PERFORMANCE OF CAPSICUM UNDER RAINSHELTER

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"Performance of capsicum under rain shelter"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled **"Performance of capsicum under rain shelter"** is a record of research work done independently by **Mr. Vezhavendan. S**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associate ship to him.

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Vezhavendan. S

Dedicated to my

beloved grandfather

(Late) Mr. V. Ramachandran

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Introduction

1. INTRODUCTION

Kerala depend on its neighbouring states for its vegetable requirements. More than 70 %of the vegetable requirement is met from Tamilnadu and Karnataka. Of the meagre production in Kerala, 75% is concentrated during summer season. During summer vegetable cultivation is under taken in rice fallows as well as in riverbeds. This circumstance clearly reveals that vegetable production in Kerala is confronted with many limitations like scarce land and climatological factors like heavy rainfall and high humidity especially during rainy season and comparatively high temperature during summer. Scarcity of cultivable land and intense rainfall during rainy seasons demand intensive and protected system of cultivation to enhance vegetable production.

While considering options of protected cultivation greenhouse, glasshouse or poly house are the pictures that come to our mind. But these structures have their own limitations restricting universal application Hence protected conditions need to be standardised for different locations based on temperature, humidity rainfall, wind velocity and other related parameters.

Kerala "Gateway of Indian Monsoon" enjoys a warm humid tropical climate. The average annual rainfall is as high as 300 cm distributed over the monsoons starting from April-May to October–November. Due to intense rainfall temperature is positively low, but humidity is very high up to 80 to 90 per cent during rainy season in Kerala. After November, the weather is more or less dry with maximum dry temperature reaching up to 35 to 36 ^{0}C in summer months of March-April. A protection structure to be designed for Kerala needs many considerations regarding rainfall and humidity. A completely covered structure is not desirable unless it is designed as fully climate controlled with very good control system for cooling and dehumidification. Such hi-tech structures cannot be recommended to farmers of Kerala whose resource bases are low. Hence a low cost structure that protect crops from heavy rainfall and also which provides

ample natural ventilation can be a probable answer to the protected cultivation system in Kerala for vegetable crops.

Capsicum is a choice vegetable fetching premium price. The climatic requirement of capsicum makes it a difficult crop to be grown under the warm humid tropical situations especially in the mid lands of Kerala. Rabi is the ideal season for the crop and cultivation is limited to high ranges. During rainy season the temperature is low and the cloudy days mimic short day conditions, which set necessary background for rain shelter cultivation of capsicum even in the plains of Kerala. Rain shelter technology can be resorted to improve the quality and yield potential also in high range region of Kerala (Idukki and Wynad districts).

Taking in to consideration of all the above aspects the present study was under taken with the following objectives

1. To study the productivity of capsicum under rain shelter and open field condition.
2. To study the feasibility of capsicum production during rainy season.
3. To find out the economics of capsicum production under rain shelter verses open field condition.

Review of Literature

2. REVIEW OF LITERATURE

Protected cultivation is the best alternative and drudgery-less approach for using land and other resources more efficiently. There are more than 50 countries in the world where cultivation of crops being undertaken on a commercial scale under cover. However, in India green house cultivation is in infant stage and has not become popular yet. Among the various advanced technologies used to achieve break through in yield potential of vegetable crops, cultivation of these crops in protected environment (glass house/green house/plastic house) has proved its potential to increase the yield manifolds. A representative review is presented under the following heads.

1. Influence of growing condition on the growth and yield of capsicum.
2. Effect of climatic factors on the growth and yield of capsicum.
3. Identification of promising capsicum varieties for green house production.
4. Growth and yield response of capsicum to different planting seasons.
5. Pest and disease incidence in capsicum under green house condition.
6. Economics of capsicum production under controlled condition verses open field.

2.1. INFLUENCE OF GROWING CONDITION ON THE GROWTH AND YIELD OF CAPSICUM

2.1.1 Influence of growing condition on the vegetative characters

Leaf area index is a major determinant of crop growth rate and temperature is the main determinant of leaf area development (Watson, 1952). High temperature increased the rate of leaf initiation and appearance (Milthorpe, 1959).In correlation studies Ponnuswamy and Muthukrishnan (1981) observed a positive correlation between plant height, fruit weight, fruit number and yield under high temperature. Heat stress induced at all stages of crop growth reduced

the plant height significantly in all cultivars compared to non-stressed plants (Arora *et al.*, 1982a and 1982b).

Plants grown under greenhouse grew more vigorously than in open field. They exhibited greater plant height. It is due to the cellular expansion and cell division under shaded conditions (El-Aidy *et al.*, 1988). Similar results were reported by Rao and Sreevijayapadma (1991). Kadam *et al.* (1991) reported that the poor vegetative growth might be due to high transpiration and higher rate of respiration under open field condition. Indeterminate growth habit was highly correlated with heat tolerance during flower bud development (Shonnard, 1991).

Abou-Hadid *et al.* (1994) reported that plants grown under tunnels in Egypt showed highly significant increase in plant height in various stages of development against open condition. Protected cultivation is actually an invention attempting to achieve higher water and nutrient-use efficiency and reducing transpiration (Prabhakar and Hebbar, 2002).

2.1.2 Influence of growing condition on the reproductive characters

The effect of different cladding materials on growth and development and yield of peppers was investigated in Lubljana, Slovenia. Plastic green houses, consisting of plastic hoops supporting ethylene vinyl acetate (EVA), poly ethylene (PE) and poly propylene (PP) were compared with a non-covered control. Temperature extremes and RH were calculated. The yields and the highest number of fruits/plant obtained under EVA (800 g/plant and 14.9 fruits/plant respectively) followed by PE (755 g/plant and 11.7 fruits/plant) (Kacjan *et al.*, 1997).

Investigations on modifying the microclimate in tunnels covered with poly ethylene (PE) and poly propylene (PP) were conducted near Krakow, Poland by Siwek and Libik (1999). The plants under PP developed slower, produced less

biomass and the ripening of fruits was lower compared to that from film tunnels. The highest yield was obtained from non-woven PP where the shading rate was lowest.

AAU (1997) reported that off-season cropping pattern under low cost plastic green house cum rain shelter is more suitable for tomato crop. Rain shelter cultivation of tomato at Plasticulture Development Center, Thavanur revealed that productivity of tomato inside the shelter was higher (5 kg/m^2) than under open field conditions (1.3 kg/m^2) (KAU, 1999).

The productivity of capsicum hybrids under low cost green house was not significantly higher (71.13 t/ha) but the produce was of excellent quality as compared to open conditions (Khan *et al.*, 2000). Agrawal *et al.* (2000) reported that the yield of capsicum under protected environment is twice that of the open field yield.

Arya *et al.* (2000) found that plastic shelters increased tomato and capsicum production yields by 169 and 956% respectively without any use of pesticides and also proposed the uses of small land area on a continuous basis, stable production, with little or no plant protection chemicals and raises farmers income.

Capsicum grown in the naturally ventilated poly house showed four times more yield and yield components compared to those grown in the field (Nagalakshmi *et al.*, 2001).

2.2 EFFECT OF CLIMATIC FACTORS ON THE GROWTH AND YIELD OF CAPSICUM

2.2.1 Ambient temperature

2.2.1.1 Influence of ambient temperature on vegetative characters

High temperature increases the rates of leaf initiation and appearance (Milthorpe, 1959). Rajender (1985) reported that temperature plays an important

role in the growth and development of plants. Temperature influences the rates of photosynthesis, respiration and other metabolic processes, which are then, offered the yield, quality of the product and timing of crops maturity.

Bakker and Van-Uffelen (1988) found that vegetative growth and development of sweet pepper depend mainly on the 24-hour mean temperature, while the effect of day/night, amplitude is of minor importance. Temperature also affects pepper flowering, fruit set and fruit growth.

Temperature is a major regulator of developmental processes (Cockshull, 1992). Malfa (1993) studied and reported the comparative response of solanaceae to maximum temperature levels in the green house. The growth of vegetative organs (leaves, stems and shoots) in aubergines and tomatoes negatively affected by the highest temperature level, as was fruit growth (weight) in capsicums.

Effect of temperature on the biological processes viz., photosynthesis, transpiration, respiration, maturity and quality of the products were further revealed through the studies of Prasad (1997). Plant height is a function of the total number of nodes and the length of each inter node and both strongly influenced by green house temperatures. Node number or formation rate is primarily a function of the average green house temperature, increasing as the average temperature increases (Berghage, 1998).

2.2.1.2 Influence of ambient temperature on reproductive characters

Temperature may influence the distribution of photo assimilates between fruit and vegetative parts as well as their rate of growth (Heuvelink, 1995). High temperature favours the distribution of assimilates to fruit, at the expense of vegetative growth (Dekoning, 1989a). It is generally reported that increasing ambient temperature by 1°C increase fruit dry matter content by 0.07 per cent (Dekoning, 1992).

Sweet pepper cultivars E-34066 and Yolo wonder were grown under ambient conditions in covered green houses. Temperature throughout anthesis was high [> 38°C (maximum) and > 16°C (minimum)] and it was suggested that this contributed to the rapid changes observed in anthesis. Fruit set was highest in the early stages of anthesis, but subsequently declined as majority of flowers aborted. Fruit set in later in the season were smaller than those set earlier. In earliest seed, size and parent germination remained constant. The latter is of particular importance for seed crops where seed quality is of primary concern (Khah and Passam, 1992).

Ali and Kelly (1993) reported that the high temperature increased the mean number of locules per fruit (shape component) in bell as well as in pointed pepper fruits. The low temperature also resulted in a minor increase in mean number of locules because of slight increase in the number of tetra locular fruits. Yet, most fruits were unmarketable because they were short and blunt.

Cockshull *et al.* (1994) reported that the temperature inside the plastic houses was higher than that out side from 1-2 hour before dawn to 1-2 hour after sun set and lower than out side the rest of the time. This put down to various factors including the higher RH and CO_2 inside the green house and absorption of the heat by the dense vegetation inside the green house.

2.2.2 Relative humidity

2.2.2.1 Influence of relative humidity on vegetative characters

The humidity between 55 and 90 per cent did not affect the growth and development of green house crops. The pollination was similarly little affected over the same range (Picken, 1984). Extremely low humidity can lead to high transpiration rates. High humidity is considered more important than low humidity

in green houses, which has significant impact on the energy balance of crops. Elevated humidity's suppress crop transpiration, a process that converts a major fraction of incoming solar radiation into latent heat (Stanghellini and Bunce, 1987).

Plants grown under humid atmosphere are characterized by large and fleshy leaves, stem and flowers. Maintenance of plants under low humidity is associated with injury to margin and tips of leaves and petals, within and showed symptoms of senescence Decreasing this fraction temporarily results in high leaf temperatures (Bakker, 1995).

2.2.2.2 Influence of relative humidity on reproductive characters

The shelf life of sweet peppers originating from different local commercial nurseries, varied from 5 to 17 days. Increasing EC level of nutrient solution reduced the shelf life, while it improved flavour, measured in sensory assessments. There was a tendency that changing relative humidity regimes during day and night resulting in an average 24 hour humidity of about 30 per cent, gave the best results for shelf life compared to constant high and low humidity levels of 70 and 90 per cent respectively (Janse, 1989).

Hand (1988) reported that from crop production stand point, the best strategy is to maintain a high humidity during the day and to avoid too high humidity at night. Such a regime will maximize the quality of output and minimize the risk of plant diseases.

