RAISING QUALITY VEGETABLE SEEDLINGS UNDER CONTROLLED ENVIRONMENT CONDITION

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PROJECT REPORT

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KERALA, INDIA

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DECLARATION

We hereby declare that this project entitled "**Raising Quality Vegetable Seedlings Under Controlled Environment Conditions" is** a bonafide record of project work done by us during the course of project and that the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of any other university or society.

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CERTIFICATE

Certified that this project report, entitled, "**Raising Quality Vegetable Seedlings Under Controlled Environment Conditions"** is a record of project work done jointly by Dinesh Pappan D, Sandra S, Suma M, Vishal Vikraman under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to them.

Tavanur,
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Vishal Vikraman

Dedicated to
our Loving Parents
And
Mother Land

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SYMBOLS AND ABBREVIATIONS

cm	-	centimetre(s)
et al.	-	and other people
Fig.	-	Figure
K.C.A.E.T	-	Kelappaji College of Agricultural Engineering And Technology
LWRCE	-	Land and Water Resource Conservation Engineering
IDE	-	Irrigation and Drainage Engineering
LDPE	-	Low Density Polyethylene
mm	-	millimetre
PFDC	-	Precision Farming Development Centre
Tab.	-	Table
%	-	Percentage
^{0}C	-	degree centigrade

Introduction

INTRODUCTION

India is the second largest producer of vegetable crops in the world (ranks next to China). Vegetables play an important role in the diet, especially in a country like India with its varied, tasty and wholesome cuisines and the large population of vegetarians. The demand of vegetables has been increasing fast in the urban areas with a gradual rise in the standard of living of the people, coupled with development of communication and transport facilities. The current production of 71 million tonnes is sufficient to provide only a per capita availability of 210 gm of vegetables a day as against the balanced diet requirement of 250 gm. The vegetable production is much less than the requirement if a balanced diet is to be provided to every individual.

As far as Kerala is concerned, about 70% of its vegetable demand is met from Tamil Nadu. The decline in vegetable cultivation and a growing import bill is only a symbol of Kerala's food dependency. To overcome this situation, increased production of vegetables is necessary. There are different ways and means to achieve this target, e.g., bringing additional area under vegetable crops, using hybrid seeds, use of improved agro-techniques. Another potential approach is the promotion of protected cultivation of vegetables.

Protected cultivation of vegetables has already been a practice in India. It offers distinct advantages of quality, increased productivity and favourable market price to the growers. Vegetable growers can substantially increase their income by protected cultivation of vegetables in off-season as the vegetables produced during the normal season generally do not fetch good returns due to their availability in the market. Off-season cultivation of cucurbits under low plastic tunnels is one of the most profitable technologies under northern plains of India. Walk-in tunnels are also suitable for effective raising of off-season nursery due to their low initial cost. Insect proof net houses can be used for virus-free cultivation of tomato, chilli, sweet pepper and other vegetables mainly during the rainy season. These low cost structures are also suitable for growing pesticide-free green vegetables. Low cost greenhouses can be used for high quality vegetable cultivation for long duration (6-10 months) mainly in peri-urban areas of the country to fetch commensurate price of produces. Poly trenches have been proved as extremely useful for growing vegetables under cold desert conditions in upper reaches of Himalayas in the country.

For the propagation of these vegetables whether in open field or in protected structures, nursery raising is very important. Nursery is a place where plants are cultivated and grown to usable size. It provides a favourable environment for emerging seedlings for their better growth and development. The production and supply of healthy seedlings is very important for getting higher yield and quality. Conventionally, vegetable seedlings are grown in open fields which lead to the production of weak seedlings. In India, vegetable seedling production is gradually changing from open field nurseries to protected nursery cultivation.

Protected cultivation of nurseries for vegetable seedling production has not been yet tried in Kerala. It is also very difficult to raise seedlings during the monsoon season in Kerala. So an attempt is made here to raise vegetable seedlings in protected structures. Different structures and media are to be tried for the same. Low tunnels covered with shade nets, green houses and shade houses are chosen as the structures for raising vegetable seedlings. Under this project, raising of solanaceous vegetable seedlings is carried out to compare the effect of different structures and rooting media on nursery raising. The objectives of the project are

1. To compare the effect of different protected cultivation structures in raising vegetable seedlings and to compare it with open field conditions.
2. To find out the most suitable structure for vegetable seedling raising in the humid tropics.
3. To standardize the media needed for raising vegetable seedlings.

Review of Literature

REVIEW OF LITERATURE

The nursery is a place for rearing and multiplying plants with minimal damage and maximum success. Its need in present era of high value agriculture has increased to a great extent because it is the only approach for effective and efficient utilization of inputs at the initial phase of plant growth. High tech interventions like protected structures, micro irrigation, plant growth regulators, soil-less media, automatic control devices, etc., have made nursery industry a viable venture.

The crop productivity is greatly influenced by the growing environment and management practices. Under open field cultivation, it is not possible to control the growing environment of plants, thereby affecting the quality and productivity of the crop. The main purpose of protected cultivation is to create a favourable environment for the sustained growth of crop so as to realize its maximum potential even in adverse climatic conditions. Protected cultivation offers several advantages to grow crops of high quality and yield using land and other resources more efficiently.

The review of literature pertaining to different structures used for nursery raising and the different media used for raising seedlings in nurseries is briefly reviewed hereunder. Some of the related works based on nursery raising in protected structures and the treatments are also included.

2.1 Structures under protected cultivation used for nursery raising

- Raising seedlings in Green House
- Raising seedlings in Shade House
- Raising seedlings in Low Tunnel

2.1.1 Raising seedlings in Greenhouse

A Greenhouse is a framed structure covered with transparent cladding material, which protects the plants from wind, precipitation and excess solar radiation, temperature extremes and pests and disease. It is a controlled environment which allows optimum growth of plants.

A greenhouse is generally covered with a transparent material such as polythene or glass. Depending upon the cladding material and its transparency major fraction of sunlight is absorbed by vegetable crops and other objects. These objects in greenhouse in turn emit long wave thermal radiations for which cladding material has lower transparency. With the result, solar energy is trapped and hence the temperature inside the greenhouse is raised. This is popularly known as greenhouse effect. This rise in temperature in greenhouse is responsible for growing vegetable in cold climates. During summer months, air temperature in greenhouse is to be brought down by providing a cooling device. In commercial greenhouses besides temperature-controlled humidity, carbon dioxide, photoperiod, soil temperature, plant nutrients etc. facilitate round the year production of desired vegetable crops. Controlled climatic and soil conditions provide an opportunity to the vegetable crops to express their yield potentials.

The seedlings of tomato, chilli, capsicum, brinjal, cucumber, cabbage, cauliflower and broccoli can be grown under plastic cover protecting them against frost, severe cold and heavy rains. The environmental condition, particularly increase in temperature inside polyhouse hastens the germination and early growth of warm season vegetable seedlings for raising early crops in spring summer. Vegetable nursery raising under protected conditions is becoming popular throughout the country especially in hilly regions. Management of vegetable nursery in protected structure is easier and early nursery can be raised. Needless to emphasize, this practice eliminates danger of destruction of nurseries by hail storms and heavy rains because world’s highest rains occur in this region and the period of rainy season is also wide (April to October). Protection against biotic and abiotic stresses becomes easier.

El-Aidy (1993), developed a simple, cheap greenhouse for tomato seedlings production which prevented the entrance of insects, minimize pesticide use and kept the incidence of tomato yellow leaf curl big eminivirus (which has severely affected tomato production in Egypt) to a minimum. The seedlings produced under these conditions were healthier than those grown outside, yet adapted successfully to the field conditions.

