.1	4.9	95.3	12
July - 20	34.4	26.5	93.4	68.0	5.5	18.9	14
Aug - 20	32.7	26.0	94.8	755.5	3.5	585.4	20
Sep - 20	34.1	26.2	94.8	70.2	5.9	211.7	10
Oct - 20	31.9	24.4	95.0	75.5	4.7	247.6	13
Nov - 20	31.4	19.6	89.6	52.8	4.1	5.6	1
Dec - 20	29.7	14.2	93.8	41.2	6.3	0	0
Total						**1592.9**	**90**

DARISAI

Month	Rainfall (mm)	Temperature (°C)		Humidity %		Wind vel. (km/ Hr)	Average Monthly SSHr	Evaporation (mm)
		Maximum	Minimum	Maximum	Minimum			
Jan - 20	17.9	21.4	5.3	85.0	69.0	3.4	196.2	58.8
Feb - 20	7.2	24.6	9.6	85.2	68.2	3.6	206.8	62.1
Mar - 20	84.8	29.8	16.4	86.0	68.5	3.1	192.0	76.7
Apr - 20	62.2	35.2	22.0	86.7	68.2	3.2	260.9	99.6
May - 20	51.4	35.0	23.0	85.1	69.4	3.0	227.5	92.5
June - 20	178.2	33.0	22.9	86.0	69.2	2.7	130.8	70.4
July - 20	396.7	32.3	23.2	85.7	69.5	2.7	135.4	73.5
Aug - 20	396.6	32.3	23.2	85.7	69.5	3.0	127.4	74.6
Sep - 20	177.2	32.3	23.0	85.3	69.6	2.9	207.8	95.9
Oct - 20	14.2	30.3	20.5	85.0	69.0	2.3	231.0	99.6
Nov - 20	10.0	28.6	15.3	85.7	68.6	2.4	232.0	91.3
Dec - 20	0.0	23.6	5.6	85.4	68.3	2.4	231.9	6.2
Total	**1396.4**							

HOGALAGERE

Month	Temp (°C)		R.H (%)		Wind speed (km/hr)	No. of rainy (days)	Rainfall received(mm)
	Max.	Min.	Morn.	Even.			
Jan - 20	28.44	14.33	93.19	33.16	20.54	1	3.6
Feb - 20	31.15	17.67	93.32	34.46	23.77	0	0.0

Month	Temp (°C)		R.H (%)		Wind speed (km/hr)	No. of rainy (days)	Rainfall received(mm)
	Max.	Min.	Morn.	Even.			
Mar - 20	34.62	19.13	83.26	23.61	26.73	0	0.0
Apr - 20	35.69	20.67	86.03	26.17	26.81	3	44.8
May - 20	35.62	22.39	84.84	34.55	30.86	6	44.7
June - 20	31.68	21.84	89.93	52.13	36.00	4	162.1
July - 20	29.63	21.45	89.10	56.81	37.38	4	56.0
Aug - 20	28.09	20.92	91.35	64.06	35.94	6	71.2
Sep - 20	29.16	20.58	92.30	63.60	27.61	14	147.2
Oct - 20	28.94	20.13	90.87	66.71	22.16	14	139.2
Nov - 20	27.5	19.0	90.2	58.2	21.4	6.0	115.5
Dec - 20	26.5	16.8	89.9	56.6	20.6	16.0	160.0
Total						**74**	**944.30**

JAGDALPUR

Month	Temp (°C)		Relative Humidity (%)		Wind Vel. (Kmph)	Bright Sunshine hours	Rainfall (mm)	Rainy days
	Max.	Min.	I	II				
Jan - 20	28.5	12.4	97	42	2.1	6.9	14.1	2
Feb - 20	29.2	12.9	94	41	2.6	7.0	32.4	2
Mar - 20	33.6	17.3	88	39	3.6	6.8	26.0	3
Apr - 20	36.1	21.0	76	34	4.9	6.9	147.4	8
May - 20	36.8	22.3	74	39	3.3	10.6	35.8	6
June - 20	32.3	23.2	88	67	4.4	4.5	250.4	15
July - 20	30.6	22.9	92	73	3.6	3.9	261.3	12
Aug - 20	28.3	22.6	94	79	4.5	2.3	437.4	17
Sep - 20	30.9	22.4	93	71	1.8	5.0	277.1	14
Oct - 20	30.3	20.2	94	60	1.6	4.9	150.3	9
Nov - 20	29.4	14.9	94	44	0.4	6.0	33.2	2
Dec - 20	28.5	8.6	95	36	0.2	7.2	0.0	0
Average	31.2	18.4	90	52	2.7	6.0	138.8	
Total							**1665.4**	**90**