Ajithkumar (1999) reported that under Vellanikkara condition relative humidity of 70-86 per cent and afternoon relative humidity of 59 per cent were required for (tomato) crop growth whereas relative humidity of 70-74 per cent during morning hours during 6^{th} and 8^{th} week after planting was optimum for the increased yield. He also found that morning relative humidity and afternoon

relative humidity during the 1st and 2nd weeks after planting had positive effect on the days to first flowering while morning relative humidity (6th-7th week) were negatively correlated with yield.

2.2.3 Light intensity

The use of genotypes better adapted to low-light environments (Papadopoulos and Ormrod, 1990). Usually radiation use efficiency is high in a crop canopy because radiation is distributed over leaves with different orientations and positions within the canopy. Only a small fraction of the leaves will receive full sun light (Bot and Challa, 1991).

In crops with closed canopies, PPFD (Photosynthetic Photon Flux Density) interception can be enhanced by better green house structures (Critten, 1993). Shaheen *et al.* (1995) grown tomato cv. Dombo, capsicum cv. Gedeon and cucumber cv. Katia F_1 under plastic green house condition and were exposed to light intensity of 100, 64, 49 and 37 per cent. Increasing shade level reduced the seedling fresh weight and dry weight in both winter and autumn trials, but the winter crop was more affected than autumn one. The highest NAR (Net Assimilation Rate) values for all three species obtained were in the control treatment. Decreasing light intensities reduced the values of NAR and total chlorophyll content. Under increasing light intensities total carbohydrates concentration increased, but N content decreased.

Optimum plant populations (Papadopoulos and Parasrajasingham, 1997) is the another best mean for the PPFD interception enhancement. *Capsicum pubescence* plants were grown under four shade levels (90, 70, 50 or 30%) while controls were grown without any shading. The highest shade level caused excessive stem elongation. Overall, the best vegetative and reproductive development occurred under 30-70% shade (Lara et al., 1999).

Bhatt *et al.* (1999) conducted a study on photosynthesis, reproductive attributes and yield in Arka Gaurav and Arka Mohini varieties of bell pepper under 100, 75, 50 or 25 per cent irradiance in natural environmental conditions during summer in Karnataka. Photosynthetic rate was higher in Arka Gaurav compared with Arka Mohini under all four irradiance levels. Fruit yield was highest (236 g/plant in Arka Gaurav and 228 g/plant in Arka Mohini) in plants grown under 50 per cent irradiance. Reduction in irradiance (50%) resulted in improvement in fruit development, growth and increased yield by 28-85 per cent compared with 100 per cent irradiance.

Four cultivars of capsicum were grown at 100, 70 or 35 per cent of natural intensity. Fruit yield and net photosynthetic rate were the highest and night respiratory rate was the lowest under 70 per cent light intensity. As light intensity decreased, the light compensation point declined, the chlorophyll contents increased (Lei *et al.*, 1999).

Ajithkumar (1999) reported that bright sunshine of 5.2-10.0 hours required for optimum growth of tomato under Vellanikkara condition. He also reported that the days to first flowering showed a negative correlation with bright sunshine raising 1^{st} - 2^{nd} week after planting.

2.3 PROMISING CAPSICUM VARIETIES FOR GREEN HOUSE PRODUCTION

Three *Capsicum annuum* hybrid cultivars, Galaxy, Colombo and Gedeon were evaluated under plastic green house cultivation and subsequent ambient or cold storage for 2 successive seasons. Colombo produced the highest yields (3.82 kg/plant in the first season and 4.17 kg/plant in the second) and Galaxy the lowest (3.25 and 3.64 kg/plant). Colombo fruits were the largest and firmest and had the thickest flesh and the highest TSS and dry percentages, although Gedeon had the highest chlorophyll concentration. Colombo fruits suffered the least weight loss

and decay incidence (Pathogen unspecified) during storage for up to 12 days at 18-20 ^{0} C + 60-65% RH or 10 ^{0}C + 85-90% RH, while galaxy suffered the most (Rahman and Sheikh, 1994).

Three capsicum cultivars planted on second June were assessed for flowering dates, beginning of cropping and full cropping, yield in each of four harvests and total yield and percentage of fruits in four different weight groups. Cultivars Vidi and Elisa gave the highest total yields (30030 and 30463 kg/ha respectively) almost twice as high as for cv. Fiuco (16268 kg/ha) (Gomez *et al.*, 1994).

Dimitrov and Kanazirska (1995) tested five long fruited varieties of capsicum. Abdera gave the highest yield, surpassing the control, Albena, by 47.6 per cent and the other varieties by 5.1-26.2 per cent. Abdera and Andalus had a wrinkled fruit surface and a high percentage of curved fruit, which reduced their market quality. The relatively high yielding varieties Astrion and PM 6 were recommended as the most promising.

Agronomic and fruit morphological characteristics were studied in 11 sweet pepper hybrids grown under plastic covers in Campinar, Sao Paulo, Brazil from November 1995 to July 1996. The hybrids were grouped according to fruit color red (Luis, Fresco, Juncal and XPH 14187), yellow (Indalo and Rapia), orange (Mandarin and orange wonder), purple (cardinal and like) and irovy (Ivory). Frisco and Luis produced the greatest yields (2.7 and 2.5 kg/plant, respectively), whereas like and orange wonder produced the lowest yield (1.91 and 1.73 kg/plant respectively). All the other hybrids displayed intermediate performance Fresco and Rapia showed the best performance in the red and yellow fruit groups respectively (Scivittaro *et al.*, 1999).

The choice of cultivars has become a major factor in determining the profitability of a crop and constitutes an important management decision. It must

be made according to target markets and production conditions (Dorais *et al.*, 2001).

2.4 GROWTH AND YIELD RESPONSE OF CAPSICUM TO DIFFERENT PLANTING SEASONS UNDER OPEN FIELD AND PROTECTED CONDITION

Maher *et al.* (1994) conducted an experiment with tomato cultivars Punjab chuhara, Pusa Early Dwarf and Pusa Ruby. They were planted in the kharif (monsoon), rabi (winter) and summer seasons of 1988-89. They found that in Pusa Early Dwarf fruit yield was the highest from kharif crops.

Shaheen *et al.* (1995) reported that increasing shade level reduced seedling fresh weight and dry weight in both winter and autumn trials, but the winter crop was affected more markedly than autumn one. The effect of transplanting date (January 30 to May 1st at 15 days interval) on fruit yield and other agronomic traits studied in tomato cv. Pusa Ruby during 1992-93. Transplanting date significantly influenced the number of branches/plant, the number or fruits/plant and fruit yield/plant. It was suggested that high yields were promoted following transplanting on 30th January under the sub tropical conditions of Jammu (Samnotra *et al.*, 1998).

Ajithkumar (1999) studied the performance of tomato cultivar Sakthi at different periods of planting revealed that February planted crop took less number of days for first flowering, 50 per cent flowering and had the shortest crop duration while June planting took maximum number of days for first and 50 per cent flowering, whereas maximum duration of the crop was recorded by planting in October. He also reported that December planting was significantly superior to other treatments with regard to yield characters. The maximum number of fruits per plant obtained was for December planting followed by October, November planting.

Capsicums are known to perform better in winter or rabi season and when grown in summer, yields are very low due to poor crop growth and fruit set and severe diseases, especially viruses except in hills. At higher altitudes in Himachal Pradesh and Nilgiris the crop is taken as summer crop sowing being done in March-April (Kalloo *et al.*,2001).

2.5 PEST AND DISEASE INCIDENCE IN CAPSICUM UNDER CONTROLLED CONDITION

Irradiance, temperature and humidity levels within green houses have a significant impact on the biology and dispersal of insect and mite pests and their biological control agents and the predatory/parasitic interactions between them (Scopes, 1973). Crops stressed by adverse environments generally are more susceptible to diseases (Schoenweiss, 1975).

It might be supposed that the given degree of environmental control that can be achieved in the green house will be helpful for the biological control of plant diseases (Andrews, 1992).

Nihoul and Hance (1994) found the effects of intercropping on the distribution of pests were analysed in a cropping system comprising rows of sweet pepper cv. Mazurka (capsicum) alternating with rows of tomatoes cv. 2209 in an 80 m^2 greenhouse in Netherlands. Infestation by *Myzus persicae, Tetranychus urticae* and *Frankliniella occidentalis* and their predator or parasitoids compared between the rows. High densities of *F. occidentalis* occurred on capsicum but not on tomatoes. *M. persicae* also found on capsicum in large numbers but was only found in dying colonies on tomatoes. Tomatoes supported higher densities of *T. urticae* than capsicum and the distribution and population dynamics for the two crops were the result of differences in food plant suitability.

The first report of blight of peppers caused by *Phytophthora capsici* in Ontario reported by Anderson and Garton (2000) and they found that the disease caused a 40 to 60% yield loss in pepper fields.

Soil related and biotic constraints to vegetable production in Belize, Central America where rainy season tomatoes and sweet peppers are destroyed by Gemini virus. The plants growing in the open-field environment are infected easily by the soil-borne pathogens deposited on the plants from clouds of the soil particles arising from soil splash during high intensity rainfall. A production system in which plant and soil surfaces protected from direct rainfall using plastic shelters was designed and field-tested with tomatoes and sweet peppers. On average, plastic shelters increased tomato and sweet pepper yields by 169% and 96% respectively, without use of pesticides, weed growth under the shelter were negligible and plants maintained greenness and production well into the fourth month after transplanting (Arya *et al.*, 2000).

3.6.ECONOMICS OF CAPSICUM PRODUCTION UNDER CONTROLLED CONDITION

An economic analysis conducted for the production of nine greenhouse crops in the Rosario area of Argentina. The economic parameters used were gross margin, net income, net profit, return on capital (ROC) and net present value. Peppers, celery, strawberries and spring tomatoes had the highest gross margins (Ferratto, 1994).

Mahajan *et al.* (1994) reported that per hectare cost of cultivation was Rs.14,714.76 and Rs.16,690.95 for aubergine and tomato respectively. Per ha returns were Rs.9,000.89 and Rs.7064.55 with benefit cost ratios of 1.20 and 1.07 respectively.

Study conducted at Plasticulture Development Center at Kelappaji College of Agricultural Engineering and Technology, Thavanur, Kerala Agricultural University indicated that, tomato cultivation under greenhouse (rain shelter) gave a B/C ratio of 1.17 per season (KAU, 1999).

Tomato, capsicum and cucumber can be cultivated profitably inside the greenhouse. Yield of tomato is about 11 kg/m²/season that can be sold @ Rs.10/kg. (Chandra *et al.*, 2000).

An experiment conducted at University of Agricultural Science, Bangalore (Amaranjundeswara, 2000) revealed that, net income of Rs.5535/season obtained from tomato crop grown in low cost greenhouse of 100 m².

Benefit cost ratio for tomato production was 1.48 with medium cost greenhouse and 2.09 with low cost greenhouse at Tamil Nadu Agricultural University (TNAU, 2000).

Anbarasan (2002) reported that the realized yield gave a B/C ratio of 0.22 under poly house and 0.46 under open field condition. However, on computing the potential /expected yield B/C ratio obtained was 1.14 and 1.58 for crops under open field and poly house conditions respectively.