Nimje *et al*., (1993) conducted studies on U-V stabilized plastic film covered, pipe framed greenhouses (20mx5m wide), the day temperature was higher and night temperature was lower than that of outside. Solar radiation entering the greenhouse was 30-40% lowers than that reaching the soil surface outside. A winter crop of tomatoes performed better in the field than greenhouse. However, okra and capsicum gave significantly higher yields (2.5-3 folds) in the greenhouse than outside, including in winter. The yield of a winter crop was 13% higher in the greenhouse than outside. Biomass production inside the greenhouse was atleast 6 fold higher than outside.

Tskelv *et al*., (1990) carried out trials over three years on a fluorescent polyethylene film to establish light and temperature conditions in the greenhouse of Bulgaria. Four greenhouses were used, two for raising tomato seedlings and the other two for early tomatoes. Standard LDPE was used as control. The seedlings showed more vigorous growth at an early stage under fluorescent film. They had a better root system, thicker stem, more leaves and large leaf area. Total yield was 23.4 percent higher resulting in good income.

In a study conducted at PFDC Farm, Hyderabad, it was revealed that vegetable crops namely Tomato, Capsicum, Chilli and Brinjal when sown inside the green house recorded higher percentage of germination with more survival and maximum plant height. They came up 7- 10 days early for transplantation as compared to open field conditions. Therefore the period can be reduced to7 -10 days and one or two irrigations can be saved in the main field during their period of growth in Kharif and rabi seasons.

Verma *et al.,* (2005) conducted study in homestead land of five small /marginal farmers during kharif (2001-02) in Chhattisgarh, using low cost polyhouse giving soil and seed treatment. They found that the combined effect of soil and seed treatment along with the use of low cost poly house and line sowing of seeding raised nursery space bed were best for the growth and development of vegetable seedlings as compared to other treatments.

Mahajan *et al*.,(2006) reported a 2-year study conducted during 2002–2004 at Department of Soil and Water Engineering, Punjab Agricultural University, Ludhiana to investigate the effect of irrigation and fertigation on Greenhouse tomato. It was found that Drip irrigation at 0.5 × E_{pan} along with fertigation of 100% recommended nitrogen resulted an increase in fruit yield by 59.5% over control (recommended practices) inside the Greenhouse and by 116.2% over control (recommended practices) outside the Greenhouse, respectively. The drip irrigation at 0.5 × E_{pan} irrespective of fertigation treatments gave a saving of 48.1% of irrigation water and resulted in 51.7% higher fruit yield as compared to recommended practices inside the Greenhouse. Total root length was more in drip irrigated crop as compared to surface irrigated crop. Greenhouse tomato fruits were found to be superior to fruits of open field crop in view of fruit size, TSS content, ascorbic acid content and pH. Further, drip irrigation in Greenhouse crop caused significant improvement in all the quality characteristics.

2.1.2 Raising seedlings in Shade house

Nurseries use shade houses as a staging area to ease plants into a harsher environment. They are used to protect plants from hot sun, wind or excessive bright light.

Dahiya *et al.*, (2005) reported the experiment conducted with the participation of farmers at the Vegetable Seed Production and Research Farm, K.V.K Sonipat, to study the effect of polyhouse, lowtunnel/lowcost polyhouse, shading net and transparent net for raising vegetable nursery. They found that a better quality nursery was obtained in protected houses which enabled the farmers to harvest vegetable crops quite earlier to take advantage of premium prices. Experiment was conducted on vegetables like tomato, brinjal sweet pepper, and sapling of musk melon, bottle guard and smooth guard during winter season (November- January) .

Sethi *et al*., (2009) conducted experimental evaluation of the modified net house during winter and summer months of year 2007–08 (December to June) by growing brinjal crop and compared with conventional net house, polyethylene sheet greenhouse and in open field condition. To make these designs low cost and more effective, low tunnels (covered with low density polyethylene sheet) were designed and were used in winter over the plant rows to generate localized greenhouse effect for faster plant growth. By doing so, average daily air temperature under the tunnels was raised to about 9–10°C above the open field air temperature. It was observed that due to the combined effect of low tunnels (in winter) and shade net (in summer), the micro-climatic parameters like air temperature, plant temperature, solar radiation and light intensity remained within desirable range during different stages of crop growth resulting in 37.6% and 11.5% increase in the yield of brinjal crop as compared to conventional net house and PE covered greenhouse yield, respectively, at 31°N latitude. Economic analysis of the modified net house was also conducted and compared with the conventional net house and PE covered greenhouse of the same area. It was observed that 500 m^2 area modified net house (coupled with low tunnels and shade net) produced highest yield.

2.1.3 Raising seedlings in Low tunnel

Plastic low tunnels are miniature form of greenhouses to protect the plants from rain, wind, low temperature, frost and other vagaries of weather. The low tunnels are very simple structures requiring very limited skills to maintain and are easy to construct and offer multiple advantages. For construction of low tunnels, film of 100 micron would be sufficient. The cost of a100-micron thick film would be about Rs.10/m^2 .

Gray *et al*.,(1980**)** conducted experiments to investigate the effect of different structures on tomato yield, plant density in the seedbed, plant age at transplanting, and of raising plants, either in low polythene tunnels, or Dutch light frames, from natural or pre-germinated seeds. Yields from plants raised in tunnels or Dutch-light frames were compared with those from plants raised in peat blocks in a heated glasshouse. Pulled (“bare-root”) plants, raised in protected seedbeds, gave yields of ripe fruit similar to, or higher than plants raised in blocks. Yields of ripe fruit from pulled plants raised in low polythene tunnels or Dutch-light frames were similar. Six and eight-week old transplants planted on the same day produced similar yields of fruit, although plants from sowings made in early April and planted in mid-May gave the highest yields. Yields of ripe fruit declined from 34.8 to 25.9 t ha^{-1} with increases in plant density in the seedbed from 64 to 257 plants m^{-2}, but yields were little affected by further increases in density up to 513 plants m^{-2}.

El-Aidy (1984) from his research on the production of some vegetable crops in Egypt concluded that low tunnels gave maximum yield compared to open field, perforated plastic covers and mulch.

Bangal *et al.* (1986) conducted studies on brinjal, by covering the rows with white transparent polythene film of 0.1cm thickness as a rectangular tunnel supported on bamboo strips. The yield obtained was higher than in open plot, irrigation requirement was lower and water use efficiency higher.

El-Aidy (1986) conducted studies on the possibility of raising the temperature around the plants in Egypt during winter and to reduce the heating effect during summer with the use of very simple protective tunnels which were covered by polyethylene film. He found that the yield of tomato under plastic tunnels was about seven times greater than that from the uncovered plants.

Gerber *et al.,* (1988) studied the effect of various low tunnels and their removal times on growth, yields and fruit quality of bell peppers (*Capsicum annuum* L.) at Urbana, Illinois (U.S.A.). Tunnel treatments consisted of wire hoops supporting clear slitted polyethylene, white slitted polyethylene, spun-bonded polypropylene and a control of no cover. Removal times were 22, 32 and 52 days after transplanting. Temperature extremes were recorded and accumulated heat units were calculated. The highest temperatures and most total heat units accumulated were found under the clear slitted polyethylene and spun-bonded polypropylene tunnels. These two materials were equally effective in increasing plant growth and early yield, but total yield was higher under the spun-bonded polypropylene. All tunnels resulted in increased production of 3- and 4-lobed fruits, while reducing 2-lobed fruit. Increased plant growth, fruit yield and improved quality of bell pepper fruit were partially attributed to increased air temperatures and more total heat units under the tunnels.

Printz (1995) conducted studies on the influence of tunnels of 4 & 5m wide for protection of crops like Strawberry, Tomato, Melon and Asparagus. It was found that the tunnels were cheap, gave climatic protection (from rain, frost and wind) and therefore earlier crops in addition to protection against certain diseases due to fungi, better working conditions (for spraying, venting and harvesting). The tunnels could be easily dismantled and moved from one plot to another in a season.