JHARGRAM

Month	Temperature (°C)		Relative Humidity (%)	Max. Wind velocity (mph)	Cloud cover (%)	Rainfall (mm)	Rainy days	Average Pressure (mb)	Sun shine hours
	Maximum	Minimum							
Jan - 20	26	16	48	13.1	19	4.6	4	1015.7	366
Feb - 20	29	18	42	13.7	17	12.9	6	1015.5	326
Mar - 20	34	24	44	17.4	22	48.2	12	1011.4	362
Apr - 20	39	26	43	23.8	19	61.9	14	1008.2	342

Month	Temperature (°C)		Relative Humidity (%)	Max. Wind velocity (mph)	Cloud cover (%)	Rainfall (mm)	Rainy days	Average Pressure (mb)	Sun shine hours
	Maximum	Minimum							
May - 20	38	26	55	29	23	142.6	15	1004.2	354
June - 20	26	28	61	21.1	49	142.5	27	1001.9	317
July - 20	34	28	71	20.3	54	149.9	25	1002.1	321
Aug - 20	33	27	78	17.5	60	360.4	28	1000	260
Sep - 20	33	26	79	16.8	52	163.1	28	1004.5	320
Oct - 20	31	24	75	14.7	41	107.2	24	1007.3	288
Nov - 20	29	20	47	14.6	9	0	0	1014.5	360
Dec - 20	27	17	37	13.0	5	0	0	1014.7	372
Total						1193.3	183		

KANABARGI

Months	Rainfall (mm)	Rainy days (No.s)	Temperature (° c)		Relative Humidity (%)	
			Max. (Average)	Min. (Average)	Max. (Average)	Min. (Average)
Jan - 20	0	0	26.14	13.90	68.15	20.35
Feb - 20	0	0	29.35	15.10	68.25	20.95
Mar - 20	10.50	1	32.35	17.30	73.28	19.36
Apr - 20	98.00	3 33	34.92	20.50	79.95	19.95
May - 20	49.80	3	35.50	23.56	85.45	22.65
June - 20	154.80	12	31.24	24.24	89.10	42.36
July - 20	163.00	15	28.50	22.20	92.58	56.45
Aug - 20	557.60	24	23.40	21.25	90.25	76.85
Sep - 20	200.20	12	23.42	21.45	92.34	72.45
Oct - 20	211.80	7	23.45	18.50	89.35	52.75
Nov - 20	0	0	29.50	16.95	87.56	43.45
Dec - 20	0	0	28.50	16.25	88.45	45.50
Total	**1445.7**	**73**				

MADAKKATHARA

Month & Year	Average Temperature (° c)		Relative Humidity (%)		Total Rainfall (mm)	Total No. of Rainy days	Total Sunshine hours (hr)
	Max.	Min.	Max.	Min.			
Jan - 20	34.14	22.48	77.8	44.6	0	0	9.28
Feb - 20	36.74	24.01	73.39	38.57	0	0	9.51
Mar - 20	36.57	24.35	85.25	45.75	33.4	2	8.65

Month & Year	Average Temperature (° c)		Relative Humidity (%)		Total Rainfall (mm)	Total No. of Rainy days	Total Sunshine hours (hr)
	Max.	Min.	Max.	Min.			
Apr - 20	36.43	24.75	86	55.25	44.7	4	8.04
May - 20	34.68	25.1	90	64.2	80.3	6	5.4
June - 20	31.1	23.6	94.5	75.25	493.6	20	2.35
July - 20	30.26	23.1	96	79	728.7	25	2.42
Aug - 20	30.55	23.17	95.5	75.25	447.1	13	5.06
Sep - 20	29.8	22.37	96.25	80.75	776.6	20	2.07
Oct - 20	31.2	21.68	95	68.6	310.3	12	5.30
Nov - 20	33.07	21.92	81.25	55.5	56.1	2	7.20
Dec - 20	31.87	21.9	75.75	55.25	8.2	1	6.36
Total					2979	105	

PARIA

Month	Max. Temp.	Min. Temp.	RH (M)	RH (E)	Wind velocity	Rainfall (mm)	Sunshine hours	Evaporation (mm)
Jan - 20	30.78	13.58	79.29	54.53	1.68	0.0	8.54	3.55
Feb - 20	34.32	16.61	68.89	42.33	1.85	0.0	8.96	4.87
Mar - 20	33.87	19.38	77.92	56.39	2.76	0.5	9.41	5.50
Apr - 20	37.86	22.18	73.33	71.41	2.72	0.0	10.13	6.05
May - 20	37.51	26.92	76.62	83.82	4.74	0.0	10.80	7.05
June - 20	35.56	27.24	94.23	95.50	5.17	69.4	6.09	4.97
July - 20	32.79	15.71	89.68	85.24	4.93	477.5	5.27	4.80
Aug - 20	30.22	0.0	91.58	90.35	5.36	993.0	1.72	5.95
Sep - 20	32.31	0.0	92.63	90.20	2.23	160.6	4.66	2.88
Oct - 20	34.73	0.0	85.96	63.60	1.42	1.7	7.26	1.49
Nov - 20	35.01	0.0	79.87	48.52	1.13	0.0	8.87	2.04
Dec - 20	31.58	12.64	85.78	59.45	1.25	61.6	7.38	2.35
Total						1764.3		

