

Standardisation of green house technology using coir bhoovastra

Project Report
05-10-2007 to 31-03-2010

Submitted to

COIR BOARD
Ministry of Agro and Rural Industries
Govt. of India, Kochi.



INDIAN CARDAMOM RESEARCH INSTITUTE
SPICES BOARD
Ministry of Commerce & Industry (GOI)
Myladumpara,
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Idukki – 685 553.

REPORT

1. **Project title** : **Standardization of green house technology using coir bhoovastra.**
2. **Reporting period** : **01-02-2007 to 31-03-2010**
3. **Participating Center** : **Indian Cardamom Research Institute, Spices Board, Myladumpara, Idukki – 685 553.**
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7. **File No** : **Admn/Coir/Res/1/ 2004**
8. **Date of sanction/
Signing of MoU** : **05-10-2007 (II Phase)**
9. **Date of start** : **01-02-2007**
10. **Duration of the project** : **Two years (II Phase)**
11. **Financial Outlay** : **Rs. 8, 61,559/-**
12. **Funds released** : **Rs. 4,12,414/- (Carryover from phase I)**
: **Rs. 3,01,500/- (2007- 2008)**
: **Rs. 1,47,645/- (2008- 2009)**
: **Rs. 8, 61,559/-**

Introduction

United Nations general assembly declared 2009 as international year of natural fibres. Millions of people around the world, among them some of the poorest people in some of the poorest countries, depend on the production and processing of natural fibres for their livelihood. Virtually every country in the world produces some natural fibres. The wide range of natural fibres includes coconut fibres, cotton, jute, flax, sisal from plants, wool(animal), silk(insect) & many others. These fibres are used in clothing and other consumer goods, as well as in industrial applications.

Coir industry constitute major cottage industries in India, employing large number of rural folks, especially women. Hence the utilization of Coir in different means is necessary for the upliftment of rural economy. With this background the studies on the utilization of coir geotextile in spices have been undertaken.

Kerala and the Coir Industry

The history of Coir and its association with the state of Kerala dates back to the 19th Century. Sandwiched between the Western Ghats on the east and the Arabian Sea on the west, Kerala is one of the most beautiful States in India. A tropical paradise of waving coconut palms and wide sandy beaches, this thin strip of coastal territory slopes down from the mountain ghats in a cascade of lush green vegetation and varied fauna. In fact, even the name Kerala (Keralam in Malayalam) is derived from this tree (“Kera” in Malayalam language means Coconut and “Alam” means Land, thus Keralam = Land of Coconut). Everything from Kerala's culture to its dishes is evolved around the Coconut tree.

Coconut husk is the basic raw material for coir products. Around 50 per cent of the available coir husk is used to produce coir products. Hence, there is scope for growth of coir industry. India accounts for more than two-thirds of the world production of coir and coir products. Kerala is the home of Indian coir industry, particularly white fibre, accounting for 61 per cent of coconut production and over 85 per cent of coir products.

Alleppey (Alappuzha in Malayalam) is the nerve centre of Kerala's famous Coir industry. Here, one can see coconut husks being beaten into fibre for making beautiful mats and other coir products. Both men and women are actively involved in the

production of Coir. The women are mainly involved in the yarn spinning sector and the men in the product-weaving sector. Coir Industry enjoys the status as the largest Cottage Industry in the State of Kerala, giving employment to over a million people.

During the Phase I of the project, among other things, growing of Vanilla, the prince of spices under coir-geotextile covered ‘pandals’ were studied. It was observed that the growth of Vanilla was better under coir geotextile covered pandals mainly due to the ability of the natural fibre to create a suitable micro-climate for plant growth. However, the coir geotextile exposed to vagaries of weather did not last long and strong support system was needed to make the ‘pandal’, which was found to be un-economical and non practical under field conditions. This positive and negative experience is using coir geotextile evolved into a concept of coir net lined greenhouse for spice production- a novel area of usage of coir nets (coir geotextiles). Thus the Phase II of the project was evolved as a collaborative programme of ICRI (Spices Board) and CCRI (Coir Board) to design a suitable coir nets and to standardize a novel technology of coir net lined greenhouse.

Objectives:

- To evaluate the use of coir geo-textiles (Coir blended yarn as cover shade materials in polyhouse for production of various spices)
- To standardize the micro environmental parameters (temperature, RH and sunshine) inside the coir net lined polyhouses for quality production of cardamom and other Spices.
- To compare the coir nets against agro-shade nets for the use in green house technology.

Methodology:

A) Activities envisaged and targets achieved during the project period.

S. No	Activities envisaged	Targets achieved
1.	Construction of polyhouse Installation of weather sensors and irrigation system	Construction of three polyhouse was completed using geo textile (Coir blended yarn -50%shade, Coir blended yarn -75%shade and agro shade net with 50% shade) Installed the weather sensors and irrigation system inside the polyhouse
2.	Conduct of nursery experiments	Completed four nursery experiments using poly bag seedlings of cardamom, pepper, coffee and tea (plantation crops)
3.	Regular monitoring & recording of climatic parameter inside the green house using sensors	Periodically updated the climatic parameters (Temp, RH and sun shine) with weather monitoring system
4.	Collection and compilation of crop response	Periodically Collected and compiled the growth response.

B) Construction of growth chambers

The various growth chambers constructed during the period was as follows:

- Polyhouse lined with coir blended yarn{80% coir+ 20% sisal} - (50% Shade)
- Poly house lined with coir blended yarn {80% coir+ 20% sisal}- (75% Shade)
- Polyhouse lined with Green Agro Shade net (50% Shade)
- Agro shade net greenhouse (50% Shade))
- Open condition.

The three polyhouse growth chambers were provided with over head fogger irrigation system. The weather sensors (dry and wet bulb thermometers and solar radiation sensors) were installed inside the poly houses and out side (open). The sensors were connected with green house data monitor for recording the data.

During the review meeting held on 07/04/2008, it was suggested that CCRI should produce a 100% coir netting rather than the blended yarn netting. Accordingly, CCRI produced 100% coir net so as to provide 50% shade. The new greenhouse lined with 100% coir net 50% shade was constructed during May 2009.



Pic 01. Polyhouses (Prototype) lined with coir nets at ICRI, Myladumpara



Pic 02. Polyhouse (Prototype) lined with 100% coir net 50% shade



Pic 03. Polyhouse lined with coir blended yarn -50% shade



Pic 04. Polyhouse lined with coir blended yarn - 75% shade



Pic 05. Polyhouse lined with Agroshade net – 50% shade



Pic 06. Polyhouse lined with 100% coir net (50% shade)



Pic 07. Green house data monitor



Pic 08. Wet & Dry Bulb thermometer sensors



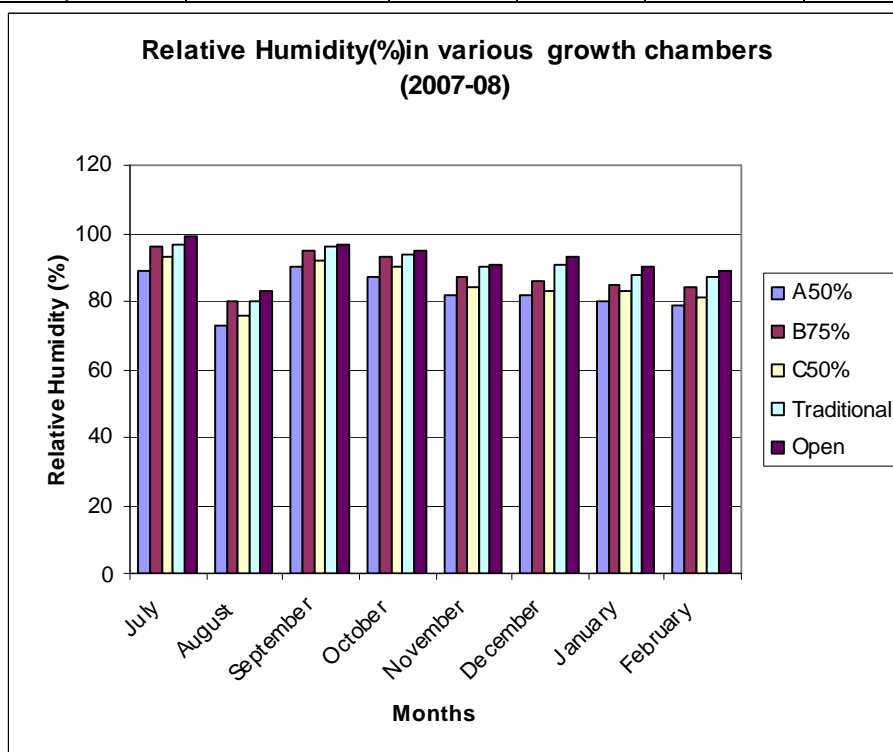
Pic 09. Solar Radiation sensor

Green House Monitor & Weather Sensors

Studies on the Microclimate regulation using coir net lined polyhouse conditions

Relative Humidity (%)

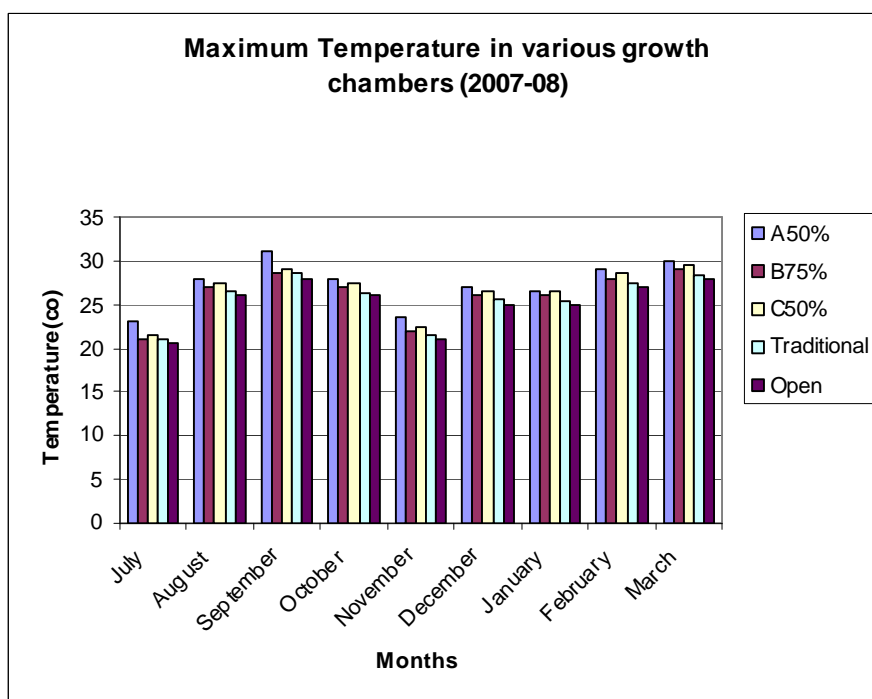
Months(07-08)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
July	89	96	93	97	99
August	73	80	76	80	83
September	90	95	92	96	97
October	87	93	90	94	95
November	82	87	84	90	91
December	82	86	83	91	93
January	80	85	83	88	90
February	79	84	81	87	89



- The RH(%) during rainy season(July, August, September) & Winter season(November, December & January) is found to be favourable in the Coir geotextile lined polyhouse conditions compared to the higher value recorded in the open & traditional agronet condition which will lead to fungal infections & rotting of the plants.