Singh *et a*l., (2003) conducted trials at the Indo-Israel Project farm at IARI, New Delhi, during winter season (December-March) for the development and evaluation of the technology for summer squash cultivation under plastic low-tunnels during offseason. The crop was advanced 60 days over to its normal season. Plastic pro-trays were used for raising off season seedlings of summer squash in soilless media. They found that offseason cultivation of summer squash under plastic lowtunnels can be adapted commercially and is undoubtedly highly acceptable in periurban areas of the northern plains of India.

2.2 Effect of rooting media and soil treatments on seedling raising

- Solarizing the area before sowing the seeds
- Raising seedlings in Propagation trays
- Ingredients used as rooting medium

2.2.1 Solarizing the area before sowing the seeds

Solarization is a method of heating the soil with sunlight by covering it with clear/transparent polythene sheet to control soil borne diseases. Solarization works in the same way as a greenhouse, where a transparent covering, in this case plastic sheet traps the sun's heat. After several days of sunshine, soil temperatures rise to as high as 52^0C in summer - hot enough and far enough down into the soil to sterilize it. It takes four to six weeks of sunny weather to pasteurize the soil at these temperatures.

Soil that has been solarized allows plants to draw the nutrients from the soil, especially nitrogen, calcium, and magnesium, more readily. Seeds germinate more quickly. Plants grow faster and stronger, often maturing earlier with substantially higher yields than in unsolarized soil. This is due to the fact that the soil becomes almost "virgin", that is whatever had been growing in it has been destroyed or driven off so the garden vegetables or plants have a significant amount of time to establish themselves without competition from insects or weeds in their garden plots.

Patten *et al*., (1991) reported that total yield of strawberry from solarized plots were greater than from the untreated plots.

Habeeburahman (1992) during his experiments on soil solarization using transparent polyethylene sheets found that among the different durations of solarization tried, 30 & 40 days were found to effect maximum reduction in weeds than the shorter duration of 10 to 20 days.

Habeeburrahman (1994) reported that, as a result of the soil solarization, effective weed control is achieved and there was appreciable yield of jowar and groundnut grown during succeeding kharif season. With regard to all the growth parameters and yield attributes of jowar and groundnut, the values recorded by transparent polythene of 0.05mm thickness for 40 days was significantly higher than the normal practice of weed control in both the crops.

Varughese(1997) studied the effect of soil solarization using LDPE mulch on moisture conservation and soil temperature variation and found that the average maximum soil temperature of non-solarized plot was 49.5^{0}C but that of solarized plots was 56.5^{0}C. The intensity of solar radiation reaching soil surface was higher in non-solarized plots than in solarized plots. There was significant increase in moisture content values in solarized plot than in non-solarized plots. The yield of bhindi was significantly higher in solarized plot. Solarization had also effect in lowering the weed count and dry weight of weeds.

Porras *et al.*, (2000) studied soil solarization and *Trichoderma*, alone and combined, in three consecutive annual production cycles in Huelva (southwestern Spain) an environment representative of the coastal strawberry production area, to evaluate the effectiveness in enhancing strawberry yield and the relationship between

Trichoderma soil population, root colonization by *Trichoderma*, yield and root weight. Solarization was conducted during the summer, using clear 50 µm low-density polyethylene mulch. *Trichoderma* spp. were applied via drip irrigation and dip, adding to the soil 7-days before planting (10^8 conidia/m^2), and strawberry roots were dipped in a suspension of *Trichoderma* (10^6 conidia/ml) prior to planting. Mean soil temperatures in solarized plots averaged 46 °C at 5 cm depth, 43 °C at 10 cm, and 38 °C at 20 cm. Solarization reduced *Trichoderma* soil populations. Nevertheless, *Trichoderma* soil populations increased over the three consecutive years in solarized plots, and no differences were observed after three repeated treatments of the same site. Solarization did not significantly reduce root colonization by *Trichoderma*. Combination of solarization with *Trichoderma* applications significantly increased *Trichoderma* soil populations relative to the solarization alone treatment, and root colonization by *Trichoderma* compared to the untreated control and the solarization alone treatment. Soil solarization, alone or combined with *Trichoderma* applications, increased strawberry yield 77.6% and 78.2% in year 2, and 11.0% and 43.2% in year 3, respectively.

2.2.2 Raising seedlings in Propagation trays

Seedling trays are also called as pro-trays (propagation trays). These trays have prepunched holes to each cavity for proper drainage of excess water and also have right spacing. First the trays are filled with the mixture of root media and then the seeds are sown in cavities (one seed in each cavity). Irrigation is done at regular intervals. Hundred percent humidity is maintained and when level comes down irrigation is applied by using fine sprinklers or mist system. Seeds start emerging after about 3-6 days of sowing depending upon the crop and variety. Shift the trays to protective structures. The trays must be irrigated by using suitable technique. The seedling will be ready in about 21-32 days for transplanting to the main field.

2.2.3 Ingredients used as rooting medium

Mainly cocopeat, vermiculite and perlite are used as a root medium for raising the nursey in high-tech nursery cultivation. These ingredients are mixed in a 3:1:1 ratio before filling in trays used for raising nursery.

Cocopeat is organic medium prepared from the waste of coconut husk. The medium has good porosity and improved drainage and air movement activity. This medium is completely free from infestation of any pest or pathogen. Nowadays cocopeat is commonly being used as a medium for raising nurseries of vegetables and ornamental plants. Its advantages are that it is lightweight, relatively inert and comes from a sustainable source.

Singh (1999) conducted experiments on nursery raising of different vegetable & ornamental crops inside the green house. It was found that there is no chance of transplanting shock for the seedlings, enabled easy transportation after packing to long distances & farmers could get the nursery ready from greenhouse at any time as per requirement. The seedlings were grown in propagation trays using coco peat.

Shikhamani *et al.,* (2000) stated that a farmer, Mr.Prakash raised seedlings of tomato, brinjal & chilly in polyhouse using pro-trays made of polypropylene. The trays were filled with a mixture comprising of soil, coco peat, sand & neemcake. It was found that propagation trays with this mixture gave better germination & seedling stand (75-95%).

Singh *et al.,* (2005) reported that at the Indo-Israel Project of the Indian Agricultural Research Institute, New Delhi, plug-tray nursery raising technology was conducted by using cocopeat, vermiculite and perlite as soilless media been standardized for raising off-season seedlings of almost all the cucurbitaceous vegetables. This technique was capable of vigorous root development, suitable for nursery raising without any damage to the seedlings. This technology was quite economical for the vegetable growers of the northern plains of India, because with the introduction of this technique, farmers could grow a large number of seedlings as per requirement for off-season cultivation of these cucurbits for fetching high price of the off-season produce. The plug-tray nursery raising technology by using soilless media could be extended to the growers in various parts of northern India for growing off-season cucurbitaceous vegetables.

2.3 Irrigation in protected structures

Water is the most important factor in nursery rising. Proper irrigation and maintenance of high humidity in the propagation environment is necessary. Micro, over head and pulse irrigation methods are very good means of watering large nursery area. Micro irrigation applies small amount of water to root zone only. Drip or trickle irrigation, uses 60-70% less water than overhead system.

Mist irrigation has major benefits in tropical climate-water is sprayed in very fine droplets in short intervals onto the plants, where it evaporates. The surface from which water evaporates is cooled because vapourization of liquid water to water vapour is energy consuming: the water vapour helps to cool the leaf surface so that the stomata stay open even in a warmer environment and assimilation can proceed unhindered.-allowing increased plant growth. It is important to note that, the mist does not irrigate the plants but prevents excessive transpiration by the plantshoots, thereby preventing desiccation.

Barfield *et al.*, (1973) conducted studies to determine the surface water storage capacity of individual leaves of lettuce, cucumber, and tomato plants for different spray irrigation drop sizes, stem angles, and leaf temperatures. For a given type of plant, significant difference was found between spray drop sizes, but stem angle and temperature had no significant effect on the storage capacity. The average surface storage capacity was 0.20 mm, 0.18 mm, and 0.11 mm for lettuce, tomatoes and cucumbers, respectively.