Materials and Methods

3. MATERIALS AND METHODS

An investigation to study the performance of capsicum (sweet pepper) under rain shelter as well as in open condition was conducted at the Department of Olericulture, College of Horticulture, Vellanikkara during Rabi (2001) and Kharif (2002) seasons. The materials used and methods followed are presented below.

The experiment was conducted in the Department of Olericulture, College of Horticulture, Vellanikkara. The site is located at 10°3' N latitude and 70°3' E longitude and at an altitude of 22.25 m above MSL. The area enjoys a typical warm humid tropical climate and receives average rainfall of 3400 mm per year.

2.1 RAIN SHELTER

A low-cost rain shelter constructed in the Department of Olericulture was used for the study (Plate. I).

The rain shelter has the following specifications

(i) Cladding material: UV stabilized polythene film

(ii) Dimension: 8 m x 5 m (40 m^2)

(iii) Height: 2.7 m

3.2 OPEN FIELD

Plain land adjacent to the rain shelter was utilized for pot culture evaluation under open field condition.

3.3 VARIETIES

Five capsicum varieties (Table.1) were used for the study.

The varieties were evaluated during both the seasons in the rain shelter and open field simultaneously in a Completely Randomised Block Design with four

Table 1. Name and source of capsicum varieties

Sl. No.	Accession No.	Varietal Name/Local name	Sources
1	CA.776	Kandalgut Selection	Y.S.Parmar University of Horticulture & Forestry, Solan, H.P.
2	CA.531	Yolo Wonder	IARI, Regional Station, Katrain
3	CA.778	Pusa Deepthi (F_1 hybrid)	IARI, Regional Station, Katrain
4	CA.532	California Wonder	IARI, Regional Station, Katrain
5	CA.567	Thiruppathisaram Kodamulagu	Thiruppathisaram Kanyakumari, Tamilnadu

replications having four plants per variety. There were 16 plants per variety and all the 16 were used for recording observations. The manure's and fertilisers applied as per the Package of Practice recommendations.

3.4 SEASONS

The research was carried out in two seasons viz. July-November 2001 (Rabi) and April-September 2002 (Kharif) under two conditions (Rain shelter and open field).

3.5 CULTURAL OPERATIONS

3.5.1 Nursery practice

Seedlings was raised in pots containing rooting medium of sand, soil and farm yard manure in the ratio of 1:1:1 and used for transplanting one month after sowing.

3.5.2 Preparation of main field

Open field was selected adjacent to rain shelter. Pots were arranged in both the growing conditions, at a spacing of 60 cm filled with potting mixture containing sand, soil and FYM in the ratio of 1:1:1.

3.5.3 Transplanting

Thirty days old seedlings were transplanted in pots kept under rain shelter as well as open field on the same day. Irrigation was given immediately after

Plate I. General view of rain shelter

transplanting using a rose can. Shading provided using green leaved twigs and it was removed after three days. The gap filling was done within ten days after transplanting.

3.5.4 Fertilizers and its application

Urea, super phosphate and muriate of potash were the source material for supplying the nutrients N, P_2O_5 and K_2O respectively. These nutrients were mixed based on recommendation of 75:45:25 kg/ha (KAU, 1996) and it was applied at the rate of 15 g/pot/application. The fertilizer mixture was applied as split doses half as basal and remaining as four top dressings at 15 days intervals from the date of transplanting for effective utilization of nutrients.

3.5.5 After cultivation

The pots and nearby areas were kept free of weed through out the crop growth period by hand weeding.

3.5.6 Staking

Staking was done by using wooden sticks and tied with jute thread to avoid lodging.

3.5.7 Plant protection

Damping-off of seedlings was controlled by the application of Dithane M-45 @ 2 g/lit as drenching in the nursery as well as in the main field. Dithane and Akomin were applied as prophylactic measure. Fytolan @ 2.5 g/lit soil drenched for the control of bacterial wilt. Imidachloprid @ 0.4 ml/lit of water and cypermethrin 2.5 ml/lit of water were sprayed against sucking insects and fruit borers (*Spodoptera litura*).

3.5.8 Harvesting

Fruits were harvested at full size and before the colour changes from green to red. Harvested fruits were subjected to further observations.

3.6 OBSERVATIONS

Sixteen plants per variety were raised under both the conditions as four replications containing four plants per replication were utilized for taking observations for the following characters Five well-developed fruits were randomly selected from each plant for recording observation on fruit characters.

3.6.1 Vegetative characters

3.6.1.1 Plant height (cm)

Heights of the plants were measured for both the seasons. Plant height was measured at 15 days intervals starting from 15 days after planting for kharif season crop. This was measured from the collar region of the plant to the tip, expressed in cm, and used for correlation purpose with weather parameters.

3.6.1.2 Branches per plant

Number of primary and secondary branches was measured for both the seasons. The number of all branches at 15 days interval was also taken for kharif season crop, and it was used for the correlation purpose with weather parameters.

3.6.1.3 Relative Growth Rate (RGR)

RGR expresses the dry weight increase in a time interval in relation to the initial weight and is expressed as g^{-1} day^{-1}. The RGR was calculated by using following formulae given by Blackman (1919).

$$L_n W_2 - W_1$$

$$RGR = \frac{}{T_2 - T_1}$$

Where,

L_n = logarithm to the base 'e' (Naperian constant)

W_2 and W_1 = Total plant dry weights at time T_2 and T_1 respectively.

3.6.2 Reproductive characters

3.6.2.1 Days to first flowering

The number of days from transplanting to first flowering was observed and recorded.

3.6.2.2 Days to first harvest

The number of days to first harvest from transplanting to first harvest was recorded and used for analysis.

3.6.2.3 Number of fruits per plant

The total number of fruits per plant was counted at each harvest for all the selected plants and the mean number was worked out.

3.6.2.4 Yield per plant

Fruit yield per plant was calculated by adding yields of individual harvest and expressed in grams.

3.6.2.5 Fruit Characters

Five fruits per replication were randomly selected from the second harvest onwards and used for the observation on fruit length, fruit girth and number seeds per fruit.

3.6.2.6 Number of harvests

The total number of harvests made from first to last harvest was recorded as number of harvests.

3.6.3 Meteorological observations

The minimum and maximum temperature was observed daily using thermometer and relative humidity using whirling hygrometer in both the conditions. Once in a week, light intensity was also measured both in the inside and outside using lux meter. The details of the meteorological observations for this period are presented in the Appendix.

3.7 INCIDENCE OF PEST AND DISEASES

Incidence of pest and diseases was observed under both the conditions and appropriate control measures were taken and recorded.

3.8 ECONOMICS OF CAPSICUM PRODUCTION UNDER RAIN SHELTER AND OPEN FIELD

Economics of capsicum production was worked out for the rain shelter crop and open field separately, in terms of total expenditure give due appreciation for recycling materials like pots and structure. Total return was estimated with realized yield. The B/C ratios were found under the situations for comparison.

3.9 STATISTICAL ANALYSIS

The data recorded on the vegetative and reproductive characters and meteorological observations were statistically analysed by using the statistical

package (MSTATC) (Freed, 1986). Simple correlations between the growth (plant height, number of branches and RGR) characters with the weekly mean values of maximum temperature, minimum temperature, relative humidity and light intensity during the crop period to determine the effect of weather elements on the growth and yield of capsicum.

Results

4. RESULTS

The observations recorded were analysed statistically and the results obtained are presented in this chapter under the following titles.

4.1 Vegetative characters

4.2 Reproductive characters

4.3 Crop weather relationship

4.4 Incidence of pests and diseases

4.5 Economics of capsicum production under rain shelter and open field conditions

4.1 VEGETATIVE CHARACTERS

4.1.1 Plant height

The data recorded on plant height are presented in Table 2. The plant height was more under rain shelter condition during both the seasons. Crops under rain shelter recorded 44.88 cm and 52.86 cm height during rabi and kharif season respectively, against 33.84 and 45.32 in the open field condition.

Among the varieties CA 567 performed well and recorded a maximum height of 58.81 cm and 62.13 cm during rabi and kharif season respectively under rain shelter. In the open field condition the height was 47.50 cm and 61.55 cm during rabi and kharif season respectively. This variety performed almost equals under rain shelter and open field conditions with regard to plant height during kharif. CA 776 (Plate II.) recorded a height of 49.68 and 40.15 cm under rain shelter during rabi and kharif seasons against 40.75 and 38.05 cm under open field condition.

Table 2. Height (cm) of the plant under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	49.68	40.98	45.33	40.15	38.05	39.10
Yolo Wonder	42.62	31.93	37.28	49.45	32.35	40.90
Pusa Deepthi	39.69	23.93	31.81	61.5	50.05	55.78
CA 567	58.81	47.50	53.16	62.13	61.55	61.84
California Wonder	33.56	24.88	29.21	53.05	42.60	47.83
Mean	44.88	33.84	-	52.86	45.32	-
CD (1)			5.73			3.72
(2)			4.76			7.95
(1) X (2)			NS			NS

CD (1) for the comparison of conditions

CD (2) for the comparison of varieties

CD (1 X 2) for the comparison of varieties within the condition.

Plate II. Performance of CA 776
A. Under rain shelter during rabi C. Under rain shelter during kharif
B. Under open field during rabi D. Under open field during kharif

Pusa Deepthi performed much better in the kharif season compared to rabi season recording height of 61.5 and 50.05 cm during kharif season under rain shelter and open field condition respectively against 39.69 and 23.94 cm during rabi season under rain shelter and open field condition respectively.

The height was lowest in California Wonder during rabi season, which recorded 33.5 cm and 24.87 cm under rain shelter and open field condition respectively. But during kharif season the lowest height recorded in Yolo Wonder (Plate III) was 49.4 and 32.35 cm under rain shelter and open field condition respectively.

4.1.2 Number of branches

The data presented in the Table 3 indicate that the crops grown under rain shelter recorded the maximum number of branches during rabi and kharif season. It was 19.93 and 12.78 against 12.56 and 10.26 under open field condition. Pusa Deepthi had 13.94 and 12.35 branches under rain shelter condition and 10.37 and 8.56 under open field condition during kharif and rabi season respectively.

California Wonder recorded 10.06 branches under rain shelter and 6.06 branches under open field condition with poor performances during rabi season, but during kharif season Yolo Wonder recorded the minimum value under both the conditions. The number of branches under rain shelter was 8.054 and 4.99 under the open field conditions.

4.2 REPRODUCTIVE CHARACTERS

4.2.1 Days to first flowering

The number of days taken for first flowering was recorded and presented in the Table 4. Earliest flowering was observed in rain shelter grown crop, which

Table 3. Number of branches per plant under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	10.68 (3.33#)	14.69 (3.70#)	12.69 (3.59#)	8.45	7.43	7.74
Yolo Wonder	12.13 (3.54#)	8.69 (3.07#)	10.53 (3.31#)	8.06	4.99	6.73
Pusa Deepthi	13.94 (3.76#)	10.38 (3.29#)	12.16 (3.52#)	12.35	8.57	10.46
CA 567	19.94 (4.52#)	12.56 (3.61#)	16.25 (4.06#)	12.78	10.26	11.03
California Wonder	10.06 (3.25#)	6.06 (2.56#)	8.06 (2.90#)	10.70	7.79	9.25
Mean	13.35 (3.68#)	10.52 (5.53#)	-	10.27	7.81	-
CD (1)			0.37			1.67
(2)			0.56			2.22
(1) X (2)			NS			NS

Figures in the parentheses are transformed values ($\sqrt{x}+1/2$ transformation)

Plate III. Performance of Yolo Wonder
A. Under rain shelter during rabi C. Under rain shelter during kharif
B. Under open field during rabi D. Under open field during kharif

was 28.06 days after transplanting during rabi and 32.47 days during kharif season against 33.47 and 34.03 days under open field conditions.