Maximum Temperature (°C)

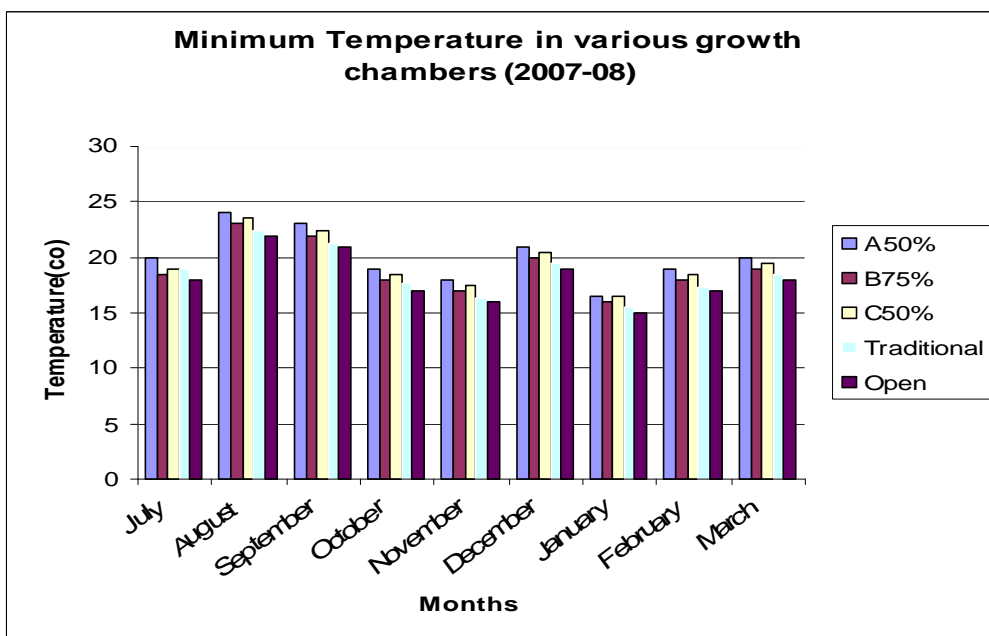
Months(07-08)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
July	23.0	21.0	21.5	21.0	20.5
August	28.0	27.0	27.5	26.5	26.0
September	31.0	28.5	29.0	28.5	28.0
October	28.0	27.0	27.5	26.4	26.0
November	23.5	22.0	22.5	21.5	21.0
December	27.0	26.0	26.5	25.6	25.0
January	26.5	26.0	26.5	25.5	25.0
February	29.0	28.0	28.5	27.4	27.0
March	30.0	29.0	29.5	28.4	28.0



- The maximum temperature is found to be optimum in the range of 23°C to 28°C during the rainy and winter seasons inside the coir geotextile lined polyhouse conditions compared to the lower values recorded in the open & traditional agronet condition which will lead to fungal infections & rotting of the plants. This is mainly due to the eco friendly aspect of coir along with the sustainable temperature regulation inside the UV coated polyfilm. Coir geotextile 50% shade lined polyhouse provides a stable maximum temperature through out the season.

Minimum Temperature (°C)

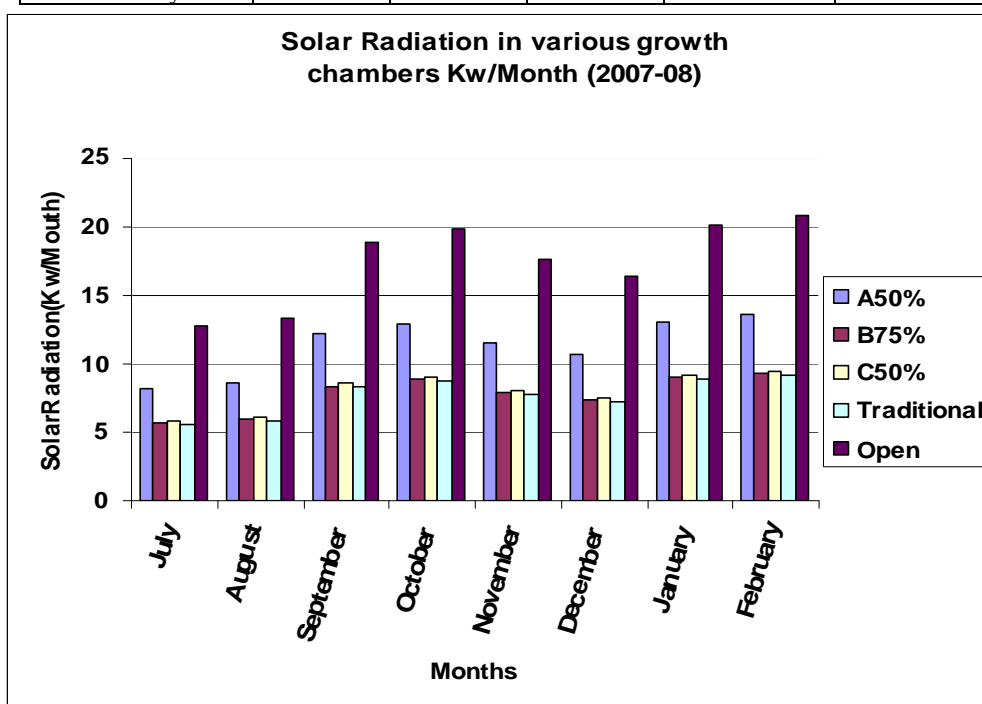
Months(07-08)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
July	20.0	18.5	19.0	19.0	18.0
August	24.0	23.0	23.5	22.5	22.0
September	23.0	22.0	22.5	21.3	21.0
October	19.0	18.0	18.5	17.6	17.0
November	18.0	17.0	17.5	16.4	16.0
December	21.0	20.0	20.5	19.5	19.0
January	16.5	16.0	16.5	15.5	15.0
February	19.0	18.0	18.5	17.3	17.0
March	20.0	19.0	19.5	18.5	18.0



- In the case of minimum temperature, it is the stable optimum temperature maintained inside the coir geotextile lined polyhouse conditions compared to the lower temperature which is unfavourable for the growth of plants inside the open and agronet conditions. Coir geotextile 50% shade lined polyhouse provides a stable minimum temperature through out the season.

Solar Radiation (Kw/sq.m/month)

Months(07-08)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
July	8.26	5.65	5.78	5.60	12.71
August	8.67	5.93	6.12	5.85	13.33
September	12.29	8.40	8.67	8.31	18.90
October	12.90	8.82	9.03	8.78	19.84
November	11.50	7.87	8.09	7.80	17.70
December	10.68	7.30	7.45	7.21	16.43
January	13.10	8.96	9.15	8.90	20.15
February	13.57	9.28	9.45	9.19	20.88



- Regulation of solar radiation or solar intensity is one of the key aspects which promote the growth of nursery seedlings inside the coir geotextile lined polyhouse conditions. The monthly mean value of solar intensity recorded inside the coir geotextile 50% shade lined polyhouse conditions shows a suitable range (8.2 – 13.5 Kw/sq.m/month) compared to the fluctuating values recorded inside other growth chambers.

Studies on the effect of various types of polyhouses on the growth of plants

Methodology

The primary seedlings of pepper, cardamom, tea and coffee were raised from cuttings and seeds of elite clones. The rooted pepper cuttings and primary seedlings were transplanted in poly bags. Among the poly bag seedlings, seedlings of uniform growth were selected for the experiment.

Twenty five poly bag seedlings each of pepper were transferred to all five growth chambers during August 2007. Twenty five seedlings of each coffee and tea seedlings were transferred to all growth chambers and each twenty five seedlings of cardamom were transferred to three poly houses during October 2007 and initial growth from all the plants were observed. Monthly growth observations were recorded from all the plants.

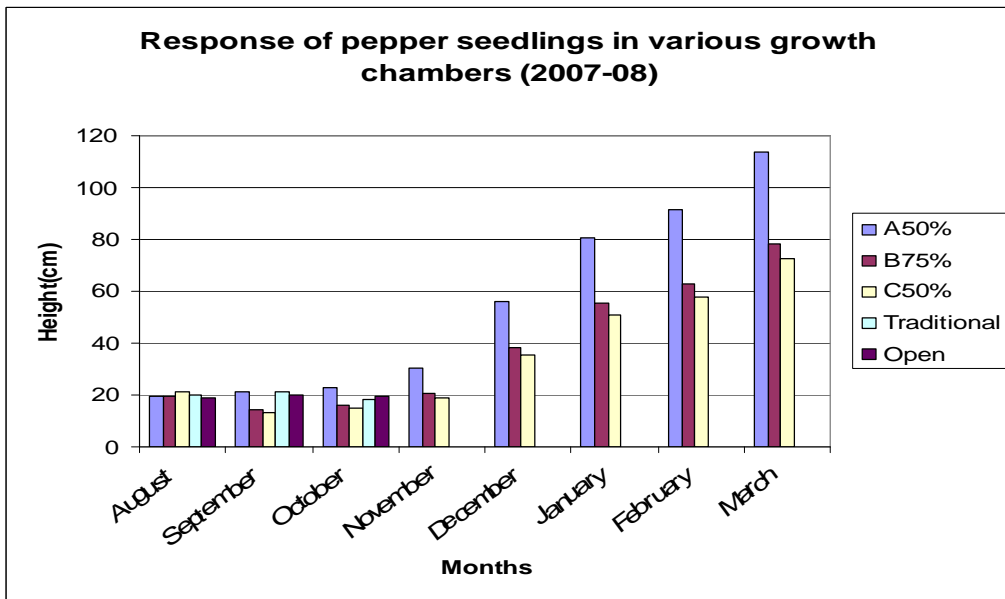
D. Results and Discussion

➤ Pepper nursery

The pepper seedlings raised under polyhouse lined with Coir blended yarn -50% Shade recorded increased growth compared to pepper seedlings raised under Coir blended yarn-75% Shade and under Agro shade net lined polyhouse (50%) shade. Occurrence of favorable temperature, sunshine and relative humidity may be the reason for better growth of pepper seedlings. All the pepper seedlings kept under non polyhouse with 50% Agro shade net and open condition perished after two months. This is mainly because of heavy rain coupled with build up of heat during sunny day which resulted in fungal infection & rotting of seedlings.