Katsoulas *et al.*, (2007) studied the influence of greenhouse humidity control on the transpiration rate (λE_c), sensible heat flux (H_c) and bulk stomatal conductance (g_c) of a soilless rose canopy (*Rosa hybrida*, cv. First Red) in a greenhouse located in the coastal area of eastern Greece. Measurements were carried out during several days in the summer (i) without air humidity control and (ii) with a mist system operating when the relative humidity of the greenhouse air was lower than 75%. The diurnal course of g_c was determined from the relation linking λE_c to canopy-to-air vapour pressure deficit (D_c) or from inversion of the Penman–Monteith equation. The two ways of estimating g_c were in good agreement, showing a significant increase of g_c under mist conditions. The analysis of the energy partition at the canopy showed high negative values of the Bowen ratio ($\beta \approx -0.7$) in both conditions, indicating that canopy transpiration played a major role in cooling the greenhouse atmosphere. The contribution of the mist system to total evaporative cooling was estimated to be about 20%, with only 40–50% of the mist water being effectively used in cooling. Calculation of the crop water stress index confirmed that the crop was less stressed under misting conditions. It was concluded that the prediction of short-term variations of λE_c and g_c in greenhouse environments must account for the magnitude and diurnal variation of air VPD.

Sanders *et al.*, (1967-1969) studied the influence of low gallonage "mist" irrigation on potato and the parameters namely: leaf, air and soil temperature, and soil moisture, relative turgor and stomatal aperature were measured. Misted canopies had lower leaf, air and soil temperature and higher soil moisture than the non-irrigated plants. Stomata of misted plants did not close as rapidly as those of non-irrigated plants.

Sanders *et al.*, (1967-1969) studied the influence of irrigation method on potato growth and the development was assessed during three years. Low volume "mist" irrigation (M), furrow irrigation (F), mist plus furrow (MF) and no irrigation (NI) were compared. During a high and moderate stress season misting maintained the haulm later into the season and increased the proportion of small and medium size tubers. Further during the high stress season misted plots (M and MF) yielded more than NI plots.

Materials and Methods

MATERIALS AND METHODS

A field study was conducted to evaluate the suitability of different protected cultivation structures for nursery raising of solanaceous vegetables under humid climatic conditions. This chapter presents the materials used and methodology employed for experimentation, data collection and analysis of data.

3.1 Experimental Site

The experiment was conducted in the structures of the Precision Farming Development Centre, KCAET, Tavanur in Malappuram District.

3.2 Climatic conditions

Agro climatically, the area falls within the border line of northern zone, central zone and kole zone of Kerala. The area receives rainfall from the South West monsoon and to a certain extent from North East monsoon.

3.3 Experimental procedure

The layout of the treatments under each structure is given in Fig.3.1. The methodology employed and various components and equipments used for the experiment are given below.

Two solanaceous vegetables were chosen for seedling raising in various structures like low tunnels under shadenets, green houses and shade houses providing different treatments. The growth response was assessed in terms of germination period, average shoot and root length and germination percentage.

Treatment methods:

- Solarized plots
- Pro-trays with rooting media
- Control

Structures selected:

- Low tunnel with shadenets
- Greenhouse

- Shade house

Seedlings were also raised in the open field for comparison.
No of replications-3

The experiment was conducted in two trials using solanaceous vegetables. The solanaceous vegetables selected for the first trial were Tomato (*Anagha)* and Brinjal (Haritha). The experiment was repeated with Tomato and Chilli (*Ujwala*). Tomato, Brinjal and Chilli showed 80, 70 and 95% germination after 25 days respectively.

3.4 Treatments

3.4.1 Solarized raised bed

It is a method of heating the soil with sunlight by covering it with clear/transparent polythene sheet to control soil borne diseases. Other additional beneficial effects include control of weeds, insect pests and release of plant nutrients resulting in increased crop growth. Solarization is a non-chemical alternative for disease, insect pest and weed control. It can be successfully used for disinfection of any seedbed to produce healthy seedlings of vegetables.

A raised bed was prepared and organic manure was added to make the bed ready for sowing. The bed was brought to field capacity by irrigating. The area was covered with 200 gauge transparent polyethylene film as tightly and closely to the ground as possible and was left for 30-40 days. The soil temperature of the nursery bed thus covered can go up to 52°C in summer. The polythene sheet is removed after 30-40 days and the area was ready for planting. Care should be taken to see that sheets do not tear off.

3.4.2 Seedling trays

Seedling trays are also called as pro-trays (propagation trays) or flats, plug trays or jiffy trays. Trays are made of polypropylene and are reusable. Seedlings get appropriate quantity of growing media and the right amount of moisture. Trays have prepunched holes to each cavity for proper drainage of excess water and also have right spacing. These trays are readily available.

Sterilized commercial growing media is better as the incidence of seedling diseases is less or nil and it contains right amount of moisture in it. The most common growing media used is coco peat, a byproduct of coir industry and it has high water holding capacity. It should be well decomposed, sterilized and supplemented with major and minor nutrients before using. It is low in nutrients and high in lignin content.

The seedling trays were filled with appropriate growing medium. A depression was made with the finger tip in the centre of the cell. One seed per cell was sown and was covered with medium. The entire stack was covered with polythene sheet for moisture conservation till germination. Seeds started emerging after about 3-6 days of sowing. The trays were shifted to protective structures. The seedlings were ready in about 25 days for transplanting to the main field.

3.4.3 Control plot

The vegetable seedlings were also tried under three protective structures (ie, lowtunnels under shadenet, green houses and shadehouses) without giving any treatments to the soil and their performance is studied.

3.4.4 Open field

The solanaceous vegetable crops are also raised in open field and their growth characteristics are studied.

3.5 The details of control structures used for the study

3.5.1 Low tunnels with shadenet

Low tunnels are basically row covers supported on wire hoops. The basic components are hoops made of PVC and polythene green house film. Once hoops are set, the plastic cover is applied with the edges of the plastic secured by tying to sticks. Modifications have been made on this basic design to allow for daytime ventilation when temperatures within the plastic begin to rise to dangerous levels.Low tunnels are relatively inexpensive requiring little capital investments. Because of their simple design, these structures are not difficult to construct and manage. Tunnels are not automated in any way, so they will require daily attention and labour to ensure proper ventilation.

Low tunnels were constructed and above it shadenet was also provided. Then the seedlings are raised inside the tunnels and the growth characteristics were studied.

3.5.2 Green house

A green house is a framed structure covered with transparent or translucent material. It is a sophisticated structure providing ideal conditions for satisfactory growth of plants. In this trial a naturally ventilated greenhouse of PFDC was selected for the trial.

3.5.3 Shade house

Nurseries use shade houses as a staging area to ease plants into a harsher environment. They are used to protect plants from hot sun, wind or excessively bright light. A shade house can protect plants from extreme heat in the middle of the day or extreme cold in the middle of the night, while the plants adapt to the harsher outside conditions. A temporary shade house was constructed near the existing greenhouse of PFDC for carrying out the trial.

3.6 Observations taken

1) Temperature and relative humidity under all structures.
2) Germination period and percentage.
3) Shoot length and root length at different intervals.
4) Plant height at time of transplanting.
5) Percentage of healthy seedlings ready for transplanting.

Solarization of the plots was done 50 days before starting the trials. Temperature under each bed was measured. Open field soil temperature was also recorded. During the experiment, germination, root length and shoot length were recorded in both the trials, 15 and 25 days after sowing the seed. The trials were conducted during the months of August-October, 2009. The germination rate of the seeds were tested before sowing.

3.6.1 Observations on soil temperature

Soil temperatures were recorded using a multi-stem thermometer with an external sensing probe. The soil temperature at 5cm depth was measured by inserting the sensing probe into the hole drilled up to that depth. The temperature that can be recorded by the instrument ranges from -50^0 C to 200^{0}C.