CA 567 grown under rain shelter was very earlier in flowering and took only 25.81 and 28.93 days during rabi and kharif reason respectively against 26.62 and 29.85 under open field condition. Pusa Deepthi flowered 27.50 and 29.27 days after transplanting under rain shelter and 39.5 and 29.95 days after transplanting under open field condition during rabi and kharif season respectively. The variety Yolo Wonder was late in flowering with 36.63 days and 39.63 days under rain shelter and open field conditions respectively during rabi season. But during kharif season the variety CA 776 required 36.0 and 39.30 days under rain shelter and open field conditions respectively.

4.2.2 Days to first harvest

The data on days to first harvest are presented in Table 5. In rabi season rain shelter crop recorded a mean of 68.74 days against 79.4 days for open field crop for the first harvest. Similarly in kharif season rain shelter crop recorded 60.42 days and open field crop recorded 63.97 days.

The first harvest obtained from Pusa Deepthi after 58.0 and 58.80 days of planting under rain shelter condition against 88.0 and 57.13 days under open field condition during rabi and kharif season respectively. The next best was CA 567 during rabi season, which recorded 62.50 and 68.63 days under rain shelter and open field condition. But during kharif season the earliest harvest next to Pusa Deepthi was obtained from California Wonder, which recorded 58.8 and 68.39 days under rain shelter and open field conditions. Among the five varieties California Wonder was the late performer (92 and 108 days under rain shelter and open field condition respectively) during rabi season, but during kharif season Yolo Wonder recorded a maximum of 62.7 and 70.75 days under rain shelter and

Table 4. Days to first flowering under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	21.88	28.25	25.06	36.00	39.30	37.65
Yolo Wonder	36.63	39.56	37.18	35.00	36.25	35.95
Pusa Deepthi	27.50	39.00	33.53	29.28	29.95	29.08
CA 567	25.81	26.63	26.22	28.93	29.85	28.93
California Wonder	28.50	32.25	30.37	33.50	35.80	34.65
Mean	28.06	33.14	-	32.47	34.03	-
CD (1)			2.72			NS
(2)			3.11			2.21
(1) X (2)			4.41			NS

Table .5 Days to first harvest under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	62.76	64.94	63.75	62.35	64.45	63.58
Yolo Wonder	68.44	69.00	68.72	62.70	70.75	66.55
Pusa Deepthi	58.00	88.00	41.50	58.80	59.13	58.46
CA 567	62.50	68.63	65.66	59.45	58.15	58.80
California Wonder	92.00	108.00	100.00	58.80	68.39	63.59
Mean	68.74	79.40	-	60.42	63.97	-
CD (1)			1.86			1.79
(2)			2.01			1.59
(1) X (2)			2.85			NS

open field conditions. The kharif season crop was earlier (62.20days) when compared to rabi season crop (67.93 days).

4.2.3 Number of fruits per plant

The data on number of fruits per plant are presented in the Table 6. The higher mean of 16.67 fruits per plant was recorded by crops grown in rain shelter condition during rabi season, but it was only 5.58 in open field condition during the same season. In kharif season, rain shelter crops produced 8.49 number of fruits per plant and 5.67 from open field crops.

The variety CA 776 recorded 36.31 and 12.72 fruits under rain shelter and open field conditions during rabi season, but during the kharif season the better performer was CA 567, which gave 22.30 and 17.05 fruits under rain shelter and open field conditions. CA 567 also performed well during rabi season and recorded a mean number of 19.75 and 10.43 fruits per plant under rain shelter and open field crops respectively. Based on the kharif season performance the best performance next to CA 567 was Pusa Deepthi (Plate IV), which recorded 7.20 under rain shelter and 5.21 under open field conditions. Yolo Wonder was the over all poor, which produced only 9.63 and 1.0 fruits under rain shelter and open field conditions respectively during rabi season and 2.863 and 1.175 during kharif season.

4.2.4 Mean fruit weight

The data on this trait are presented in Table 7. Kharif season crop under rain shelter produced largest fruits weighing 35.57 g against 22.51 g under open field condition, while the rabi season produced small fruits weighing 20.66 g and 8.27 g under rain shelter and open field condition respectively.

Table 6. Total number of fruits per plant under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	36.31 (5.98#)	12.72 (3.64#)	24.51	5.38	3.13	4.25
Yolo Wonder	9.63 (3.14#)	1.00 (1.14#)	5.32	2.86	1.17	2.02
Pusa Deepthi	6.25 (2.76#)	1.50 (0.93#)	3.88	7.20	5.21	6.21
CA 567	19.75 (4.50#)	10.44 (3.29#)	15.09	22.30	17.05	19.68
California Wonder	10.38 (3.93#)	3.25 (1.93#)	6.81	4.70	1.76	3.23
Mean	16.67 (3.9#3)	5.58 (2.19#)	-	8.49	5.67	-
CD (1)			0.38			1.77
(2)			0.53			1.98
(1) X (2)			0.76			NS

Table 7. Mean fruit weight (g) under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	20.26	11.81	16.33	26.73	19.48	29.10
Yolo Wonder	30.68	8.60	19.64	53.10	22.53	37.81
Pusa Deepthi	33.43	10.30	21.86	41.80	33.80	37.80
CA 567	9.25	8.27	8.76	16.48	12.23	14.35
California Wonder	9.69	8.14	8.91	39.78	24.52	32.15
Mean	20.66	8.27	-	35.57	22.51	-
CD (1)			3.09			6.86
(2)			4.14			6.88
(1) X (2)			5.86			9.73

Plate IV. Performance of Pusa Deepthi
A. Under rain shelter during rabi C. Under rain shelter during kharif
B. Under open field during rabi D. Under open field during kharif

The hybrid Pusa Deepthi recorded highest mean weight of 33.43 g under rain shelter and 10.3 g under open field conditions during rabi season. But during kharif season Yolo Wonder produced larger fruits weighing 53.10 g and 22.52 g under rain shelter and open field conditions. The variety CA 567 (Plate V) had lowest fruit weight of @ 9.15 g and 7.17 g during rabi season and 16.22 and 12.23 during kharif season under rain shelter and open field conditions respectively.

4.2.5 Fruit yield per plant

The observations on fruit yield per plant are presented in the Table 8. The crops grown under rain shelter yielded more during both the season @ 236.27 g and 158.36 g in rabi and kharif season respectively, whereas 48.31 g and 82.48 g during rabi and kharif season respectively under open field condition.

The variety CA 567 showed significant difference with maximum yield per plant of 318.50 g in rabi and 228.17g in kharif seasons under rain shelter condition and 125.75 g and 157.40 g during rabi and kharif season respectively under open field condition. CA 776 was the best suitable variety for rabi season and recorded the maximum yield of 331.93 g under rain shelter and 77.659 under open field. But during kharif season the hybrid Pusa Deepthi produced maximum means next to CA 567 yielding 206.10 g and 127.45 g under rain shelter and open field respectively. California wonder (Plate VI) had the lowest mean value of 105.37 g and 129.05 g during rabi and kharif seasons respectively under rain shelter and 17.50 g and 26.58 g in rabi and kharif seasons respectively under open field condition.

4.2.6 Number of seeds per fruit

The data on this character are presented in Table 9. Rain shelter crops were better with the greater mean of 135.95 and 129.77 seeds in rabi and kharif season

Table 8.Fruit yield (g) per plant under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	331.93 (18.10#)	77.65 (8.74#)	204.79 (13.42#)	87.52	40.99	64.24
Yolo Wonder	231.50 (14.96#)	14.50 (3.45#)	123.00 (9.23#)	140.90	60.06	100.48
Pusa Deepthi	194.00 (13.62#)	16.13 (1.78#)	100.06 (7.70#)	206.10	127.45	166.78
CA 567	318.500 (17.83#)	125.75 (11.16#)	222.13 (14.4#9)	228.18	157.40	192.79
California Wonder	105.38 (10.22#)	17.50 (4.21#)	61.44 (7.2#2)	129.05	26.58	77.81
Mean	236.26 (14.95#)	48.305 (5.38#)	-	158.35	82.49	-
CD (1)			1.68			30.99
(2)			2.19			40.18
(1) X (2)			3.11			NS

Plate V. Performance of CA 567
A. Under rain shelter during rabi C. Under rain shelter during kharif
B. Under open field during rabi D. Under open field during kharif

Plate VI. Performance of California Wonder
A. Under rain shelter during kharif B.Under open field during kharif

respectively compared to 76.75 in rabi and 94.69 seeds per fruit in kharif under open field conditions.

The variety CA 567 evinced the highest number of 151.13 in rain shelter and 101.63 in open field condition during rabi season. During kharif season Yolo Wonder produced a maximum mean of 146.00 under rain shelter while it was 83.13 under open field condition. The second best mean obtained during rabi season from CA 776 was 146.56 and 124.00 under rain shelter and open field conditions respectively, during kharif it gave 129.70 and 100.25 seeds under rain shelter and open field conditions respectively. The variety California Wonder recorded the lowest mean value of 110.63 and 111.55 seeds during rabi and kharif season respectively under rain shelter condition, while it was only 87.63 and 90.00 seeds during rabi and kharif seasons respectively under open field condition.

4.2.7 Mean fruit length

The data on this trait are presented in Table 10. Rain shelter crops exhibited the mean length of 5.64 cm and 5.56 cm during rabi season and kharif season while the corresponding values were 3.96 cm and 4.78 cm under open field conditions.

The variety CA 567 had a fruit length of 6.71 cm and 7.45 cm under rain shelter, but it gave the mean of 5.89 in rabi and 6.9 cm in kharif under open field conditions. The hybrid Pusa Deepthi had a mean length of 6.31 cm and 6.82 cm under rain shelter during rabi and kharif season respectively as against 4.02 cm and 6.50 cm during rabi and kharif season respectively under open field condition. Fruit length was very low from Yolo Wonder during rabi season @ 4.43 and 3.68 cm under rain shelter and open field condition respectively. But during kharif season the poor response was from CA 776, which gave the mean value of 4.08 and 2.98 cm under rain shelter and open field condition respectively.

Table 9.Number of seeds per fruit under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open Field	Mean
CA 776	146.56	124.00	135.25	129.70	100.25	114.98
Yolo Wonder	139.75	34.00	69.88	146.00	83.13	114.56
Pusa Deepthi	131.76	56.37	75.56	120.25	100.90	120.58
CA 567	151.13	101.88	116.81	141.55	99.18	110.26
California Wonder	110.63	87.63	109.13	111.55	90.00	100.78
Mean	135.95	76.75	-	129.77	94.69	-
CD (1)			15.99			15.01
(2)			19.88			NS
(1) X (2)			28.11			NS

Table 10.Fruit length (cm) under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	4.59	3.77	4.18	4.08	2.99	3.54
Yolo Wonder	4.43	3.68	4.01	5.26	3.96	4.61
Pusa Deepthi	6.31	4.02	5.15	6.82	6.50	6.66
CA 567	6.71	5.89	5.99	7.45	6.90	7.18
California Wonder	6.18	4.34	5.56	4.19	3.57	3.88
Mean	5.64	3.96		5.56	4.78	-
CD (1)			0.63			0.26
(2)			1.03			0.52
(1) X (2)			0.45			NS

4.2.8 Mean fruit girth

The data recorded on fruit girth is presented in Table 10. Mean fruit girth was found to be more under rain shelter condition compared to open condition during both the seasons. Crop under rain shelter recorded the maximum mean girth of 11.40 cm in rabi season against 7.33 cm under open field condition. In kharif season the highest mean of13.49 cm was recorded for crops grown under rain shelter condition while it was only 12.04 in open filed crops.