Response of pepper seedling in various growth chambers (Length in cm)

Months (2007-08)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)
August	19.6	19.2	21.3
September	21.0	14.4	13.3
October	23.1	15.8	14.6
November	30.2	20.7	19.1
December	55.9	38.2	35.3
January	80.7	55.2	51.1
February	91.5	62.6	57.9
March	114.0	78.5	72.6
Percentage of increase in growth after six months	82.8%	75.5%	70.6%



Pic 10. Growth Performance of pepper

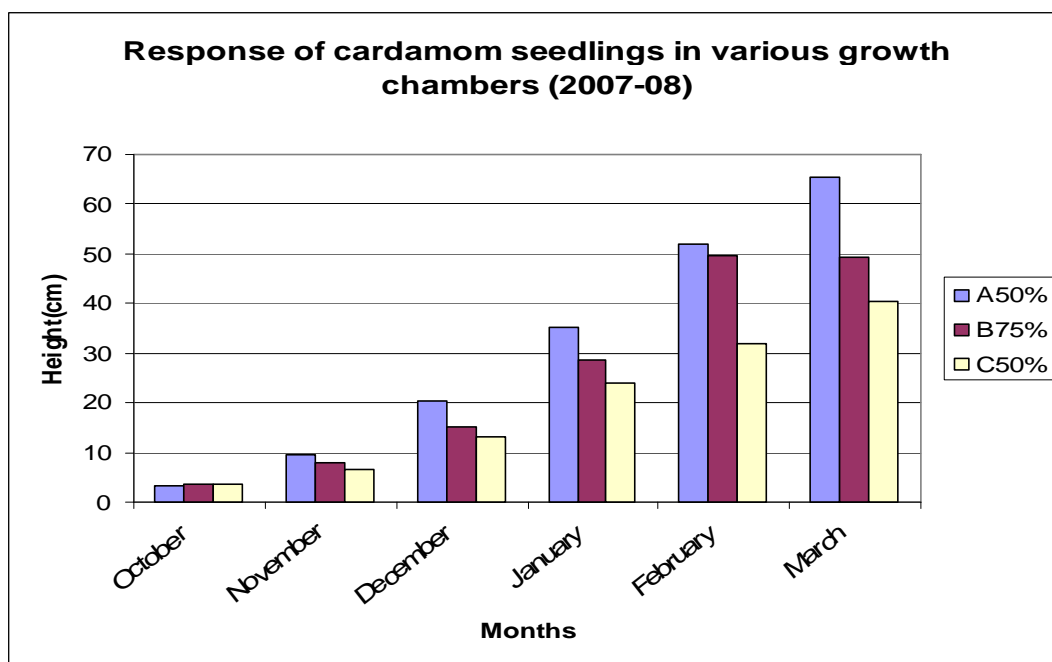
➤ **Cardamom nursery**

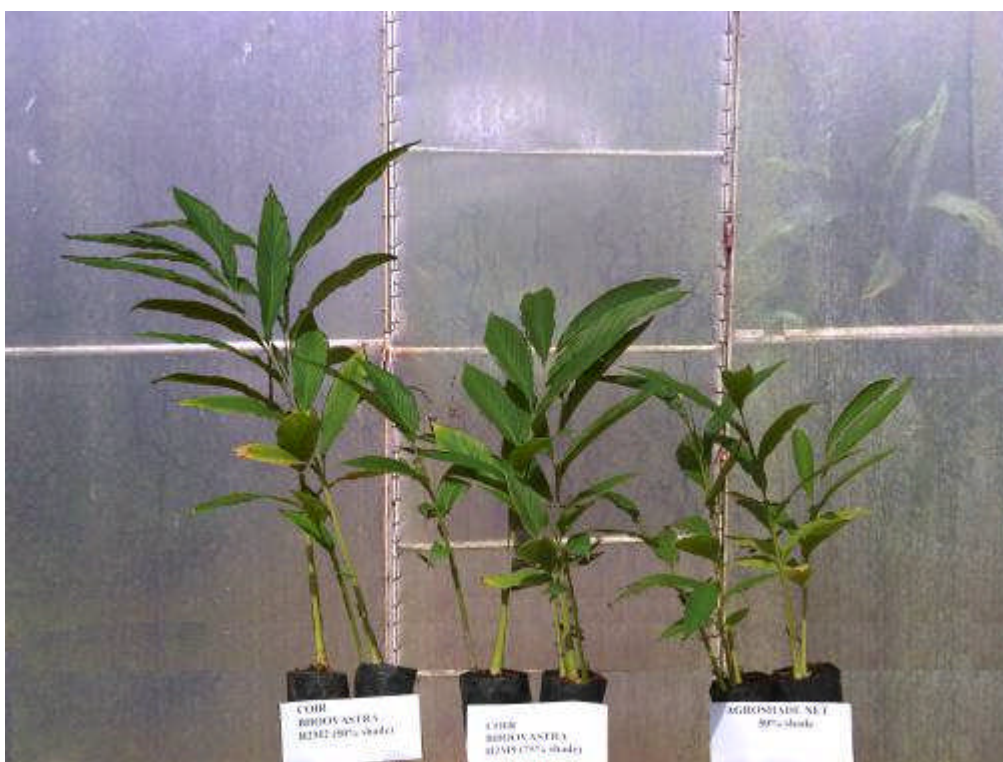
Cardamom poly bag seedlings raised under polyhouse lined with Coir blended yarn (50% Shade) recorded increased height compared to cardamom seedlings raised under Coir

blended yarn (75% Shade) and under Agro shade net lined polyhouse (50%) shade. Occurrence of favorable temperature, sunshine and relative humidity may be the reason for better growth of cardamom seedlings.

Response of cardamom seedlings in various growth chambers (Length in cm)

Months (2007-08)	Coir net (A-50% shade)	Coirnet (B-75% shade)	Agronet (C-50%shade)
October	3.4	3.5	3.6
November	9.5	7.8	6.5
December	20.3	15.2	13.0
January	35.1	28.7	24.0
February	51.8	39.7	32.0
March	65.1	49.3	40.5
Percentage of increase in growth after six months	94.8%	92.9%	91.1%





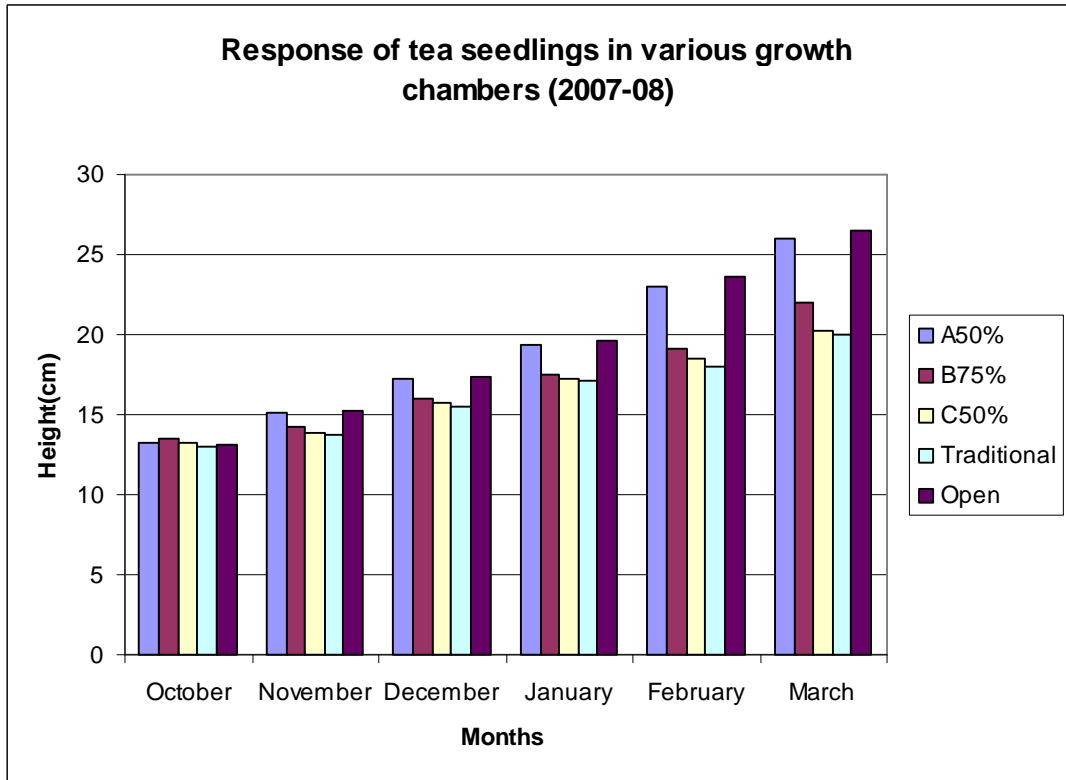
Pic 11. Growth performance of Cardamom

c) Tea nursery

The tea seedlings kept in open condition performed better than seedlings kept inside the growth chambers. However the seedlings kept under the polyhouse lined with Coir blended yarn (50% Shade) the performance of the seedlings in open condition. Occurrence of favourable microclimatic conditions like optimum RH%, higher max. & min. temperature compared to other growth chambers may be the reason for better performance inside coir blended yarn 50% shade during rainy and winter seasons.