3.6.2 Observations on relative humidity

Relative humidity was recorded by using the instrument thermo-hygroclock.

3.6.3 Observations of shoot length and root length

Sample plants were pulled out from each treatment at 15 and 25 days after sowing the seed. The root length and shoot length were measured by using a scale

.3.6.4 Observations of rainfall

The rainfall data was taken from the meteorological observatory in our campus. The rainfall was recorded by using Symons' non-recording rainguage. It essentially consists of a circular collecting area of 12.7cm (5.0 inch) diameter connected to a funnel. The rim of the collector is set in a horizontal plane at a height of 30.5 cm above the ground level. The funnel discharges the rainfall catch into a receiving vessel. The funnel and receiving vessel are housed in a metallic container. Water contained in the receiving vessel is measured by a suitably graduated measuring glass, with an accuracy upto 0.1mm.

3.6 Statistical analysis and interpretation of data

Fischers method of analysis of variance was used for the analysis and interpretation of the data obtained in these experiments. The f-values are obtained and are compared with the table values. The f test was done at 5% level of significance.

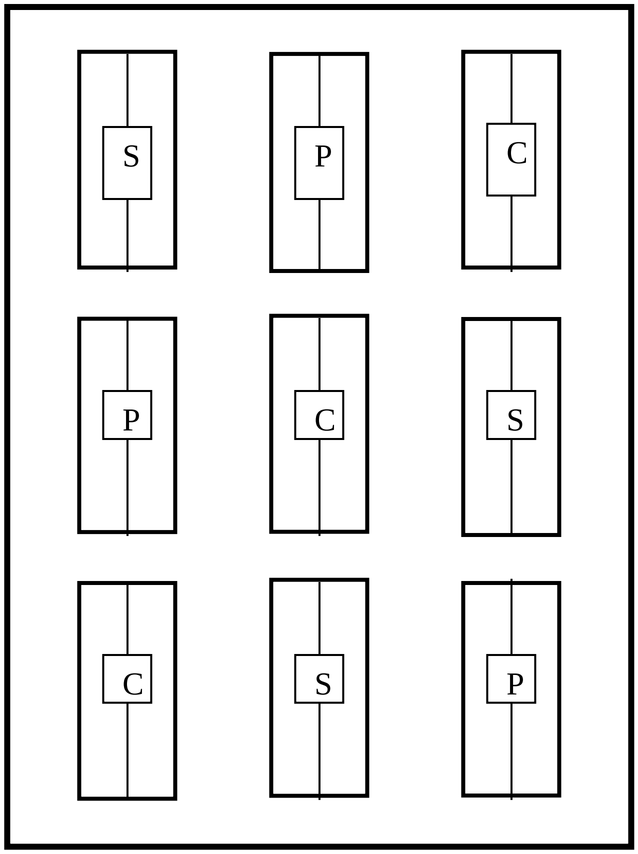

Fig 3.1 Layout of the experiment under each structure

S-Solarized bed

P-Propagation trays with cocopeat as the rooting media

C-Control

Plate 3.1 Propagation tray with tomato seedlings

Plate 3.2 Low tunnels under shadenet

Plate 3.3 Mist irrigation inside Greenhouse

Results and Discussion

RESULTS AND DISCUSSION

The results of the field study conducted to evaluate the suitability of different protected cultivation structures under various treatments are presented and discussed in this chapter.

The experiment was conducted in two trials using solanaceous vegetables. The solanaceous vegetables selected for the first trial were Tomato and Brinjal. The experiment was repeated with Tomato and Chilli. In this chapter the notations T1, T2 and T3 represents treatments with solarized plots, plots in which seedlings were raised in propagation trays with cocopeat as rooting media and control plots respectively.

4.1 Effect of solarization on soil temperature

Solarization of the plots was done 50 days before sowing the seeds. Temperature under different plots was measured daily during the peak hours. The temperature was recorded using a digital thermometer. The soil temperatures recorded are presented in Appendix 1. The maximum temperature recorded under the solarized plots came upto 53^0 C, while that from the non solarized plots came only up to 47.5^0C. The maximum temperature obtained from the solarized bed inside the green house was 50^0C. Thus solarization could increase the soil temperature by around 7^0C.

A graph was plotted with 5 days average values of temperature obtained from different treatments ie., from the non solarized plots, solarized plots in the open field and from the solarized plots in the greenhouse. The maximum temperature was obtained under solarized plots in open field. Next to it came the temperature from the solarized plots under greenhouse.

Since the seedlings are highly susceptible to be affected by very high temperatures, a shade net was given over the area before sowing the seeds. The temperatures under various plots were also recorded after giving the shade net. The soil temperature of the solarized bed decreased after providing the shadenet. The maximum soil temperature was recorded from the non solarized plot in the openfield. It can be interpreted that providing a shadenet decreases the soil temperature to a considerable extent.

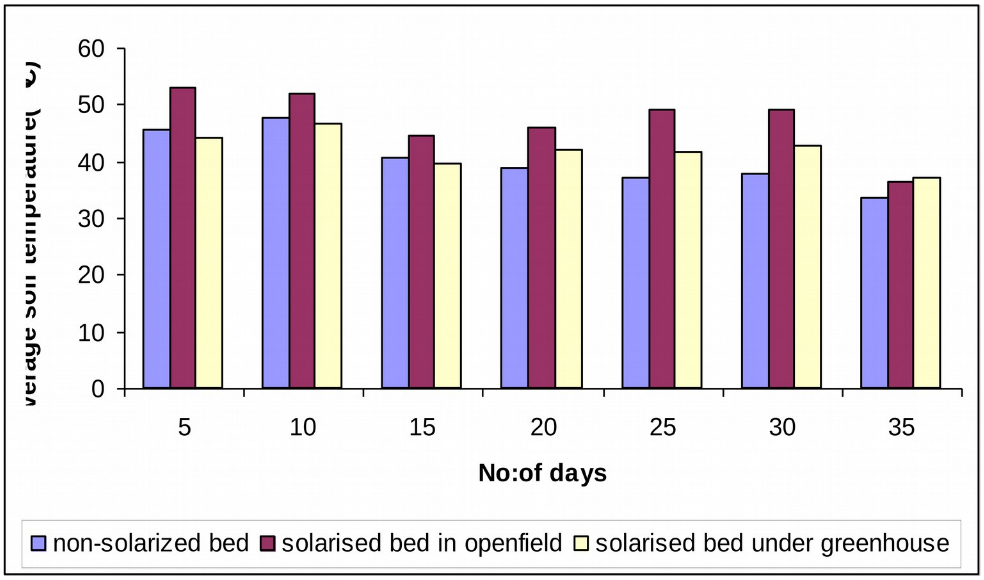

Fig. 4.1. Effect of solarisation on soil temperature

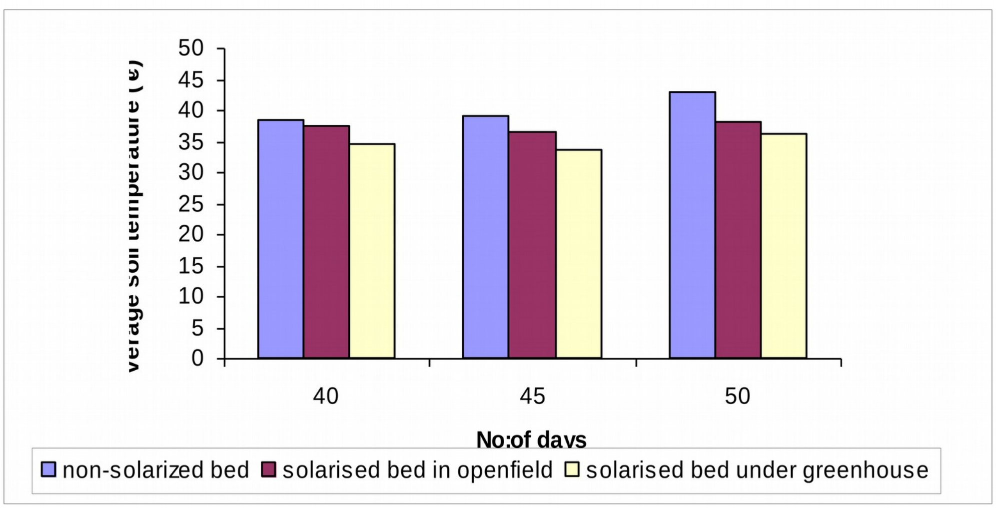

Fig. 4.2 Effect of solarisation on soil temperature (shadenet provided over open field solarized bed**).**

4.2 Trial 1

4.2.1 Effect of different treatments on germination

The seeds were sown on 25th August, 2009. During the experiment, the no of seedlings, root length and shoot length were recorded in both the trials at 15 and 25 days after sowing the seed. The observations for individual crops were statistically analysed for both the trials and for analysis, the observations on the 25th day were taken. Since the design was a Two Factor Completely Randomized Design, the analysis was done based on that. The fishers method of analysis of variance was adopted.