The hybrid Pusa Deepthi showed significant difference with higher mean girth of 14.65 during rabi season under rain shelter but it was only 4.98 under open field condition. During kharif season the same hybrid gave the mean girth of 14.49 and 13.18 cm under rain shelter and open field conditions. Yolo Wonder produced higher mean girth during kharif season was 16.53 under rain shelter and 13.425 under open field condition, but during rabi season the value was 13.30 and 5.20 under rain shelter and open field conditions respectively. The variety CA 567 had lowest mean girth of 8.83 and 9.72 cm under rain shelter during rabi and kharif season respectively and 8.62 and 9.73 in open field condition during rabi and kharif season respectively.

4.2.9. Number of harvest

The data on number of harvest are presented in table 11. More number of harvest (mean of 3.27 and 2.26) was recorded by crops grown in rain shelter condition during kharif and rabi season respectively. In open field condition the crops gave a mean value of 1.65 during rabi and kharif season.

In rain shelter condition, the number of harvest was more in variety CA 567 viz., 4.57 and 3.25 during kharif and rabi season respectively as compared to 3.37 rabi season and 2.35 in kharif season under open field condition. The variety CA 776 gave 3.88 rain shelter and 2.90 harvests under open field condition during rabi

Table 11.Fruit girth (cm) under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain Shelter	Open Field	Mean
CA 776	12.32	10.39	11.36	11.01	11.03	11.01
Yolo Wonder	13.30	5.20	9.25	16.53	13.43	14.98
Pusa Deepthi	14.65	4.98	9.82	14.49	13.18	13.84
CA 567	8.39	8.62	8.73	9.73	9.73	9.73
California Wonder	7.93	7.45	7.67	15.73	15.73	14.29
Mean	11.41	7.33	-	13.48	13.50	-
CD (1)			0.27			0.64
(2)			0.96			1.08
(1) X (2)			1.36			1.53

Table 12. Number of harvests under different seasons and growing conditions

Varieties	Rabi season			Kharif season		
	Rain shelter	Open field	Mean	Rain shelter	Open field	Mean
CA 776	3.88 (2.09#)	2.895 (1.84#)	3.39 (1.96#)	1.93	1.20	1.56
Yolo Wonder	2.45 (1.71#)	0.25 (0.84#)	1.35 (1.27#)	1.45	1.05	1.25
Pusa Deepthi	2.33 (1.67#)	3.38 (1.97#)	1.29 (1.25#)	3.00	2.45	2.73
CA 567	4.56 (2.25#)	3.38 (1.97#)	3.97 (2.11#)	3.25	2.35	2.800
California Wonder	3.13 (1.19#)	1.50 (1.32#)	2.31 (1.60#)	1.65	1.20	1.43
Mean	3.27 (1.92#)	1.65 (1.36#)	-	2.25	1.65	-
CD (1) (2) (i) X (2)			0.14 0.29 0.40			0.33 0.32 NS

season but it was only 1.93 in rain shelter and 1.20 in open field during kharif season. The hybrid Pusa Deepthi gave a mean harvest of 3.0 and 2.45 during kharif season under rain shelter and open field conditions respectively. The poor performance during both the seasons from Yolo wonder gave the mean harvest of 2.45 and 0.19 during rabi season and 1.45 and 1.05 during kharif season under rain shelter and open filed condition respectively.

4.3 CROP WEATHER RELATIONSHIP

Weather parameters did not show much influence on plant growth characters like plant height, number of branches and relative growth rate (RGR). The main weather parameters observed and correlated with the plant characters were maximum and minimum temperature, morning and evening relative humidity and light intensity. RGR during Kharif showed significant positive correlation (r=0.71) but it was negatively correlated with RGR during rabi.

4.4 INCIDENCE OF PEST AND DISEASES.

There was much difference in the incidence of insects and diseases, under rain shelter and open filed conditions. Some insects and diseases were severe under rain shelter but less under open field and vice versa (The observed pests and diseases are presented in the Table 13).

4.5 COST ECONOMICS OF CAPSICUM PRODUCTION UNDER RAIN SHELTER AND OPEN FIELD.

Success of any new technology is mainly depends on how it is economically feasible. Economics of production is very important in the farmer and consumer point of view. Economics worked out for capsicum production under rain shelter and open field are presented in Table 15.

The realized yield showed the B/C ratio of 1: 0.51 for crop grown under rain shelter condition and 1: 0.15 under open field. B/C ratio for rain shelter crop was

Table 13.Correlation co-efficient between plant characters of capsicum and weather parameters

Weather parameters		Plant height	Number of branches	RGR in Kharif	RGR in Rabi
Temperature	Minimum	0.37	0.35	0.71*	-0.07
	Maximum	0.38	0.25	0.25	-0.14
Relative Humidity	Morning	0.16	-0.02	0.01	-0.16
	Eveninig	0.22	0.062	-0.19	-0.09
Light Intensity		0.07	0.31	0.35	-0.12

* Significant at 1% level

Table 14. Pests and disease incidence during cropping period

Sl. No.	Pest	Rain shelter	Open field
1.	Thrips	Severe	Less incidence
2.	Mites	Very severe	Less incidence
3.	Fruit borer	Mild incidence	Mild incidence
4.	Root grubs	Mild incidence	Mild incidence
5.	Damping off	Mild incidence	Less incidence
6.	Bacterial wilt	Less incidence	Severe incidence
7.	Leaf blight	Mild incidence	Severe incidence
8.	Anthracnose	Mild incidence	Severe incidence

Table 15. Economics of Capsicum production

1. Rain shelter area : 40 m^2 (8 m x 4 m)
2. Frame work : GI pipes
3. Roof cladding : UV stabilised film
4. Crop : Capsicum (Bell pepper)

Sl. No.	Particulars	Rain shelter	Open field
1	Fixed cost		
	a. Cost of structure (excluding cladding material)	8000/-	-
	b. Life of structure (in seasons)	20 years	-
	c. Depreciation (a/b)	400/-	-
	d. Cost of cladding material (in seasons)	1100/-	-
	e. Life of cladding material (in seasons)	5 years	-
	f. Depreciation (d/e)	220/-	-
	g. Cost of pots (Rs 10/pot)	800/-	-
	h. Life of pots (4 seasons)	4 seasons	3 seasons
	i. Depreciation (g/h)	200/-	267/-
2.	Interest cost per season (a+d+g) X18 % / number of seasons	356/-	36/-
3.	Total operational cost/season /Sq. m (1c+ 1f +1i + 2)	29/-	8/-
4.	Cost of cultivation/sq. m. including labour*	45/-	45/-
5.	Total cost of cultivation/sq. m. (3+4)	74/-	53/-
6.	Yield of produce (Kg/sq. m.)	944 g	188g
7.	Revenue (Rs. 40/kg)	38/-	8/-
8.	B/C ratio	1: 0.51	1: 0.15

* Note : 75 % of the cost of cultivation is accounted by labour.

nearly four times higher than open field crop. The 75 per cent of total cost of cultivation incurred by labour.

Discussion

5. DISCUSSION

Climate decides crop selection while weather decides crop production and productivity. Crop production depends on the chain of factors Viz. genotype, soil, weather, technology and the farmer. Any weak link in the chain of factors will decide the final crop out put (Rao et al., 2002).

Kerala enjoys a warm humid tropical climate. High monsoon rainfall from June to September followed by moderate to severe dry spell is the characteristic feature of the humid tropics. The average annual rainfall is as high as 300 cm distributed over the monsoons. Due to intense rainfall, temperature is positively low, but humidity is very high up to 80 to 90 % during rainy season.

Of the vegetable production within the state about 80% is produced in summer as fallow cultivation. Quite a good number of people involves in summer cultivation of vegetable for their livelihood. But during intense rain fall period vegetable production is minimum. Hence it can be logically assumed that heavy rainfall is one of the major limiting factors for growing vegetables in Kerala during monsoon.

Protected cultivation of vegetables in rain shelter provides ample scope for enhancement of vegetable production by facilitating off-season cultivation in Kerala. *Capsicum is a choice vegetable fetching premium price.* The climatic requirements of capsicum make it a difficult crop to be grown under the warm humid tropical situation especially in the midlands of Kerala.

During rainy season the temperature is low and cloudy days mimics short day condition which set necessary background for rain shelter cultivation of capsicum even in the plains of Kerala.

The present study was intended to study the performance of five different varieties of capsicum under rain shelter and open field conditions during rabi and Kharif seasons. The results obtained in this study are discussed here under

5.1 PERFORMANCE OF CAPSICUM INFLUENCED BY DIFFERENT GROWING CONDITION AND SEASONS:

5.1.1 Vegetative Characters:

In capsicum, growth is a genetic character largely influenced by growing conditions and seasons. In the present investigations though the temperature was high in rain shelter plant height was also high (Table 2) (Fig 1 &2). Similar result was reported by El-Aidy etal (1988). Plant height is a function of number of nodes and length of each internode, and both are strongly influenced by greenhouse temperatures. Node number or formation rate is primarily a function of the average greenhouse temperature increasing as the average temperature increases (Berghage, 1998).

In pepper, the vegetative growth and development depend mainly on the 24-hour mean temperature while the effect of the day/night amplitude is of minor importance (Bakker and Van-Uffelen, 1988).

The plant height was higher inside the rain shelter, which was not only influenced by temperature but also by light intensity. The intensity was nearly 25-30% less than the open field under rain shelter, which played a greater role in plant height. Similar results were obtained by Lara et al., (1999) and Bhatt et al., (1999). Shading the plants increased the cell division and cell expansion (Schoch, 1972).