Response of tea seedlings in various growth chambers (height of the seedlings in (cm))

Months (2007-08)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
October	13.3	13.5	13.2	13	13.1
November	15.1	14.2	13.9	13.7	15.3
December	17.2	16	15.8	15.5	17.4
January	19.4	17.5	17.3	17.1	19.6
February	23	19.1	18.5	18	23.6
March	26	22	20.2	20	26.5
Percentage of increase in growth after six months	48.8%	38.6%	34.6%	35.0%	50.5%



Pic 12. Growth performance of Tea

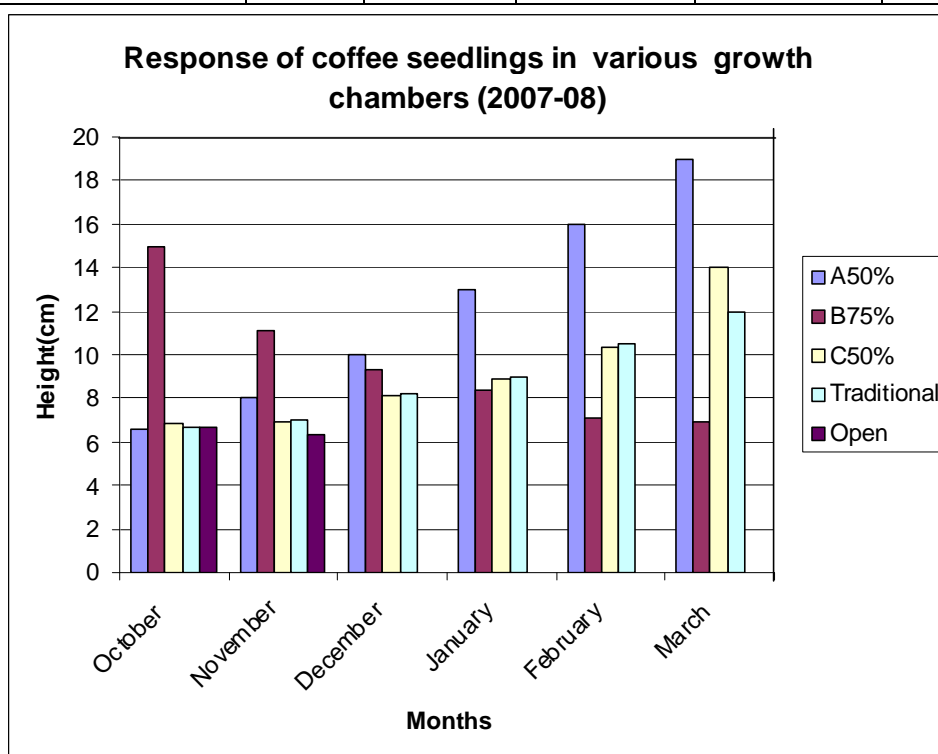
D) Coffee nursery

The coffee seedlings raised under polyhouse lined with Coir blended yarn (50% Shade) recorded increase in height compared to coffee seedlings raised under Coir blended yarn (75% Shade) and under Agro shade net lined polyhouse (50%) shade. Occurrence of favorable temperature, sunshine and relative humidity may be the reason for better growth of coffee seedlings.

All the coffee nursery seedlings kept under open Condition perished after one month of planting. This may be mainly because of building up of heat during sunny days which resulted

Response of coffee seedlings in various growth chambers (Height in (cm))

Months (2007-08)	Coirnet (A- 50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
October	6.60	6.90	6.80	6.70	6.70
November	8.00	7.10	6.90	7.00	6.30
December	10.00	8.40	8.10	8.20	*
January	13.00	9.30	8.90	9.00	*
February	16.00	11.10	10.30	10.50	*
March	19.00	15.00	14.00	12.00	*
Percentage of increase in growth after six months	65.2%	54.0%	51.4%	44.2%	





Pic 13. Growth performance of Coffee

SALIENT FINDINGS

- Coir geotextile lined polyhouse have found to provide favorable solar radiation. Relative humidity and temp inside the polyhouse, compared to polyhouse covered with Agro shade net growth chamber. It shows the advantage of natural fibre over synthetic one for lining inside green house conditions.
- Between the two (Coir blended yarn-50% Shade, coir blended yarn -70% Shade) Coir geotextile lined poly houses, the polyhouse covered with Coir blended yarn -50% Shade provided favorable microclimate inside the polyhouse for gravity growth of cardamom. Pepper, coffee and tea seedlings.
- Poly bag pepper seedlings attained the stage of planting in the main field (114cm) in coir geotextile lined polyhouse with 50% Shade. 45% increased length of seedlings compared with polyhouse lined with 75% Shade coir geotextile and 57% increased in length compared to polyhouse lined with 50% Agro shade net.
- Cardamom seedlings under coir geotextile lined - 50% Shade polyhouse recorded 75% increased growth compared to agro shade net (50% Shade) covered polyhouse.

- Coffee seedlings provided with 50% Shade covered with coir geo textiles found to be 35% better growth compared to agro shade net (50% Shade) polyhouse.

Conclusion:

Coir blended yarn having 50% shade is optimum for providing lining in polyhouses for production of seedlings of plantation crops.

Spices Cultivation

Collaborative project with CCRI where in attempts are made to find out a new use of Coir geotextile/Coir blended yarns for better production of various spices & plantation crops. In the first part, CCRI has provided two coir blended yarn net materials having 50% shade & 75% shade (80% coir & 20% Sisal). The coir geotextiles were used for inside UV-filmed polyhouses with dimensions Length(10m) x Breadth (5m) x Height(4m). CCRI supplied coir net made of 100% coir yarn (50% shade) during May 2009 and a new polyhouse evaluation trial was initiated with the modified coir geotextiles supplied.

Methodology

Five varieties of paprika seeds from Spain were sown in trays on 5-4-08 and one month old seedlings were transplanted in polybags on 5-5-08. The poly bags seedlings were maintained at 50% shade poly house. The grown up seedlings with uniform growth were transplanted in earthen pots filled with top soil and Vermicompost @ 2 seedlings/pot. Each varieties was planted in four pots and a set of 20 pots(4x5) were kept under different polyhouse conditions in all growth chambers on 27-05-08.

The various growth chambers are as follows

- **P1 : Polyhouse lined with coir blended yarn (50% Shade)**
- **P2 : Poly house roofed with coir blended yarn (75% Shade)**
- **P3 : Polyhouse roofed with Green Agro Shade net (50% Shade)**
- **P4 : Green Agro shade net house (50% Shade)**
- **P5 : Open condition.**
- **P6 : * Polyhouse roofed with pure coir yarn (50% shade)**

(* Installed the pure coir yarn lined polyhouse during May 2009)

Initial growth was measured at the time of planting in pots (27-5-08) and subsequent growth was measured at monthly intervals. The matured green paprika & fruits were harvested at maturity and yield was recorded. The leaves and matured fruits were subjected to bio chemical analysis and results are as follows.

Cardamom nursery plants were planted inside polyhouses on June 2008 for Observational trials on its performance under various geotextile lined polyhouses. Pre-rooted herbal spices Oregano and Thyme from polybags were transplanted to pots on 3rd week of february into various geotextile lined polyhouses. Periodically recorded the growth & other characters of various spices.

Environmental parameters:

Significantly lesser relative humidity and more maximum and minimum temperature is recorded in poly houses lined with coir blended yarn than at open condition for the growth period of the crop. (*Tables A to C below*)

Table A. Relative Humidity (%)

Months(2008)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
April	82.1	89.4	86.2	90.0	92.3
May	80.2	87.5	84.1	88.0	90.2
June	87.0	93.0	91.0	95.0	97.0
July	87.2	93.4	91.5	95.3	97.2
August	74.1	81.2	77.0	81.3	84.2
September	89.0	94.0	91.0	95.0	96.0
October	88.0	94.0	91.0	94.0	95.0

Table B. Maximum Temperature (°C)

Months(2008)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
April	30.0	28.4	29.0	27.9	27.7
May	30.8	29.0	29.5	28.5	28.2
June	27.2	26.0	26.5	25.5	25.0
July	26.0	25.5	26.0	25.0	24.8
August	27.0	26.0	26.5	25.5	25.0
September	30.0	27.5	28.0	27.5	27.0
October	27.0	26.0	26.5	25.4	25.0

Table C. Minimum Temperature (°C)

Months(2008)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
April	22.3	19.9	20.5	21.2	19.2
May	21.0	19.6	20.2	21.0	18.9
June	20.9	18.8	19.4	19.8	17.9
July	20.8	18.4	19.0	19.6	17.6
August	23.0	22.0	22.5	21.5	21.0
September	22.0	21.0	21.5	20.3	20.0
October	18.0	17.0	17.5	16.6	16.0

Table D. Solar Radiation (Kw/m²/ Month)

Months(2008)	Coirnet (A-50% shade)	Coirnet (B-75% shade)	Agronet (C50% shade)	Traditional Agronet	Open Condition
April	15.8	10.8	10.6	10.9	24.3
May	18.3	12.5	12.2	12.6	28.1
June	9.0	6.2	6.0	6.4	13.9
July	8.6	5.9	5.7	6.1	13.2
August	8.3	5.6	6.0	5.5	13.5
September	12.0	8.1	8.3	8.0	18.6
October	12.6	8.5	8.9	8.45	13.00

- The photo synthetically active solar radiation(PAR) received during crop period indicated that in all months open condition recorded more solar radiation followed by the poly house roofed with coir blended yarn(50%) shade. (*Table D above*)

Results:



Pic 14



Pic 15



Pic 16

Paprika - Ist Season (April 2008 – October 2008)

i) Growth: The mean height of the paprika revealed that coir geotextile lined polyhouse with 50% shade (P1) recorded maximum height at all growth stages of the crop.(Table 1)

ii) Fruit characters & Yield: All fruit characters ie, Mean length, Weight, No.of seeds, Weight of seeds & percentage of flesh weight of fruit recorded maximum yield coir geotextile lined polyhouse with 50% shade (P1) which resulted in higher yield compared to open field and other polyhouses.(Table 2)

iii) Biochemical Parameters of paprika plant: Among 2 parameters studied, the total amino acid content of paprika plant both at pre-flowering & flowering stages, the coir geotextile lined polyhouse with 50% shade (P1) produced more total amino acids.(Table 3)

iv) Biochemical parameters of paprika fruits: The paprika grown under coir geotextile lined polyhouse with 50% shade (P1) produced more capsaicin content (0.667%) & capsanthin content (76.132 ASTA units) compared to the paprika under other growth chambers.(Table 4)

B) Paprika – Second season (December 2008- March 2009)

The paprika grown under coir geo textile lined polyhouse with 50% shade (P1) produced more flowers and fruits/plant (Table 5).



The experiment was discontinued since the plants were infected by leaf curl virus & thrips and could not be controlled by both chemical & biological methods.

C) Herbal Spices



Pic 17. Oregano



Pic 18. Thyme

The response (biomass) of herbal spices under various polyhouses revealed that both Oregano and Thyme performed better under coir geotextile lined polyhouse with 50% shade (Tables 6 & 7). In quality characters the Volatile oil content of herbal spices Oregano & Thyme kept under Coir geotextile lined polyhouse A : 50% shade (P1) are on par with that of the one kept under open condition. Oleoresin content of Thyme was higher in Coir geotextile lined polyhouse A : 50% shade whereas the oleoresin content of Oregano was better under Coir geotextile lined polyhouse B: 75% shade (P2)(Table 8 & 9).