The data of number of seedlings ready for transplanting on the 25th day after sowing as well as the results of statistical analysis conducted to study the effect of different protected structures and different treatments on the germination rate of tomato and brinjal are given in table 4.1.

In the case of tomato crop, in trial 1, during the peak rainy season, it was found that maximum percentage of seedlings was obtained from the low tunnels and greenhouse. Even then, there was no significant difference in the values between structures and also between treatments i.e., for tomato crop in trial 1, the germination values have no significant variation between the three structures and treatments.

In the case of Brinjal crop, there was significant difference in the percentage of seedlings received from the different structures. Green house had the highest percentage of seedlings. Next to greenhouse, lowtunnel had the maximum percentage and finally shade house.

In the first trial, based on the number of seedlings, both crops gave best performance in the green house, followed by low tunnels.

The rainfall data during the experiment period is given in Appendix 2. The maximum rainfall occurred during the first trial period.

4.2.2 Effect of different treatments on shoot length in the first trial

The data of shoot length of seedlings on the 25th day after sowing as well as the results of statistical analysis done to find out the effect of different structures and treatments on the shoot length of tomato and brinjal are given in table 4.2.

From the analysis of data it was found that there was significant difference in the shoot length of tomato between structures. Out of the three structures, the seedlings from the greenhouse have shown maximum shoot length. Next to green house, low tunnel and then comes the shade house. There was no significant difference found in the shoot length between the treatments.

In the case of Brinjal also, the seedlings from the greenhouse has shown maximum shoot length, without much significant difference. But in this case the plants from the solarized plots had increased shoot length and the increase was also significant. This shows that solarization had some effect in preparing the seedling ready for transplanting compared to the other treatments.

4.2.3 Effect of various treatments on root length in the first trial

The data of root length of seedlings on the 25th day after sowing as well as the results of statistical analysis done to find out the effect of different structures and treatments on the root length of tomato and brinjal are given in table 4.3.

The effect of the protected cultivation structures on root length of seedlings was not similar to that of shoot length. The shoot length was higher for the seedlings from the shade house, but the difference was not significant. Also there was no difference in root length of seedlings with the treatments, in the case of tomato and brinjal.

4.3 TRIAL-2

4.3.1 Effect of various treatments on germination

The seeds were sown on 25th September,2009.The data of number of seedlings ready for transplanting on the 25th day after sowing as well as the results of statistical analysis conducted to study the effect of different protected structures and different treatments on the germination rate of tomato and chilli are given in table 4.4.

There was no significant difference in the number of seedlings of tomato received on 25th day between the structures. But there were significant difference in number of seedlings of tomato between the treatments. Solarized plots gave the maximum value. There was no significant difference in germination of chilli between the structures. But in the case of chilli the best performance was from the propagation trays, followed by solarized bed and the difference was significant. Even though there was no significant difference in the number of seedlings between the structures, it is seen that it was higher in the low tunnels than in other treatments for both the crops.

4.3.2 Effect of various treatments on shoot length of tomato and chilli

The data of shoot length of seedlings on the 25th day after sowing as well as the results of statistical analysis done to find out the effect of different structures and treatments on shoot length of tomato and chilli are shown in table 4.5. There was significant difference in shoot length between the structures. Low tunnels showed the best performance.

The shoot length of chilli also varied between the structures. The seedlings in the low tunnels had maximum shoot length followed by that in green house. Different soil treatment methods or rooting media did not have any effect on the shoot length of tomato or chilli.

4.3.3 Effect of various treatments on root length of tomato and chilli

The data of root length and results of statistical analysis of tomato and chilli are given in table 4.6. The root length of tomato showed significant difference between structures. Seedlings in the low tunnel gave maximum root length. There was no significant difference in values of root length for chilli between structures and in between the treatments.

4.4 Comparison of the effect of different structures on crop performance to that of open field

4.4.1 Trial 1

The performance of seedlings under different structures was compared with that of open field conditions. The comparison of various factors on crop performance is shown in figures 4.3 to 4.14. From the graphs plotted from trial 1, we can infer that, protected structures show greater effect on nursery raising of solanaceous crops than from the open field conditions. The seedlings in protected structures gave better performance.

Greenhouse has shown maximum number of seedlings, followed by low tunnels and then shade house. Better shoot length was shown by greenhouse, but root length performance was better in shade house

4.4.2 Trial 2

In the case of trial 2, the result was different. From the rainfall data given in appendix 2, it is seen that rainfall was less during the 2nd trial period. At that time the performance of the seedling was better in the low tunnels than in the other structures. The reason for this difference may be due to the change in the amount or intensity of rainfall.

In both cases the performance of the seedlings was better in the protected cultivation structures. From the economic point of view also it is better to have low tunnels for raising vegetable seedlings than in green houses.

As a general conclusion from the study it was found that, it is better to raise solanaceous vegetable seedlings in greenhouse during the peak rainy season and to raise them in low tunnels during the rest of the period. It was also found that the best soil media (treatment) among the three treatments tried, was the one that was solarized before sowing.

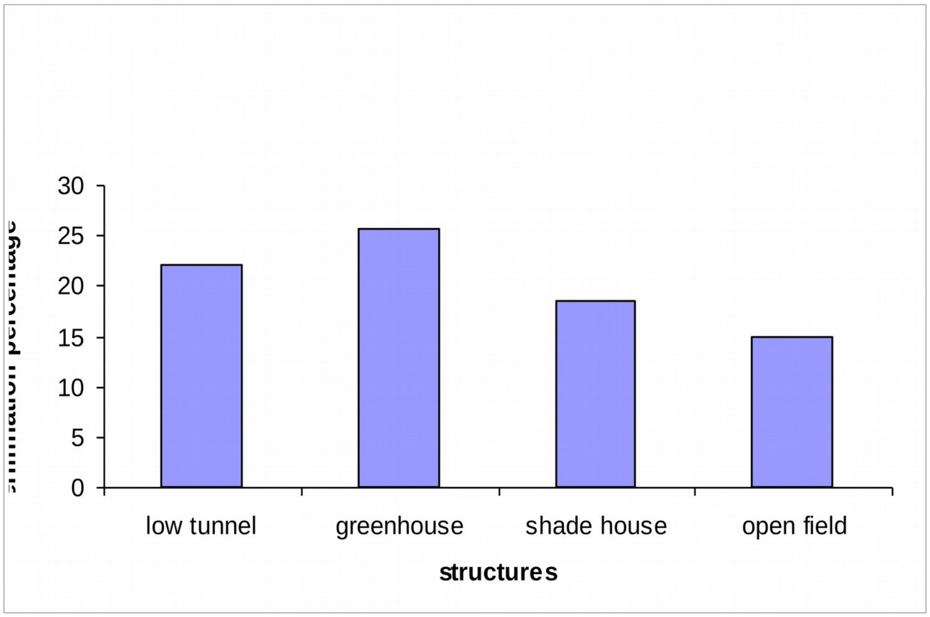

Fig. 4.3. Comparison of number of brinjal seedlings raised under different field conditions(Trial 1)