Under the dark (or low light intensity) condition the auxin concentration is more compared to high light intensity condition. Increase in auxin concentration

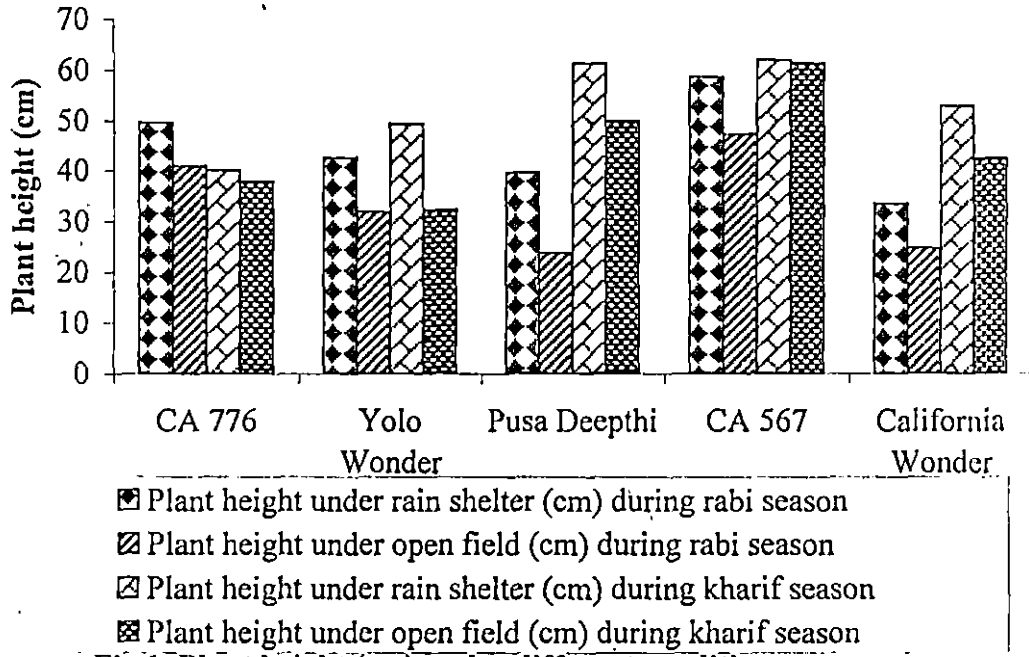

Fig.1. Plant height (cm) under different conditions during different seasons

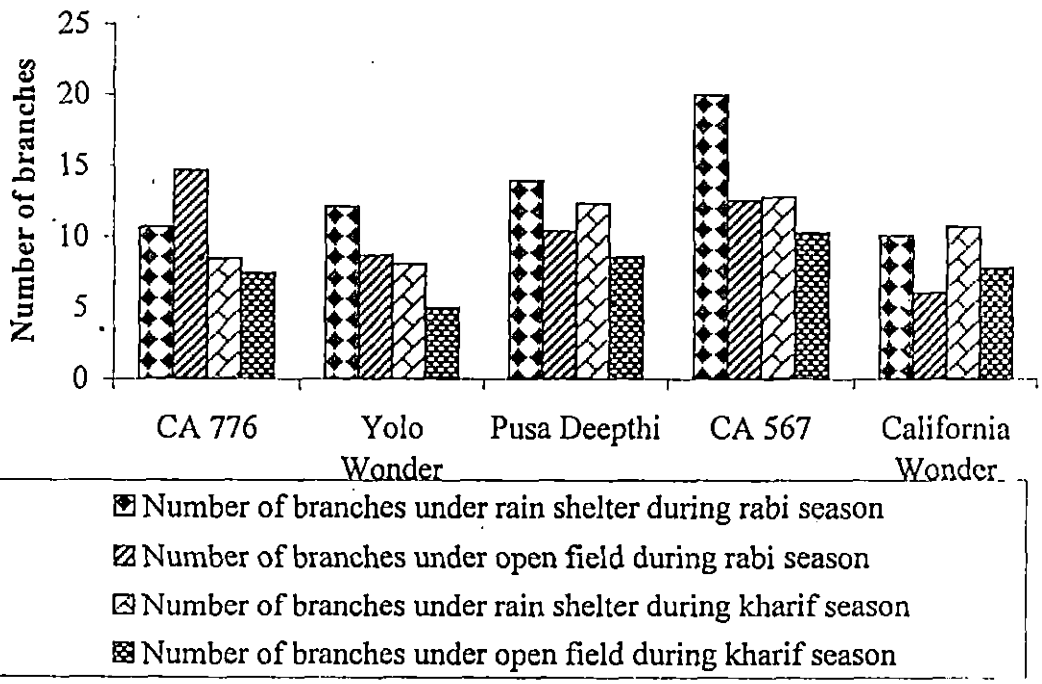

Fig. 2. Number of branches under different conditions during different seasons

results in increasing plant height because of apical dominance. Apical dominance along with increased rate of cell division and cell enlargement greatly influences plant height.

Relative humidity inside rain shelter was (3 to 5 percent) higher compared to open field. Increase in RH level decreases the water loss by the process of transpiration and evaporation. Thereby plants can utilize the water efficiently for cell division and cell enlargement and attained higher growth.

As like that of condition, different season also influences plant height. Kharif season crops showed more plant height than the rabi season crops. This might be due to the difference in the climatic factors like higher temperature etc. during kharif season. During both the seasons, the plant height was higher inside the rain shelter than outside.

Number of branches was greatly influenced by growing conditions, plants grown under rain shelter had more number of branches. Increase in temperature increases node number, which increases the formation of new branches (Berghage, 1998).

Increase in relative humidity level influenced positively the number of branches. Shinde et al., (1999) reported that micro irrigation with sugarcane trash mulch increased the RH level there by plant height and number of branches was increased. Nagalakshmi et al., (2001) reported that the poly house grown crops produced plants with more height, branches etc. than open field capsicum crops.

5.2 REPRODUCTIVE CHARACTERS

The rain shelter crop flowered earlier than open field crop. It might be due to hormonal activity and balance. Though capsicum is a day neutral plant, growing condition had some influence on flowering. Protected crop flowered

earlier because of reduced light intensity and higher temperature. Less light intensity (mimics short day) might be helpful to increase the anthesin concentration and well balanced with GA and influenced early flowering. The same principle can be applied to season too. The rabi season crops flowered earlier when compared to kharif season crops. Early flowering and fruiting was also reported by Jankulovski etal (1995) in capsicum.

Temperature affects pepper flowering, fruit set and fruit growth. Bakker (1989) found that low mean temperature significantly delayed flowering in sweet pepper. Under the rain shelter condition the temperature was higher than the open field condition, this might played a role in early flowering.

The first harvest was obtained from rain shelter crops during Kharif and Rabi seasons. This can be substantiated with increase in temperature. High temperature accelerates fruit development and reduces the time required for ripening (Koshitan and Ormrod, 1972). Temperature may influence the distribution of photo assimilates between fruit and vegetative parts as their rate of growth (Heuvelink, 1995 and Dekoning, 1996).

High temperature favours the distribution of the assimilates to fruit, at the expense of vegetative growth (Dekoning, 1989b). Sink strength and photo assimilates import into fruit increases with temperature (Ho and Hewitt, 1986).

The higher light intensity and temperature during Kharif season made earliest harvest than Rabi season under both the condition. These two factors influences synthesis of photo assimilates and transportation into reproductive parts.

5.3 FRUIT YIELD AND FRUIT CHARACTER

Number of fruits per plant and mean fruit weight contributes to total yield (Fig. 3 &4). During both the seasons, higher yield was obtained from rain shelter condition (Fig. 5&6).

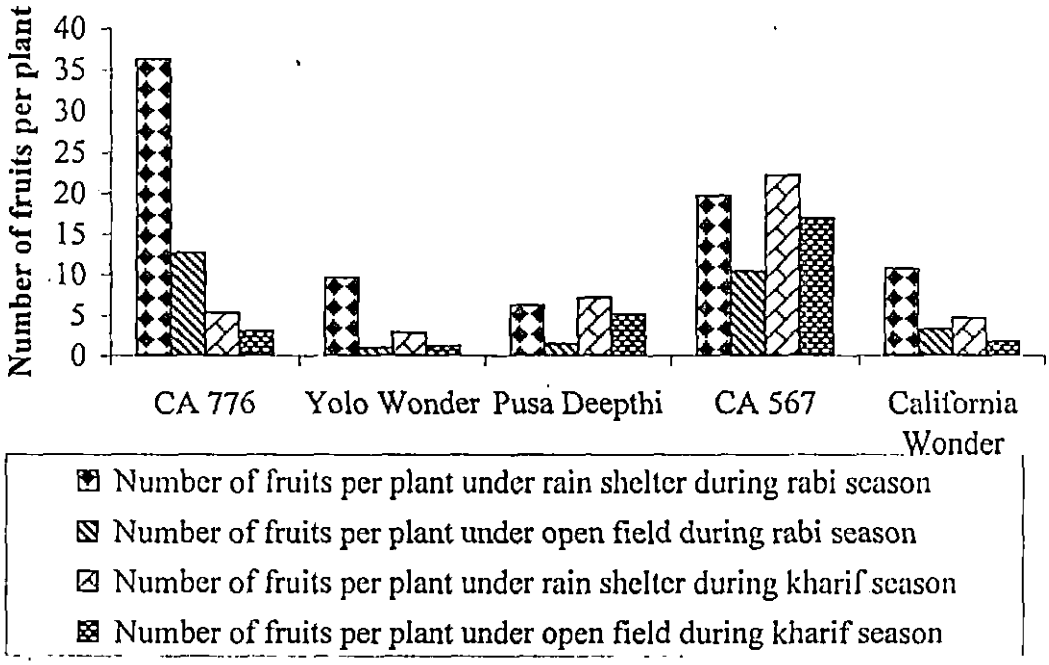

Fig. 3. Number of fruits per plant under different conditions during different seasons