The response of herbal spice Rose mary under various geotextile lined polyhouses were recorded. Rosemary performed better growth performance under coir geotextile lined polyhouse with 50% shade- P1 & Polyhouse roofed with pure coir yarn (50% shade)- P6 (Table10).

D) Cardamom

Response of Cardamom under various geotextile lined polyhouse revealed that the plants under coir geotextile lined polyhouse A – 50% shade (P1) is having highest mean no. of panicles/clump & mean height of tillers (Tables 12 & 13).



E) Black Pepper

Response of Black pepper under various geotextile lined polyhouse revealed that plants kept under coir geotextile lined polyhouse B- 75% shade (P2) performed better (Table 14).

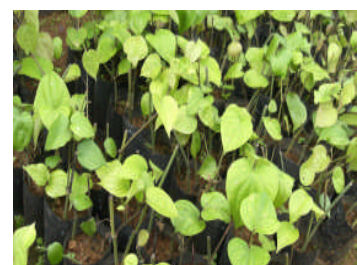


Table 1. Mean height of the paprika plants under various coirnet lined polyhouses conditions.

Growth Chamber	Preflowering Stage(in cm) (June 2008)	Flowering Stage(in cm) (July 2008)	Fruiting stage(in cm) (August 2008)
P1	55.6	75.2	83.0
P2	52.8	64.4	81.2
P3	54.4	65.6	80.6
P4	50.2	72.2	73.0
P5	48.0	54.4	60.8
CD(0.05%)	2.2	3.4	3.8
Varieties			
Spain-A	27.0	51.0	61.6
Spain-B	53.2	65.0	75.6
Spain-C	61.2	65.4	73.6
Spain-G	61.8	69.4	82.6
Spain-L	57.2	80.2	85.2
CD(0.05%)	4.5	5.7	6.1

Table 2. Mean fruit characters & yield of paprika under various coirnet lined polyhouses

Growth Chamber	Mean Length of Fruit (cm)	Mean Weight of Fruit (g)	Mean Number of Seeds/fruit	Mean Weight of seeds/fruit (g)	% Flesh weight of fruits	Mean Yeild (g/plant)
P1	12.0	17.2	119.0	1.49	92.7	110.9
P2	10.8	12.8	112.0	1.32	91.4	60.3
P3	11.5	15.8	114.0	1.47	92.2	86.9
P4	10.2	10.3	82.0	1.13	90.9	49.2
P5	10.6	16.8	121.0	1.53	92.4	77.8
CD (0.05%)	0.35	1.06	11.7	0.15	0.20	6.3
Varieties						
Spain-A	7.4	10.8	55.0	0.7	90.2	31.6
Spain-B	13.0	29.1	142.0	1.8	83.5	95.5
Spain-C	14.7	16.3	136.0	1.4	94.2	122.9
Spain-G	12.7	13.0	161.0	1.7	88.6	93.6
Spain-L	7.3	3.7	54.0	1.5	83.2	13.4
CD(0.05%)	1.5	1.2	12.9	0.2	2.3	15.1

Table 3. Biochemical parameters of paprika leaves under various coirnet lined polyhouses.

Growth Chamber	Chlorophyll content(mg/100g)		Total aminoacid content(mg/100g)	
	Preflowering Stage (June 2008)	Flowering stage (July 2008)	Preflowering Stage (June 2008)	Flowering Stage (July 2008)
P1	0.1527	0.1638	23.3	21.3
P2	0.1535	0.1685	19.8	18.5
P3	0.1532	0.1694	20.0	12.9
P4	0.1635	0.1711	13.2	12.9
P5	0.1562	0.1619	16.6	16.3
CD(0.05%)	NS	NS	2.2	1.9
Varieties				
Spain-A	0.1916	0.1946	18.5	16.3
Spain-B	0.1738	0.1754	18.8	16.9
Spain-C	0.1015	0.1126	17.9	16.0
Spain-G	0.1732	0.1796	18.1	15.8
Spain-L	0.1389	0.1744	18.7	15.3
CD 0.05%)	0.190	0.210	NS	NS

Table 4. Biochemical parameters of paprika fruits under various coirnet lined polyhouses.

Growth Chamber	Capsaicin Content (%)	Capsanthin Content (ASTA Units)
P1	0.667	76.132
P2	0.616	60.386
P3	0.642	72.598
P4	0.626	65.474
P5	0.627	71.614
CD(0.05%)	NS	2.150
Varieties		
Spain-A	0.772	53.190
Spain-B	0.220	83.482
Spain-C	0.511	65.956
Spain-G	0.470	101.59
Spain-L	1.200	41.850
CD(0.05%)	0.120	12.60

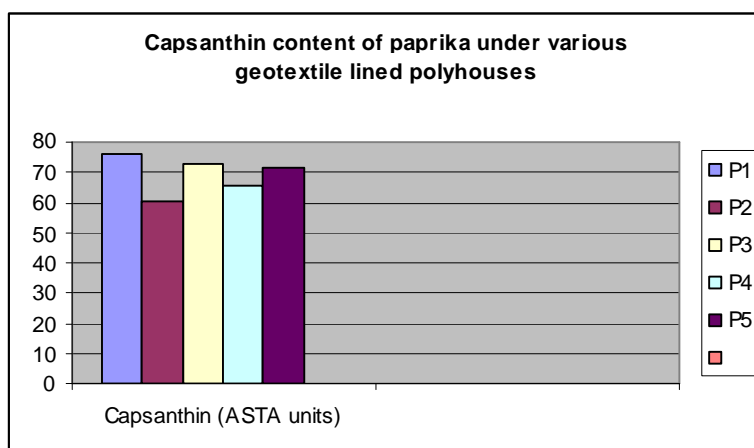
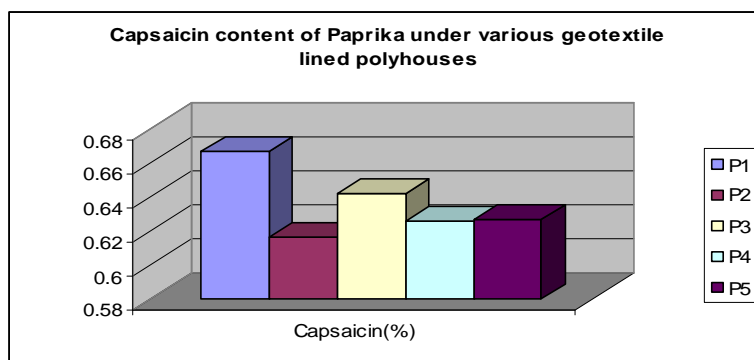


Table 5. Growth of paprika under various coirnet lined polyhouses (60 DAP) (March 2009- Second season)

Growth Chamber	No. of flowers /plant	No: of fruits/plant
P1	7.85	0.53
P2	3.17	0.27
P3	2.79	0.13
P4	5.92	0.50
P5	2.65	0.17

Table 6. Green Yield of Herbal Spices (Oregano & Thyme) under various geotextile lined polyhouse conditions.

Months (2009)	P1 (In gms)		P2 (In gms)		P3 (In gms)		P4 (In gms)		P5 (In gms)	
	Oreg	Thy	Oreg	Thy	Oreg	Thy	Oreg	Thy	Oreg	Thy
March	51.67	55.87	50.53	39.49	55.25	81.59	25.1	26.95	11.43	12.23
April	100	45.2	66	18.4	90	31.1	87.4	94.3	35.5	57.6
May	4.18	1.75	7.22	0.77	4.25	2.05	7.42	2.88	1.35	5.15
June	14.6	8.2	4.2	0.00	10	10	38.9	16	31.4	34.5
Total	170.4	111.0	127.9	58.6	159.5	124.7	158.8	140.1	79.7	109.5

Table 7. Dry Yield of Herbal Spices (Oregano & Thyme) under various geotextile lined polyhouse conditions.

Months (2009)	P1 (In gms)		P2 (In gms)		P3 (In gms)		P4 (In gms)		P5 (In gms)	
	Oreg	Thy	Oreg	Thy	Oreg	Thy	Oreg	Thy	Oreg	Thy
March	11.52	13.72	9.13	7.37	11.13	16.96	3.35	4.14	4.25	5.17
April	20.10	12.10	12.8	3.0	15.20	6.80	14.1	17.7	8.9	17.7
May	0.64	0.30	0.98	0.13	0.84	0.42	1.07	0.43	0.27	1.31
June	2.20	1.50	0.50	0.0	1.40	1.70	4.8	2.7	5.5	7.8
Total	34.50	27.60	23.40	10.5	28.60	25.90	23.3	25	18.9	32

Table 8. Recorded Oleoresin content of herbal spices (April 2009)

Growth Chamber	Oregano Oleoresin Content(%)	Thyme Oleoresin Content(%)
P1	3.28	4.48
P2	4.70	4.09
P3	3.55	3.76
P4	3.27	4.04
P5	2.79	3.97

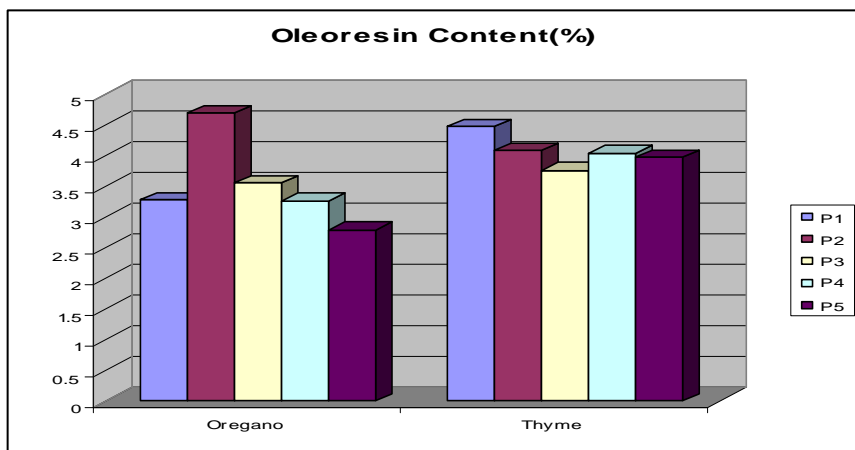


Table 9. Recorded volatile oil content of herbal spices (May 2009)

Growth Chamber	Oregano Volatile Oil Content(%)	Thyme Volatile Oil Content(%)
P1	0.93	2.96
P2	0.76	2.10
P3	0.50	2.00
P4	0.80	2.40
P5	1.04	3.33

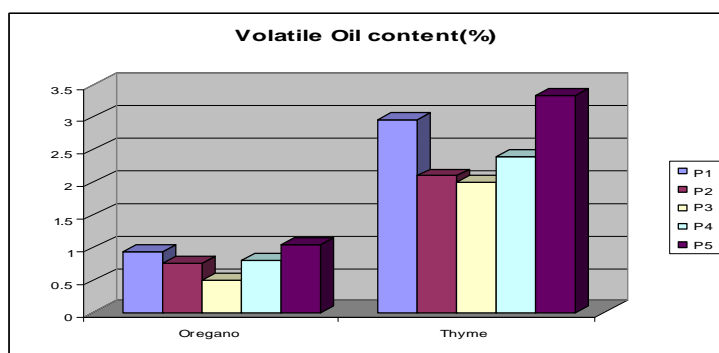


Table 10. Growth performance of herbal spice Rose Mary under various geotextile lined polyhouse conditions.