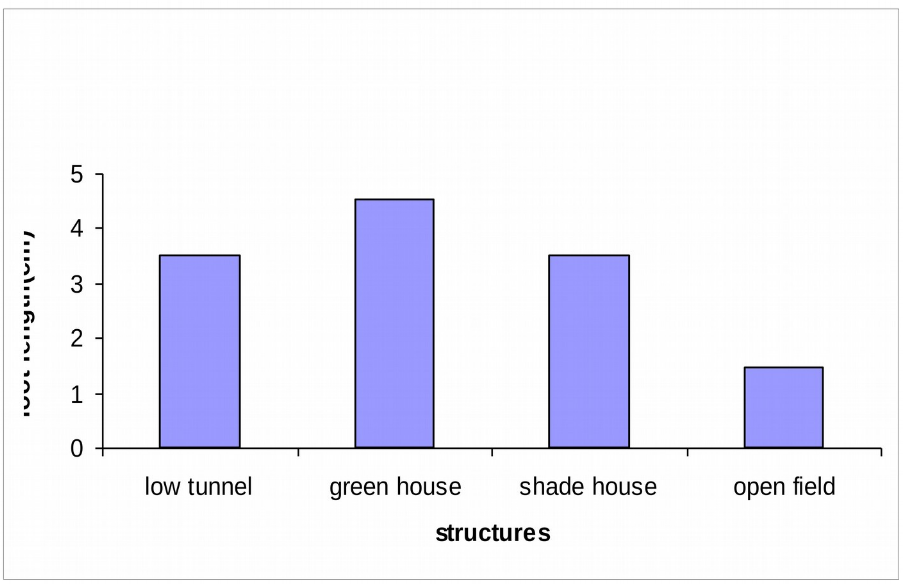

Fig.4.4. Comparison of shoot length of brinjal seedlings raised under different field conditions(Trial 1)

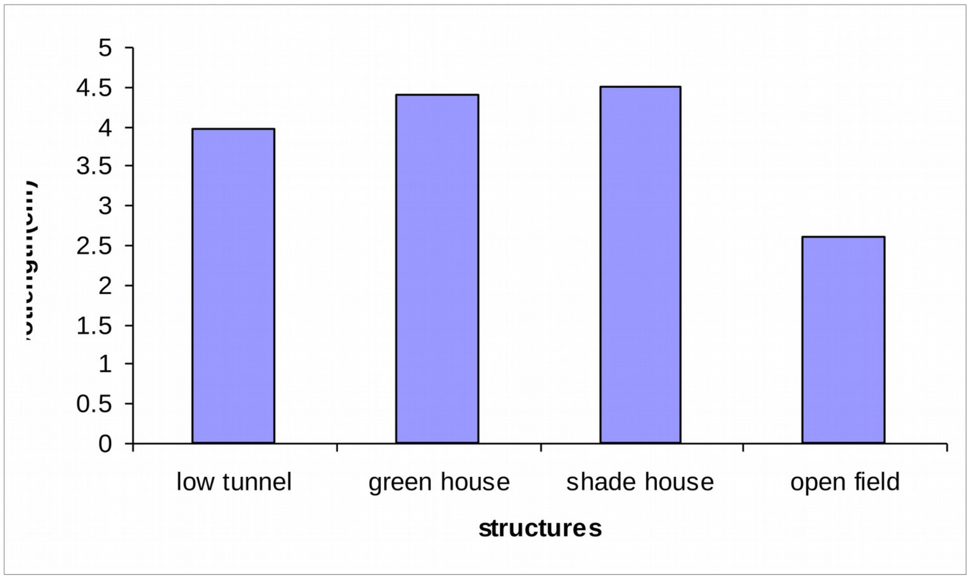

Fig. 4.5. Comparison of root length of brinjal seedlings raised under different field conditions(Trial 1)

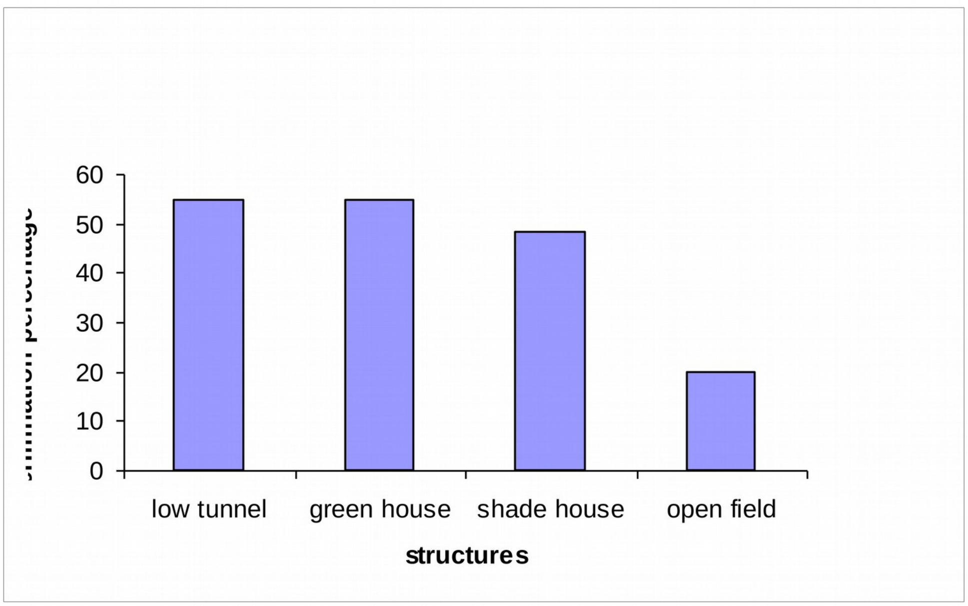

Fig.4.6. Comparison of number of tomato seedlings raised under different field conditions(Trial 1)

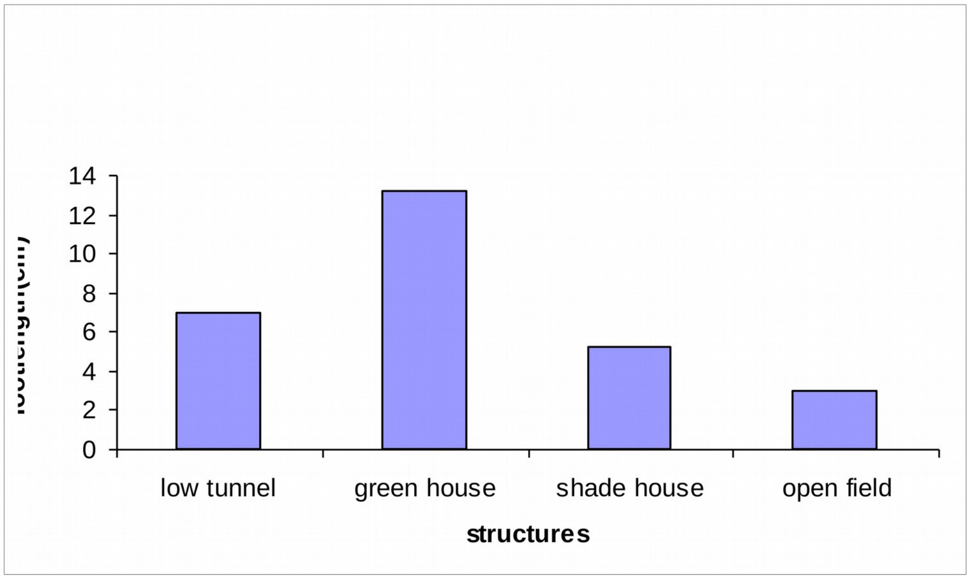

Fig.4.7. Comparison of shoot length of tomato seedlings raised under different field conditions(Trial 1)