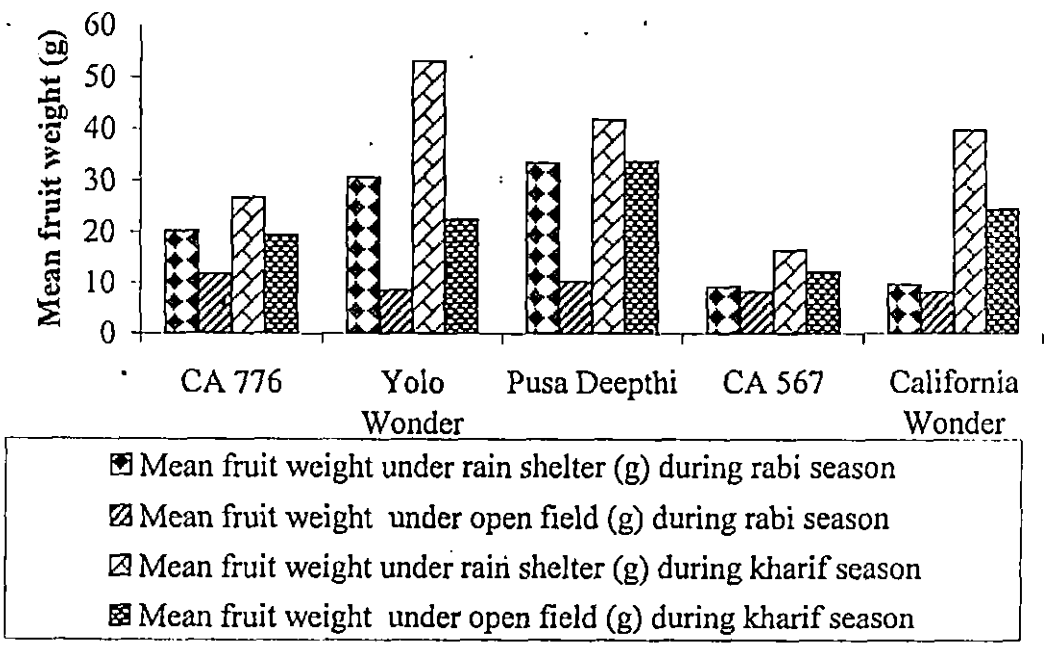

Fig.4. Mean fruit weight (g) under different conditions during different seasons

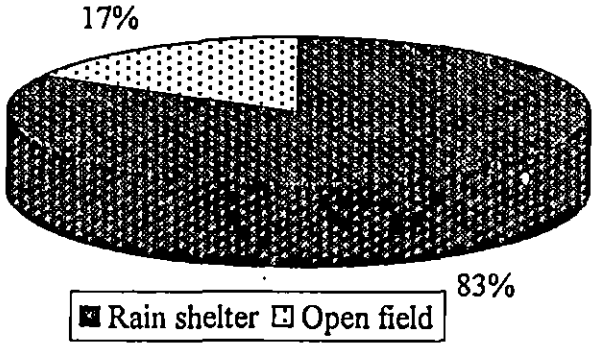

Fig. 5. Fruit yield (%) under different conditions during rabi season

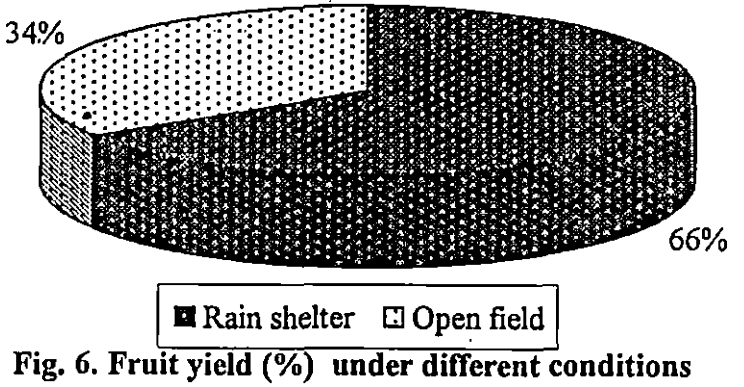

Fig. 6. Fruit yield (%) under different conditions during kharif season

During rabi season the yield showed five fold increase inside than outside, but during kharif it was only double than outside crop (Fig 7&8). The Kharif season yield was only half of the rabi season yield both in open and rain shelter condition. Insect pests especially mite incidence was more severe on kharif crop under rain shelter condition than open field and hence reduced the yield. Capsicums are known to perform better in rabi season and when grown in summer, yields are very low due to poor crop growth and fruit set and also severe diseases (Deshpande, 2001).

The yield inside was more because of more number of fruit with high mean fruit weight. The total number of flower was significantly related to 24 hour mean temperature as well as day and night temperature amplitude. At high temperature more flowers are formed and fruit growth is enhanced implying high assimilation demand (Schapendonk and Brouwer, 1984). The net result of these responses is that temperature strongly affects the mean fruit weight as well as the yield of high quality fruits (Bakker and Van uffelen,1988, Bakker, 1989).

Extremely low humidity can lead to high transpiration and reduced photosynthetic rates. High humidity is considered more important in greenhouses, which has a significant impact on the energy balance of crops. Elevated humidity suppresses crop transpiration, a process that converts a major fraction of incoming solar radiation into heat (Stanghellini, 1987). Decreasing this fraction temporarily results in high leaf temperatures (Bakker, 1995). Low humidity has also been reported to cause reduction in fruit growth rates.

Fruit length, girth along with number of seeds decides fruit size, shape and quality (Plate VII.). Fruit weight, length, girth and number of seeds per fruit were higher inside than outside during both the seasons. Fruit length and girth was more during kharif season compared to rabi season that is why the kharif season fruits were larger. But the number of seeds was higher during the rabi season. Fruit weight, length, girth, pericarp thickness and number of seeds per fruit where

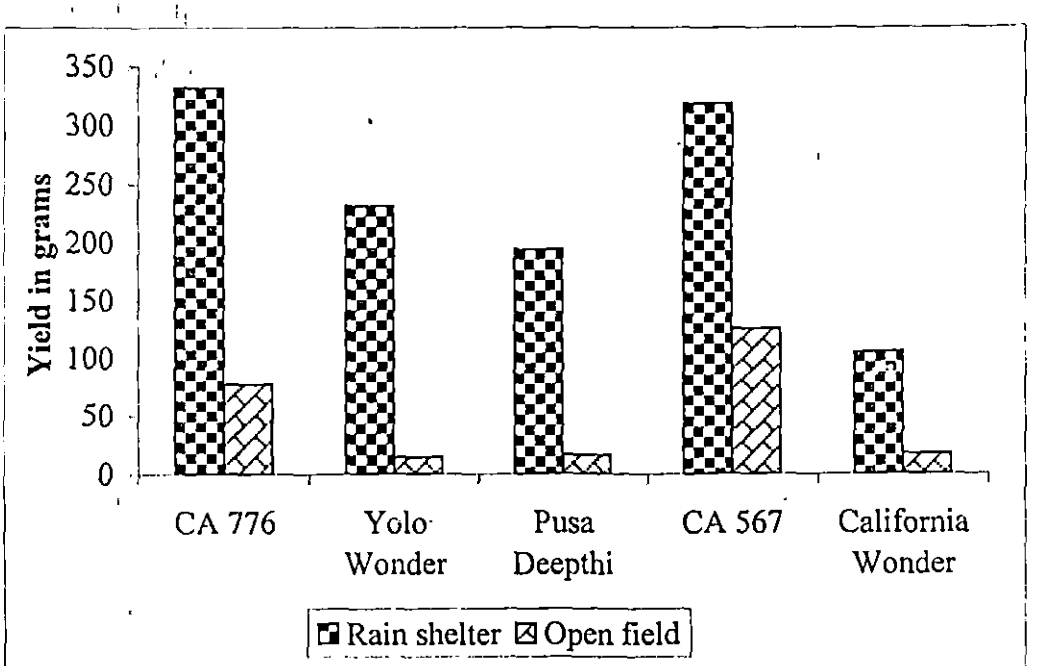

Fig. 7. Fruit yield per plant (g) during rabi season

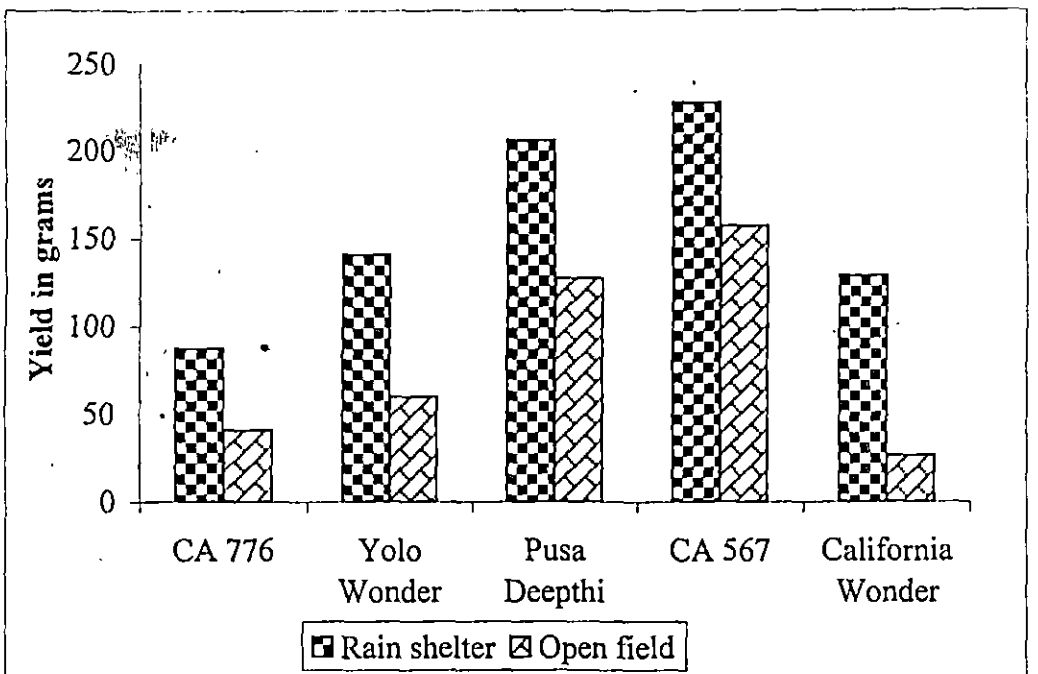

Fig. 8. Fruit yield per plant (g) during kharif season

Plate VII. Fruit Quality under rain shelter condition
A. Yolo Wonder B. Pusa Deepthi C. CA 567

high with high temperature. At 18° C the sweet pepper fruits were flattened and unsuitable for market (Ali and Kelley, 1993). High night temperature during flowering and development was a prerequisite for well shaped elongated pods.

Shading the plants increased the leaf surface, cell division and cell expansion. Reduction of solar radiation by 50% increased the fresh weight of peduncle, whole fruit, pericarp, placenta and seeds but no effects on dry weight and dry matter content (Bigotti, 1974). On the other hand, 30% reduction in solar radiation almost doubled the yield of sweet pepper due to an increase in both number of fruits and fruit size (Quaglitto, 1976). Short day conditions stimulated plant growth and increased the productivity by 21 to 24%, besides improving quality of capsicums (Egorova, 1975).

Decreased fruit weight, length, girth and size out side possible due to dry air (low RH) compared to inside. Low RH induces high amount of transpiration there by water loss. Water is essential for cell division and (especially) enlargement. So high RH in rain shelter induces rapid cell enlargement and the larger fruits were produced.

Rain shelter is a partially covered structure with side ventilation. So there was no restriction for insect pollinators. Under open field conditions, the pollinators get interrupted due to the continuous rainfall. This might be the main reason for the result of less number of seeds per fruit under open field condition. The reason might be the wash-off pollen grains form anther as well as stigmatic surface under open field condition.

The fruit set and other fruit characters (length, girth, weight etc.) were mainly influenced by pollination and number of seeds. The growth hormones, which are present in the seeds, will decide the fruit size and shape. The highly seeded fruits had very well shape and size mostly found under rain shelter rather than open field condition, might be due to above-mentioned reasons.

Number of harvest was greatly influenced by growing conditions. The number of harvest was reduced nearly half in open field when compared to rain shelter. Under rain shelter condition the plant was protected by UV stabilized polythene sheet that avoided the harmful UV radiation. The harmful radiation that is the factor that induces chlorophyllase and other destructive enzyme activity and chlorophyll get degraded. So the entire production activity gets affected. Apart form this prolonged rainy period leads to the more incidence of pest and diseases. All these above factors leads to the early ending of crop and reduced number of harvest and production under open field condition (Vidalie et al., 1985)

5.4 CROP WEATHER RELATIONSHIP

Changes in climatic factors, especially temperature brings about considerable variations on the vegetative characteristics of chilli and capsicum. The interval between seedling emergence and flowering prolongs as air and soil temperature falls (Muthukrishnan et al., 1986). Our study showed that the correlation of minimum temperature with RGR during rabi was significant.

Morning relative humidity showed positive influence on plant height, and RGR during kharif but negative influence on number of branches and RGR during rabi. Evening relative humidity has positive effect on plant height and number of branches but negative on RGR during kharif and rabi, which shows that there is not much influence of relative humidity on the plant growth and development. Grange and Hand (1987) concluded that relative humidity's in the range of 60 to 90 percent had little influence on the growth and development of plants. Normally grown in green houses, this explains why there has been relatively little interest on controlling relative humidity.