Growth Chamber	Mean height of plant (cm)			Mean no. of main branches/plant		
	May09	June09	July09	May09	June09	July09
P1	17.6	23.9	26.3	5.6	12.7	14.7
P2	16.5	19.4	16.5(*R)	3.4	7.7	7.8(*R)
P3	15.0	20.6	*D	4.3	8.3	*D
P4	19.7	24.6	25.0	4.7	13.0	18.2
P5	19.6	23.7	33.0	8.6	13.2	16.3
P6	17.1	22.3	26.1	5.2	11.8	15.3

*D – Damaged Plants

*R – Rotten on the top part of plants

❖ Studies on Cardamom under various geotextile lined polyhouse conditions

Table 11. Response of Cardamom growth character- Mean no. of total tillers/clump under various geotextile lined polyhouse conditions.

Months (2009)	P1 (Coir geo textile-shade 50%)	P2 (Coir geo textile-shade 75%)	P3 (Agroshadenet 50%shade)	P5 (Control)
March	42.5	28.0	46.5	4.0
April	47.5	38.0	54.5	5.0
May	53.0	42.5	59.5	5.0
June	55.0	40.5	61.0	6.5
July	63.5	42.5	64.0	8.0

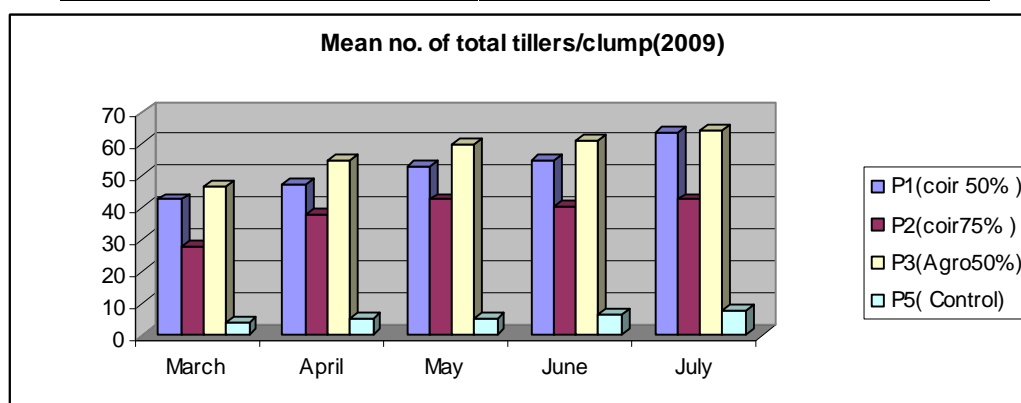


Table 12. Response of Cardamom growth character- Mean no. of panicles/clump under various geotextile lined polyhouse conditions.

Months (2009)	P1 (Coir geo textile-shade) 50%	P2 (Coir geo textile-shade) 75%	P3 (Agroshadenet - 50%shade)	P5 (Control)
March	23.5	15.0	13.0	0.0
April	28.5	22.5	15.5	0.0
May	33.5	26.0	20.0	0.5
June	37.5	31.5	26.5	0.5
July	45.5	33.1	30.5	0.5

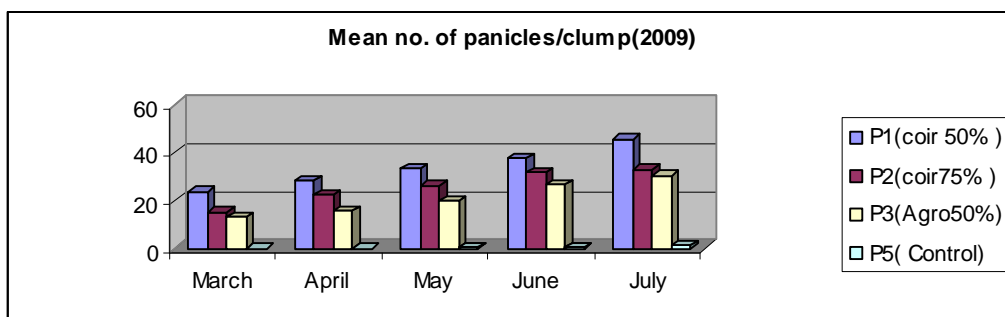


Table 13. Response of Cardamom growth character- Mean height of tiller/clump under various geotextile lined polyhouse conditions.

Months (2009)	P1 (Coir geo textile-shade) 50%	P2 (Coir geo textile-shade) 75%	P3 (Agroshadenet - 50%shade)	P5 (Control)
March	164.0	129.6	137.3	107.5
April	176.8	143.1	153.8	112.5
May	192.5	155.5	175.1	119.4
June	203.4	170.8	191.5	122.1
July	250.0	220.0	235.0	169.0

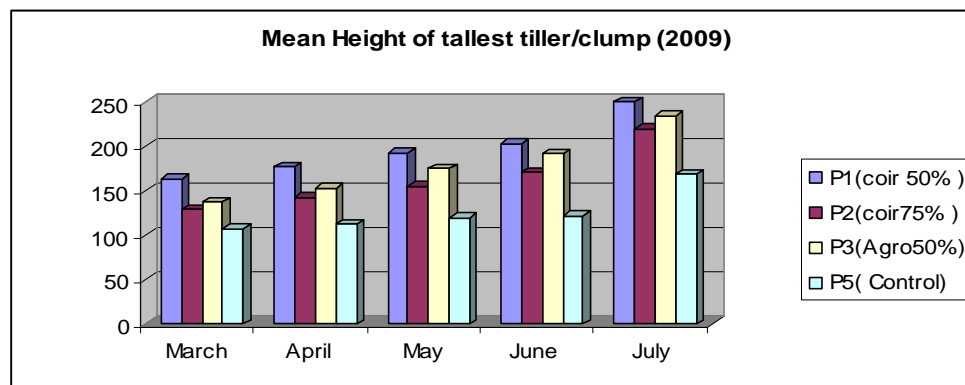


Table 14. Growth performance of Black Pepper under various geotextile lined polyhouse conditions. (2009)

Growth Chamber	Total length of vine(cm)					No: of leaves/vine				
	Mar	Apr	May	Jun	Jul	Mar	Apr	May	Jun	Jul
P1	22.5	31.2	45.6	51.2	61.8	6.1	7.7	9.6	11.1	11.6
P2	20.0	31.0	47.8	59.8	78.2	5.9	7.4	10.0	10.9	11.7
P3	26.5	32.8	46.3	53.8	68.4	7.8	9.2	11.7	12.8	13.2
P4	16.7	18.7	24.4	28.8	40.0	5.2	5.8	6.9	7.5	7.9
P5	16.9	20.2	26.0	27.6	32.4	4.8	5.3	5.6	5.9	6.6
P6	-	31.2	46.1	53.4	60.3	-	8.5	9.2	11.3	11.9

❖ Meteorological Observations under various geotextile lined polyhouse conditions.

Table 15. Relative Humidity (%) under various geotextile lined Polyhouse conditions.

Months (2008-09)	P1	P2	P3	P4	P5
November	81.7	86.4	83.9	89.4	96.1
December	81.6	85.8	82.7	90.2	91.6
January	78.8	85.7	82.4	87.5	89.0
February	80.2	81.7	81.3	86.3	87.2
March	79.4	80.0	80.1	83.1	84.5
April	81.8	89.0	85.3	88.7	90.5
May	78.6	86.2	81.2	86.4	87.4
June	86.3	92.4	90.4	93.2	95.8
July	86.8	93.0	90.7	94.8	96.8

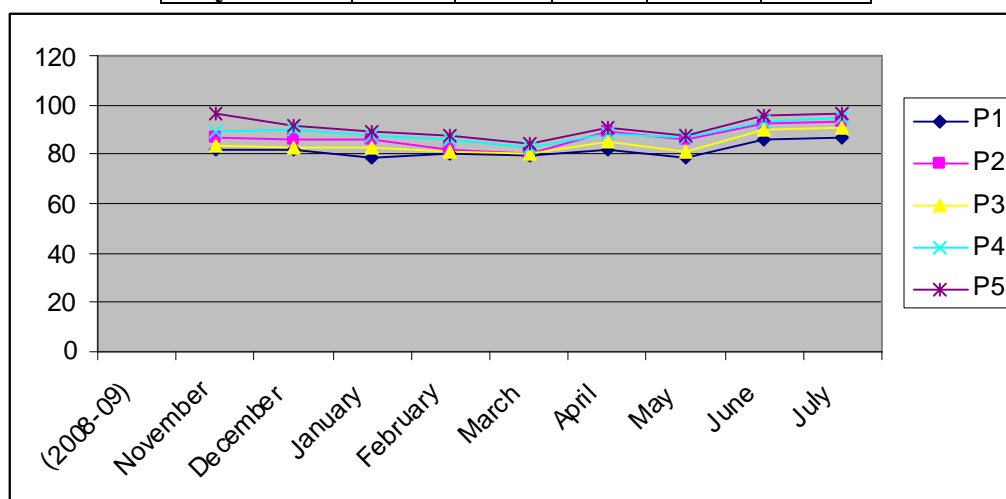


Table 16. Maximum Temperature (°C) under various geotextile lined polyhouse conditions.