PILICODE

Month & year	Temperature (°C)		Relative humidity (%)	Rainfall (Monthly cumu. mm)	No. of rainy days	Bright Sunshine hours
	Maximum	Minimum				
Jan - 20	31.6	21.7	74.0	0	0	9.4
Feb - 20	32.0	22.4	74.8	45.8	1	8.8
Mar - 20	32.6	24.2	75.0	28.0	1	8.4
Apr - 20	34.0	26.0	76.0	3.4	3	8.5
May - 20	33.7	25.9	78.0	122.1	8	7.3
June - 20	29.4	24.0	88.0	944.7	28	2.4
July - 20	28.5	23.8	87.7	979.7	27	3.6

Month & year	Temperature (°C)		Relative humidity (%)	Rainfall (Monthly cumu. mm)	No. of rainy days	Bright Sunshine hours
	Maximum	Minimum				
Aug - 20	28.8	23.6	91.4	1003.9	27	5.3
Sep - 20	29.7	23.9	84.6	804.5	24	3.3
Oct - 20	29.9	24.1	80.4	278.1	14	7.4
Nov - 20	33.1	22.5	81.2	34.2	3	7.2
Dec - 20	32.8	22.2	78.0	93.3	3	7.8
Total				**4337.7**	**139**	

TURA

Month	Rainfall (mm)	Temperature (°c)		Relative Humidity (%)	
		Maximum	Minimum	Maximum	Minimum
Jan - 20	00	28	15	80	62
Feb - 20	00	30	15	86	73
Mar - 20	12	32	17	87	76
Apr - 20	85.2	33	17	89	67
May - 20	273.5	35	18	88	69
June - 20	407.1	39	19	91	68
July - 20	1241.9	42	19	90	68
Aug - 20	359	38	17	90	67
Sep - 20	281.89	35	16	88	63
Oct - 20	205	36	16	87	64
Nov - 20	10	36	15	83	60
Dec - 20	0	28	14	80	60
Total	**2875.59**				

VENGURLA

Month	Temperature (°c)		Humidity (%)		Rain fall (mm)	No. of rainy days
	Maximum	Minimum	Forenoon	Afternoon		
Jan - 20	33.27	17.98	90.72	64.40	0.00	00
Feb - 20	34.99	18.39	88.25	54.71	0.00	00
Mar - 20	34.50	20.64	76.11	60.43	0.00	00
Apr - 20	35.80	24.07	79.71	67.86	0.00	00
May - 20	35.75	25.90	78.22	71.46	47.60	03
June - 20	32.53	23.74	92.64	82.82	1158.00	23
July - 20	31.19	23.41	94.14	87.06	1626.40	33
Aug - 20	31.41	23.67	93.36	83.43	583.00	28
Sep - 20	31.89	23.16	94.31	80.38	864.00	22
Oct - 20	33.22	23.32	94.88	78.26	439.40	13

Month	Temperature (°c)		Humidity (%)		Rain fall (mm)	No. of rainy days
	Maximum	Minimum	Forenoon	Afternoon		
Nov - 20	35.41	19.64	86.50	69.52	0.00	00
Dec - 20	34.65	18.51	92.16	66.15	4.00	01
Total					**4722.40**	**123**

VRIDHACHALAM

MONTH	Temperature (°c)		Sunshine (Hours)	Rainfall (mm)	Rainy Days (No.s)	Mean Relative humidity (%)
	Max	Min				
Jan - 20	31.6	21.4	6.5	36.0	5	75.3
Feb - 20	35.1	25.7	8.7	1.2	-	71.2
Mar - 20	39.1	27.2	8.0	-	-	72.2
Apr - 20	30.0	29.2	8.1	9.8	1	76.1
May - 20	33.1	28.1	7.9	32.8	3	70.2
June - 20	33.3	26.3	6.1	130.7	4	65.3
July - 20	31.2	26.1	5.1	155.4	7	72.2
Aug - 20	31.1	26.2	5.2	60.8	3	73.2
Sep - 20	33.7	25.1	3.8	217.6	8	75.1
Oct - 20	34.3	24.3	5.3	171.2	4	74.2
Nov - 20	30.5	20.8	4.3	145.0	6	79.5
Dec - 20	28.5	21.3	2.1	406.8	11	79.0
Total				**1367.00**	**52**	

हर कदम, हर डगर
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