Light intensity had positive influence on plant height number of branches and RGR during kharif. Light intensity inside was less than open field condition that gave the little shaded condition to the crop. Shading the plants increased the

leaf surface, cell division and cell expansion (Schoch, 1972) 30 per cent reduction in solar radiation almost doubled the yield of sweet pepper due to an increase in both number of fruits and fruit size (Quaglitto, 1976). Even though the weather parameters like temperature (minimum and maximum) relative humidity (morning and evening) and light intensity was not influenced significantly or individually. But had a cumulative effect, which is evident from the performance of the crop under rain shelter condition.

5.5 INCIDENCE OF PEST AND DISEASES

The warm humid environment in a green house is ideal for the development of many diseases. The most important are damping off, and anthracnose, leaf blight *(Alternaria Solani)* (Jarvis, 1992). The dominant environmental factors involved in the pathogenesis of foliar diseases are temperature, light, relative humidity and their interactions (Raviv and Reuveni, 1998). The incidence of diseases like leaf blight and anthracnose was more under rain shelter conditions. This might be favored by high temperature along with high relative humidity. But under open field condition bacterial wilt and rotting was more. The reason may be splashing of soil particles during rainy period and severe & continuous rain. Under the rain shelter condition the small sucking insects like thrips and mites was more when compared to open field. It might be the result of high temperature and relative humidity inside. It is very evident from the severe incidence of mite inside the shelter than outside.

Mite attack showed prominent symptoms in the vegetative and reproductive parts. The fruits produced under rain shelter were malformed and small due to the attack of mites and caused severe yield loss during kharif season. Apart from this, the continuous heavy rain destructed and washed out the small soft-bodied sucking insect under open condition and not in the rain shelter condition. So the condition along with the season played a major role in the incidence of pest and diseases

5.6.ECONOMICS OF CAPSICUM PRODUCTION UNDER RAIN SHELTER AND OPEN FIELD

Growing condition is the important factor as like genetic factor, which affects the yield and quality and there by economics, by protecting the crop from adverse environmental conditions. Greenhouse grown crops always provides higher yield with very good quality. The fruits obtained from rain shelter were dark green, shiny, very attractive and free from diseases like fruit rot. So definitely it will fetch premium price in the market.

The B/C ratio obtained from rain shelter crop was 1: 0.51 and 1: 0.15 for open field crop. The B/C ratio might be less under both the condition, but it was nearly four times higher under rain shelter crop when compared to open field crop, it shows the cost effectiveness of rain shelter.

The labour cost was 75 per cent of total cost of cultivation. If we are utilizing the family labour, it not only provides better profit but also create chances of self-employment for the literate, unemployed youth of Kerala. Hence rain shelter based intensive off-season vegetable production system is to offer a lot of scope in the coming years.

Summary

6. SUMMARY

An investigation to study the performance of capsicum under rain shelter and in open field conditions was conducted at the department of Olericulture, College of Horticulture, Kerala agricultural university, Vellanikkara during rabi (2001) and kharif (2002) seasons.

The experiment was laid out in a Completely Randomized Block Design with four replications. Four capsicum varieties viz. CA 776, Yolo Wonder, California Wonder and CA 567 and one F1 hybrid Pusa Deepthi were used for the study. Observations on morphological, Phenological and yield attributes were recorded during the course of investigation. The daily weather parameters recorded inside the rain shelter and in the open field during the cropping period were used to compute the crop weather relationship. Economics of capsicum production under both the condition (rain shelter and open field) were worked out to find out the profitability and sustainability of different growing conditions. The salient results obtained during the course of investigation are summarised below.

1. Rain shelter crops recorded higher plant height during rabi as well as kharif season. Kharif season crops under rain shelter condition recorded maximum plant height.
2. Growing condition had significant influence on number of branches. During both the season rain shelter crop had more number of branches.
3. Rain shelter grown crop flowered earlier than open field crop. Rabi season crops earliest than kharif season crop.
4. Growing condition had significant influence on days to first harvest than open field crop.
5. Rain shelter crops during rabi season produced more number of fruits per plant (16.67)
5. Larger fruits were produced during kharif and fruits recorded a mean weight of 35.57 g under rain shelter and 22.51 under open field.

6. The crops grown under rain shelter recorded maximum yield (236,27 g and 158,36 g) in rabi and kharif season respectively (Where as it was 48.31 g and 82.48 g during rabi and kharif season respectively under open field condition).
7. Though the variety CA 567 gave more yields consistently during both the seasons, the yield was higher under rain shelter condition.
8. CA 776 was the best suitable variety for rabi season (and recorded the yield of 331.93 g under rain shelter and 77.66 g under open field).
9. The crops under rain shelter had more number of seeds per fruit.
10. Rain shelter crops exhibited lengthy fruits than open field crop fruits.
11. Mean fruit girth was found to be more under rain shelter condition compared to open field condition during both the season.
12. Number of harvest was greatly influenced by growing condition. Rain shelter crop had maximum number of harvest than open field crops.
13. Even though the weather parameters like temperature (minimum and maximum), relative humidity (morning and evening) and light intensity was not influenced significantly or individually. But had cumulative effect, which is evident from the performance of the crop under rain shelter condition.
14. The insects like mites and fruit borer and diseases like anthracnose and blight incidence was higher under rain shelter, but under open field fruit borer, bacterial wilt, stem rot incidence was higher.
16. The realised yield gave a B/C ratio of 1: 0.51 under rain shelter and 1:0.15 under open field condition (75 % of total cost of cultivation incurred by labour).

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*originals not seen

Appendices

Appendix:I

Weather data recorded during cropping period, August 2001 to November 2001 (Rabi)

Months	Std. Weeks	Temperature (^{0}C)				Rainfall (mm)
		Minimum		Maximum		
		Rain shelter	Open field	Rain shelter	Open field	
August	3	24.14	23.30	31.20	30.08	34.25
	4	24.12	23.25	30.97	30.01	3.65
September	1	24.10	23.18	32.71	31.45	0.00
	2	24.35	23.42	33.80	32.48	0.35
	3	24.82	23.62	32.64	31.8	0.10
	4	23.80	22.40	30.22	28.75	22.60
October	1	24.35	23.17	31.17	30.02	0.44
	2	24.71	22.81	32.10	31.14	13.60
	3	23.85	22.84	31.64	30.60	8.85
	4	25.80	25.20	32.72	30.60	7.75
November	1	25.50	25.00	32.00	30.05	5.27
	2	24.85	24.11	32.29	31.42	8.88
	3	25.62	24.82	31.85	31.14	1.20
	4	25.58	24.83	32.13	29.22	0.00
	Average	24.65	23.71	31.96	30.62	7.60

Appendix : II

Relative humidity percentage observed at different time intervals during cropping period, August 2001 to November 2001 (Rabi)

Time	Relative Humidity (%)	
	Rain shelter	Open field
8 A.M	78.00	71.00
10A.M	77.50	75.00
12A.M	78.50	75.50
2 P.M	74.00	71.50
4 P.M	88.50	82.00
6 P.M	85.00	83.00
Average	80.25	76.33

Appendix : III

Light intensity (Lux) observed at weekly interval during cropping period, August 2001 to November 2001 (Rabi)

Date	Rainshelter	Open field
17.09.01	60,200	82,000
24.09.01	16,880	21,180
01.10.01	54,160	69,040
08.10.01	37,560	59,800
27.10.01	15,900	24,240
Average	36,920	51,252

Appendix: IV

Weather data during cropping period, June 2002 to September 2002 (Kharif)

Months	Std. Weeks	Temperature (°C)				Relative humidity (%)				Rain fall (mm)
		Minimum		Maximum		Morning		Evening		
		Rain shelter	Open field	Rain shelter	Open field	Rain shelter	Open field	Rain shelter	Open field	
June	1	27.83	26.75	34.87	33.50	94.25	93.50	77.00	71.25	9.85
	2	27.71	27.00	30.21	29.71	95.16	91.14	88.28	84.57	24.96
	3	28.14	27.50	33.10	32.00	92.57	89.00	85.10	77.57	8.90
	4	28.14	27.60	31.90	31.25	90.25	87.75	83.50	80.62	9.80
July	1	28.03	27.50	34.50	33.57	94.28	89.42	81.80	71.28	9.50
	2	27.20	26.40	32.35	31.07	93.14	91.71	85.57	78.40	9.30
	3	26.07	25.57	31.92	30.35	92.00	90.00	78.85	76.71	5.86
	4	25.62	25.00	30.60	29.40	90.60	88.30	85.10	82.30	9.38
August	1	24.71	24.20	28.71	27.85	95.87	94.71	88.17	84.85	11.57
	2	24.64	24.07	28.92	28.07	95.36	94.22	86.57	83.14	13.10
	3	25.62	24.64	32.14	31.21	96.14	94.57	90.71	88.40	46.70
	4	26.30	25.50	34.90	33.60	94.00	92.90	89.10	85.6	2.00
September	1	25.64	25.28	31.47	30.42	95.14	94.00	75.20	70.57	13.52
	2	25.35	24.78	33.92	32.64	94.57	92.42	82.00	76.57	0.00
	3	26.21	25.71	32.56	31.50	93.71	91.57	67.00	65.00	0.00
	4	26.43	25.81	34.25	32.93	90.75	88.88	72.37	65.57	0.60
		26.47	25.81	32.27	31.19	93.61	91.50	82.27	77.60	12.26

Appendix V

Light intensity (Lux) during cropping period, June 2002 to September 2002 (*Kharif*)

Date	Light Intensity (lux)	
	Rain shelter	Open field
11.06.02	25,200	32,700
24.06.02	90,750	1,03,000
30.06.02	11,550	15,475
09.07.02	28,150	41,125
16.07.02	33,400	49,125
26.07.02	40,960	70,275
11.09.02	15,820	29,920
22.09.02	14,140	25,400
26.09.02	34,080	59,120
Average	37,006	51,715

PERFORMANCE OF CAPSICUM UNDER RAINSHELTER

By

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ABSTRACT OF THE THESIS

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ABSTRACT

An experiment was carried out in the Department of Olericulture, College of Horticulture, Vellanikkara, during the rabi (2001) and kharif (2002) seasons to study the performance of capsicum under rain shelter. The experiment was laid out in Completely Randomised Block Design with four replications. Four Capsicum varieties, viz. CA 776, Yolo Wonder, California Wonder, CA 567 and one F1 hybrid Pusa Deepthi were used for the study.

The study revealed that the crops grown under rain shelter performed better with respect to all the characters viz. Plant height, number of branches, early flowering, early harvest, number of fruits per plant, fruit size, fruit yield per plant, number of seeds per fruit and number of harvests.

As like the growing condition, the season also influenced some attributes. Rabi season crop gave better results regarding number of fruits per plant, fruit yield per plant, number of seeds per fruit, fruit size and number of harvests. Where as kharif crop produced tall plants with larger fruit size.

Though the variety CA567 gave more yield consistently during both the seasons, the yield was higher under rain shelter condition. CA 776 (CA 776) performed well during rabi but its performance was poor during kharif due to the severe incidence of pest and diseases.

Even though the weather parameters like temperature, humidity and light intensity not influenced individually and significantly but had cumulative effect, which is evident from the performance of the crop under rain shelter condition. The severe incidence of pest like mite caused reduction in the yield during kharif season under rain shelter.

The B/C ratio obtained from rain shelter crop was !: 0.51 and 1: 0.15 for open field crop. 75 per cent of total cost of cultivation was incurred labour charge. If we are utilizing the family labour, it not only provides better profit but also create chances of self-employment for the literate, unemployed youth of Kerala.