Months (2008-09)	P1	P2	P3	P4	P5
November	24.0	22.3	22.9	22.1	25.7
December	26.4	25.8	26.1	25.2	23.5
January	25.9	25.8	26.7	23.1	24.0
February	29.4	28.8	28.2	27.1	27.5
March	30.0	29.0	29.3	28.4	28.6
April	31.6	28.7	29.1	27.9	28.7
May	31.8	29.6	28.9	28.5	27.8
June	26.8	26.2	25.3	23.5	25.0
July	25.2	24.8	23.4	23.1	22.7

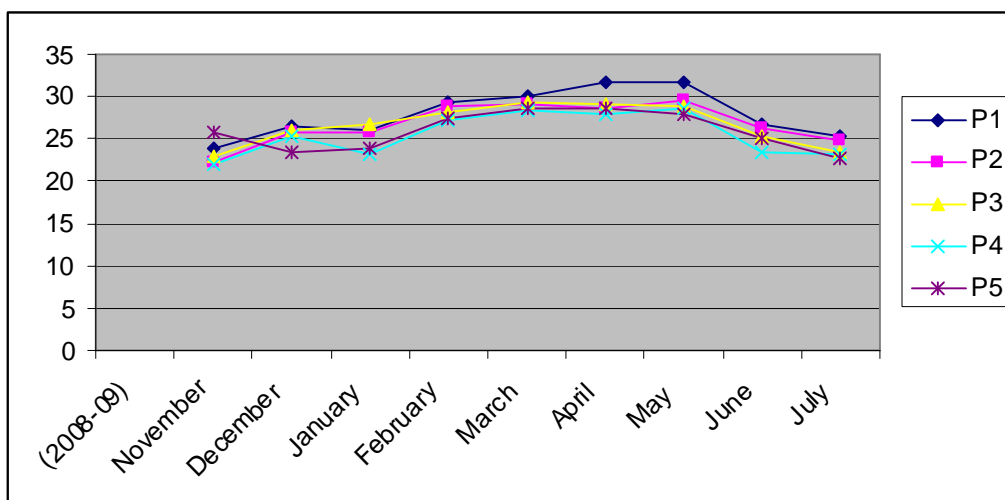


Table 17. Minimum Temperature (°C) under various geotextile lined polyhouse conditions.

Months (2008-09)	P1	P2	P3	P4	P5
November	18.4	17.6	18.0	16.9	17.50
December	20.5	19.8	21.0	19.7	16.5
January	16.9	16.3	17.0	16.0	14.4
February	19.6	18.5	18.8	16.7	15.4
March	21.4	20.2	20.1	19.0	16.9
April	22.5	20.8	20.8	20.0	18.5
May	21.7	20.0	20.4	21.2	18.6
June	20.5	18.3	19.1	19.5	17.5
July	21.2	18.8	19.6	20.0	17.7

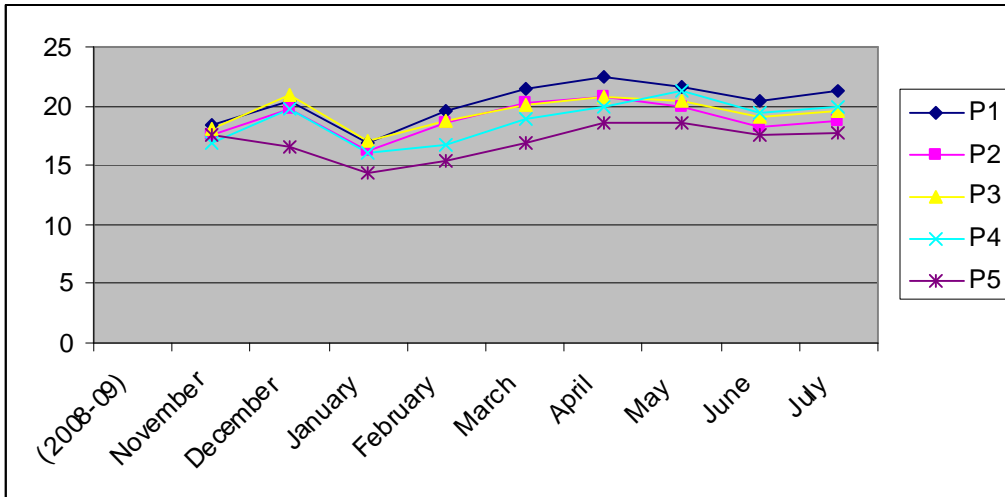
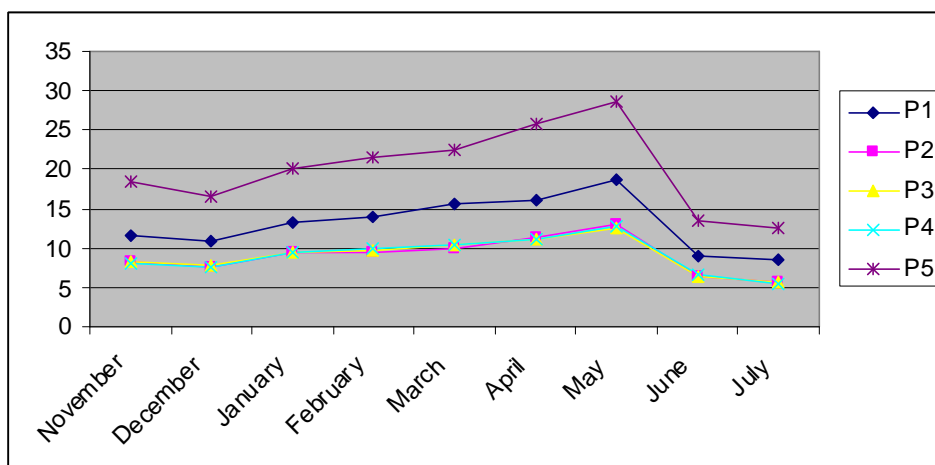


Table 18. Solar Radiation (Kw/m²/ Month) under various geotextile lined polyhouse conditions.

Months (2008-09)	P1	P2	P3	P4	P5
November	11.7	8.2	8.3	8.0	18.5
December	10.9	7.6	7.8	7.5	16.6
January	13.3	9.4	9.4	9.5	20.1
February	13.9	9.5	9.8	9.9	21.6
March	15.5	9.9	10.3	10.5	22.5
April	16.0	11.4	11.0	11.0	25.8
May	18.6	12.9	12.5	12.8	28.7
June	9.1	6.5	6.3	6.7	13.5
July	8.4	5.6	5.6	5.5	12.5



Salient findings in the nursery experiments – Phase II

- **Coir Blended yarn polyhouse have found to provide favorable solar radiation, Relative humidity and Temperature inside the polyhouse compared to polyhouse covered with Agro shade net growth chamber. The photo synthetically active solar radiation(PAR) received during crop period indicated that in all months open condition recorded more solar radiation followed by the poly house roofed with coir blended yarn(50%).**

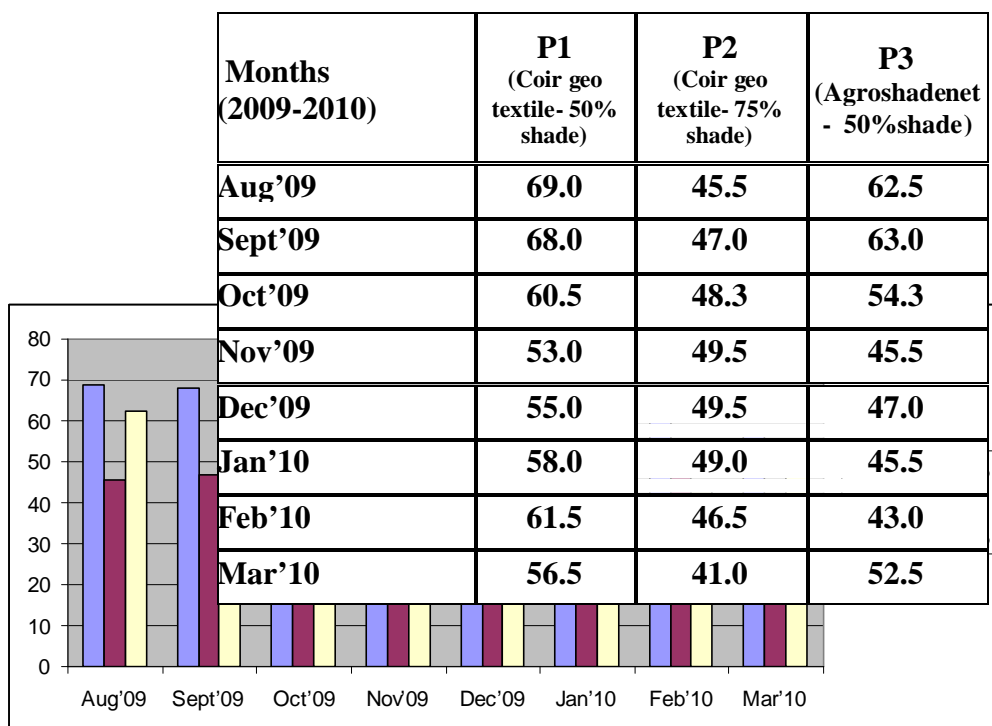
Significantly lesser relative humidity and more maximum and minimum temperature is recorded in poly houses roofed with coir blended yarn than at open condition for the growth period of the crop.

- **Among the two (50% Shade, 70% Shade). Coir Blended yarn poly houses, the polyhouse covered with 50% Shade provided favorable microclimate inside the polyhouse for better growth of cardamom. Pepper, coffee and tea seedlings.**
- **Poly bag pepper seedlings attained the stage of planting in the main field (114cm) in coir Blended yarn polyhouse with 50% Shade. 45% increased length of seedlings compared with polyhouse roofed with 75% Shade and 57% increased in length compared to polyhouse lined with 50% Agro shade net.**
- **Cardamom seedlings under Blended yarn polyhouse (50% Shade) recorded 75% increased growth compared to agro shade net (50% Shade) covered polyhouse.**
- **Coffee seedlings provided with 50% Shade covered with coir geo textiles found to be 35% better growth compared to agro shade net (50% Shade) polyhouse.**

❖ Studies on Cardamom under various shade net lined polyhouse conditions

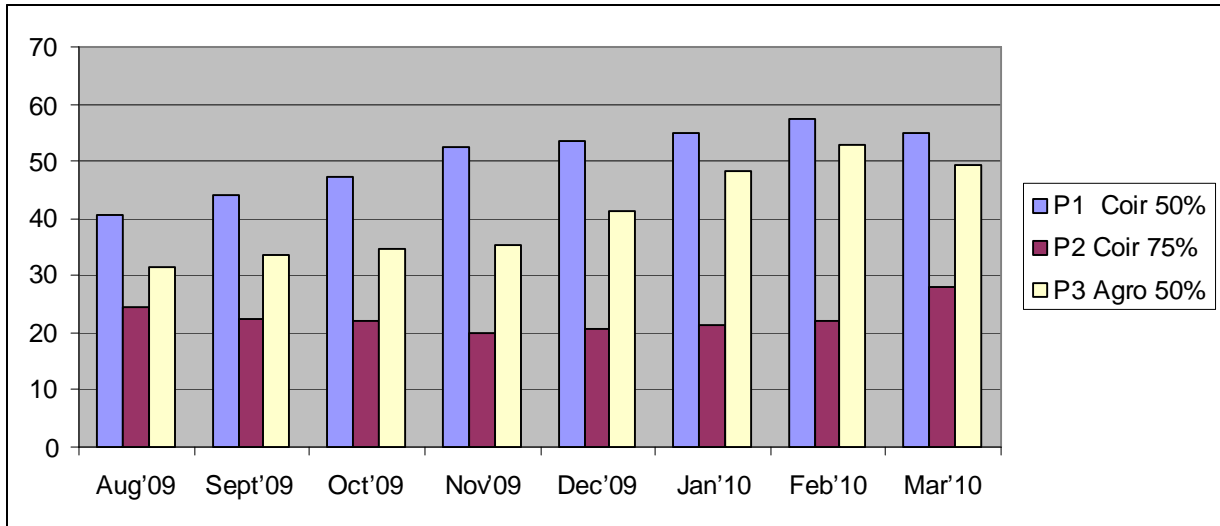
Response of growth characters reveal that Small Cardamom nursery plants under polyhouse lined with Coir geotextile 50% shade performed better compared to polyhouses lined with Coir geotextile 75% shade & Agronet 50% shade.

Cardamom growth character- Mean no.of total tillers/clump under various shade net lined Polyhouse conditions.



Cardamom growth character- Mean no. of panicles/clump under various shade net lined Polyhouse conditions.

Months (2009-2010)	P1 (Coir geo textile- 50% shade)	P2 (Coir geo textile- 75% shade)	P3 (Agroshadenet - 50%shade)
Aug'09	40.5	24.5	31.5
Sept'09	44.0	22.5	33.5
Oct'09	47.3	22.0	34.8
Nov'09	52.5	20.0	35.5
Dec'09	53.7	20.8	41.2
Jan'10	55.0	21.4	48.3
Feb'10	57.5	22.0	53.0
Mar'10	55.0	28.0	49.5



❖ **Microclimatic parameters recorded under various shade net lined polyhouse conditions. (August 2009- March 2010)**

Relative Humidity (%)

Months (2009-2010)	A (Coirnet 50%)	B (Coirnet 75%)	C (Agronet 50%)	D (open)	E (Pure Coir net)
Augt'09	93	90	95	92	95
Sept09	97	91	94	92	94
Oct'09	93	78	95	95	93
Nov'09	96	91	97	97	95
Dec'09	97	79	96	99	98
Jan'10	89	79	87	95	96
Feb'10	74	76	83	91	94
Mar'10	61	66	62	98	86

Maximum Temperature (°C)

Months (2009-2010)	A (Coirnet 50%)	B (Coirnet 75%)	C (Agronet 50%)	D (open)	E (Pure Coir net)
Augt'09	27.4	25.9	26.2	25.7	26.7
Sept09	28.1	26.3	26.4	26.3	26.9
Oct'09	30.3	28.7	28.3	33.2	31.2
Nov'09	26.4	25.9	25.4	27.7	27.9
Dec'09	24.3	25.8	23.6	20.7	24.5

Jan'10	26.7	25.8	24.8	29.4	26.0
Feb'10	28.6	27.6	26.2	28.6	27.1
Mar'10	31.9	31.0	30.6	31.8	31.6

Minimum Temperature (°C)

Months (2009- 2010)	A (Coirnet 50%)	B (Coirnet 75%)	C (Agronet 50%)	D (open)	E (Pure Coir net)
Augt'09	19.1	19.1	19.0	19.1	19.2
Sept09	18.0	18.7	18.9	18.7	18.2
Oct'09	18.4	18.2	18.2	19.9	17.7
Nov'09	18.8	18.7	18.2	19.6	19.1
Dec'09	17.8	18.0	18.4	19.6	18.4
Jan'10	17.7	17.6	17.7	19.2	18.0
Feb'10	16.7	16.6	16.6	18.9	17.0
Mar'10	17.7	17.4	17.6	16.0	18.1

Solar Radiation (KW/Sq.m/month)

Months (2009- 2010)	A (Coirnet 50%)	B (Coirnet 75%)	C (Agronet 50%)	D (open)	E (Pure Coir net)
Jul'09	6.2	4.2	4.3	4.2	9.5
Augt'09	8.5	5.8	6.0	5.7	13.1

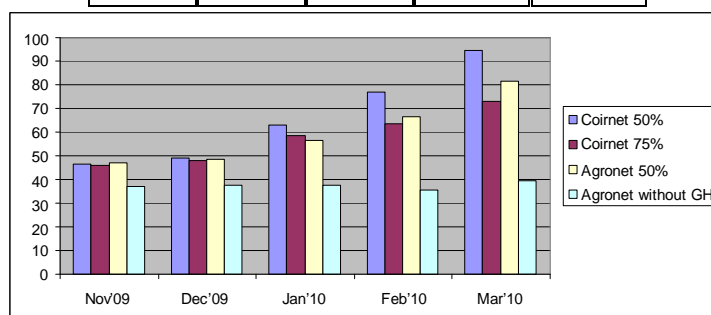
Sept09	7.9	5.4	5.6	5.4	12.2
Oct'09	12.8	8.8	9.0	8.8	19.8
Nov'09	9.09	6.2	6.4	6.2	14.0
Dec'09	11.4	7.8	7.9	7.7	17.5
Jan'10	16.8	11.5	11.7	11.4	25.8
Feb'10	19.6	13.4	13.7	13.3	30.2
Mar'10	21.7	14.9	15.2	14.8	33.5

Coir as trailing material for Black Pepper

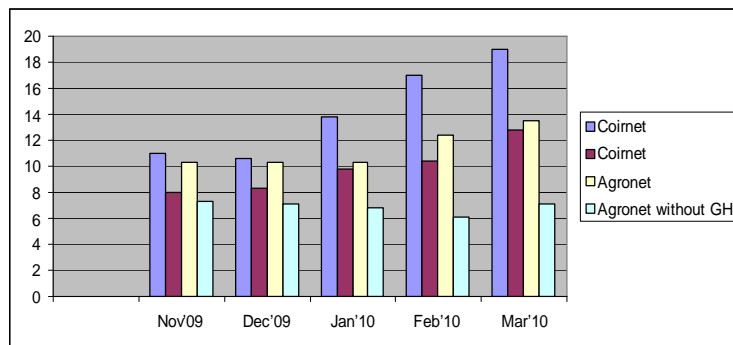
Black Pepper nursery observational trial

Response of Coir as trailing material for Black pepper under various geotextile lined polyhouse revealed that plants kept under coir geotextile lined polyhouse (P1)- 50% shade has increase in Vine length(cm) & total no. of leaves/plant.

<i>Vine Length (in cms)</i>				
Months	Coirnet 50%	Coirnet 75%	Agronet 50%	Agronet without GH
Nov'09	46.5	46.0	47.1	37.1
Dec'09	49.2	47.8	48.3	37.3
Jan'10	62.8	58.3	56.4	37.6
Feb'10	77.2	63.5	66.66	35.3
Mar'10	94.4	72.9	81.75	39.66



<i>No. of leaves/plant</i>				
Months	Coirnet 50% GH	Coirnet 75% GH	Agronet 50% GH	Agronet without GH
Nov'09	11.0	8.0	10.3	7.3
Dec'09	10.6	8.3	10.3	7.1
Jan'10	13.8	9.8	10.3	6.8
Feb'10	17.0	10.4	12.4	6.1
Mar'10	19.0	12.8	13.5	7.1



Participated in the 'International Exposition on Coir 2010' from 4th to 7th February 2010 organized by Central Coir Research Institute held at Coir Board, Kalvoor, Alleppey.



Pic 19. Prototype of green house technology lined with coir bhoovastra in the international exposition.



Pic 20 & Pic 21. Delegates observing the prototype during the international exposition.

Synopsis:

For finding new use of coir net in green house technology, trials started during October 2007 to March 2010. Under trials, we evaluated 3 sets of coir geotextiles against polythene/nylon sheet. The salient outcome of the study are as follows:-

- For lining polyhouses, natural fibres (coir & coir blended yarn) have an advantage over synthetic material (Nylon Agroshadenets) because Coir geotextile lined polyhouses have found to provide favorable solar radiation, relative humidity and temperature conditions inside compared to the polyhouse covered with Agro shade net.
- We have standardized coir net lined polyhouse which were designed and evaluated for production of planting materials of spices & plantation crops.
- Among the various coir geotextiles, coir nets providing 50% shade provided more favorable conditions for growth of test plants in polyhouses.
- 50% shade polyhouse gave a better microclimate for production of various test crops under greenhouse conditions.
- Spices like pepper, paprika, herbal spices have better growth performance compared to other situations.

Conclusion:

- For the first time, ICRI-CCRI has collaborated in finding a new use for coir geotextile in green house technology. It has immense application in protected cultivation of various high value horticulture crops like floriculture, vegetables and nursery production.

Future line of work:

- The trials have been undertaken only in pilot scale. A scaling up study of use of coir geotextile lined polyhouses or nursery production of various crops is to be undertaken to come out with economics & commercial feasibility of coir net lined green house technology.

UTILISATION CERTIFICATE FROM 01-04-2009 TO 31-03-2010

1.	Title of the Project/Scheme	:	Eco-friendly production of export oriented spice crops using coir products/COIR BOARD
2.	Name of the Organisation	:	Indian Cardamom Research Institute, Spices Board, Myladumpara-685553
3.	Principal Investigator	:	Dr.J Thomas, Director[Res]
4.	Department of Coir Board letter No. date of Sanctioning the project	:	CB/S&T/2003/13/10,dt.17-12-2003
5.	Amount brought forward from the previous Financial year	:	Rs.3,60,713/-
6	Amount received from Coir Board during the period [please give number and date of sanctions showing the amount paid]	:	NIL
7	Total amount that was available for Expenditure [excluding commitments] Incurred during the period.[SI No.5+6]	:	Rs.3,60,713/-
8[a]	Actual expenditure [excluding commitments] incurred during the period. [please give details of cheque No.etc]	:	Rs.2,30,260/-

8[b]	Committed Expenditure	:	NIL
9	Unspent balance refunded, if any [please give details if cheque No. etc]	:	NIL
10	Balance amount available at the end of the Period.	:	Rs.1,30,453/-
11	Amount allowed to be carried forward	:	Rs.1,30,453/-

Certified that the expenditure of Rs.2,30,260/- [Rupees Two lakh thirty thousand two Hundred and sixty only] was actually incurred on the project/scheme for the purpose for which it was sanctioned.

**Director [Res]
Principal Investigator of the scheme**