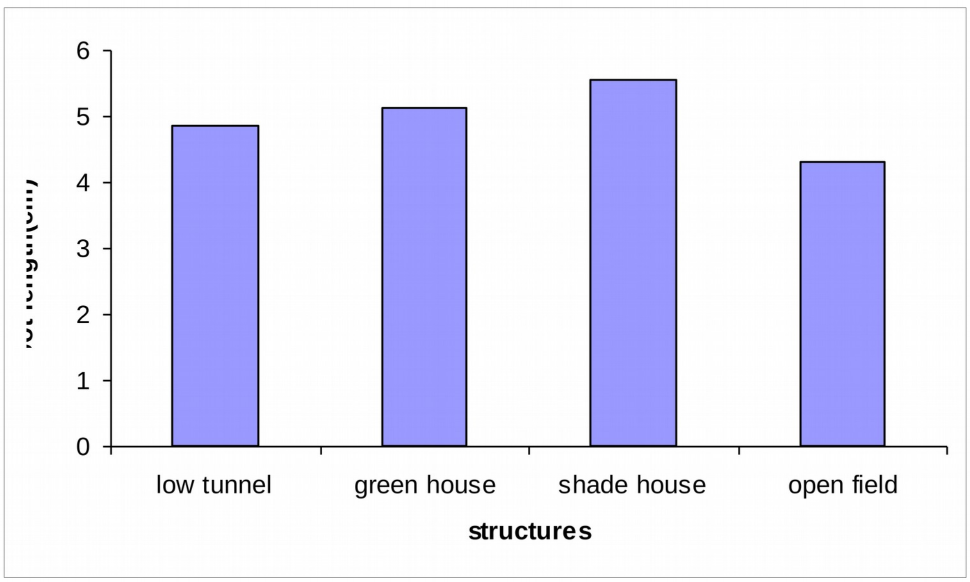

Fig.4.8. Comparison of root length of tomato seedlings raised under different field conditions(Trial 1)

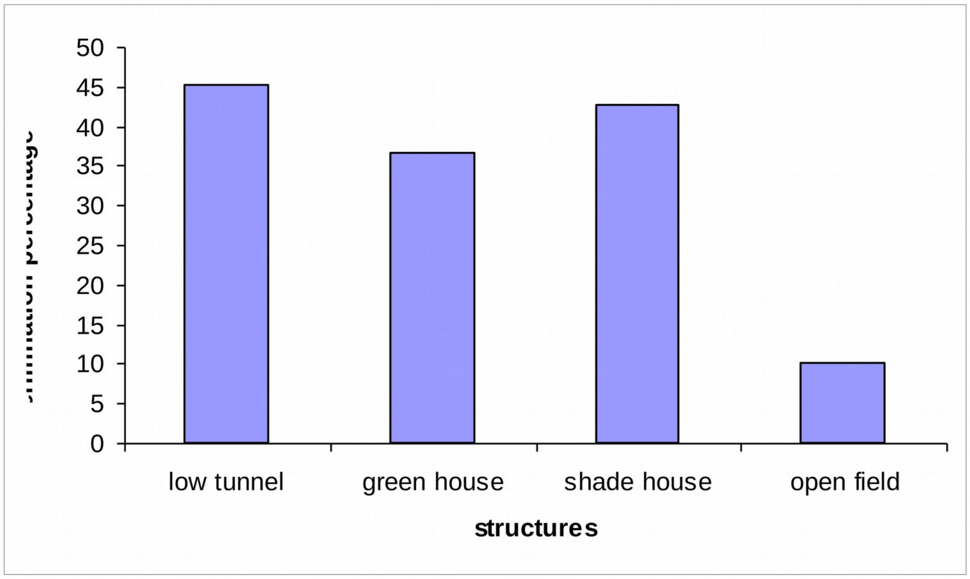

Fig .4.9. Comparison of number of tomato seedlings raised under different field conditions(Trial 2)

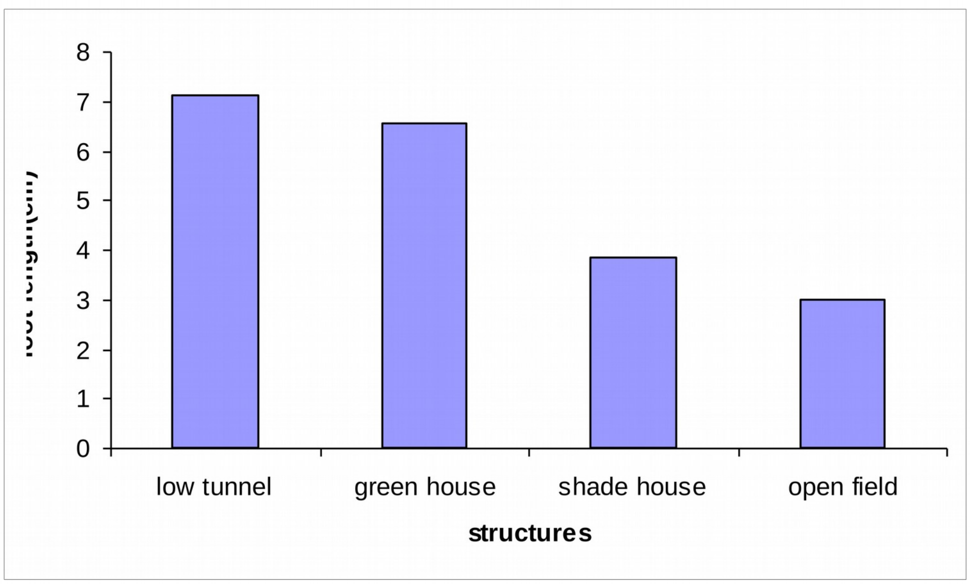

Fig. 4.10. Comparison of shoot length of tomato seedlings raised under different field conditions(Trial 2)

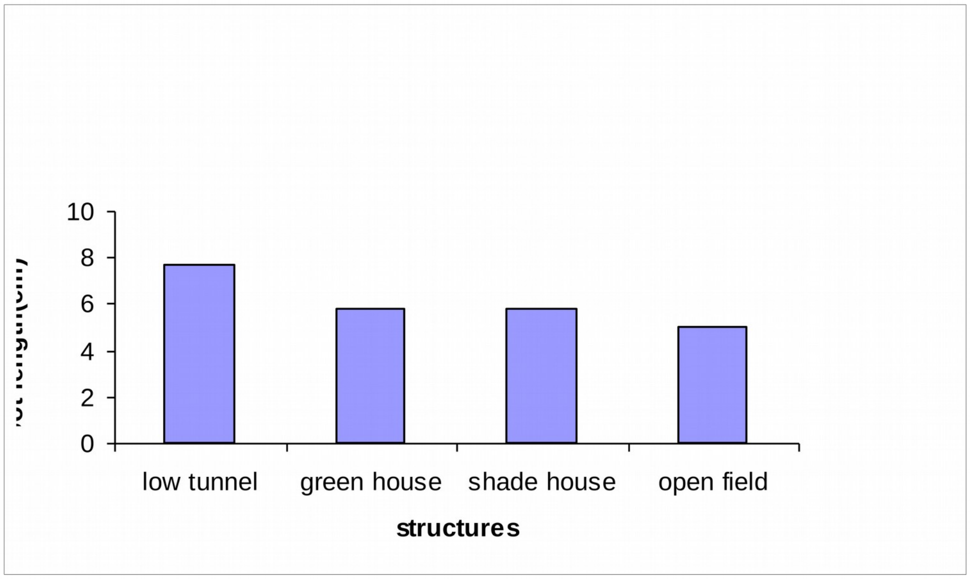

Fig.4.11. Comparison of root length of tomato seedlings raised under different field conditions(Trial 2)

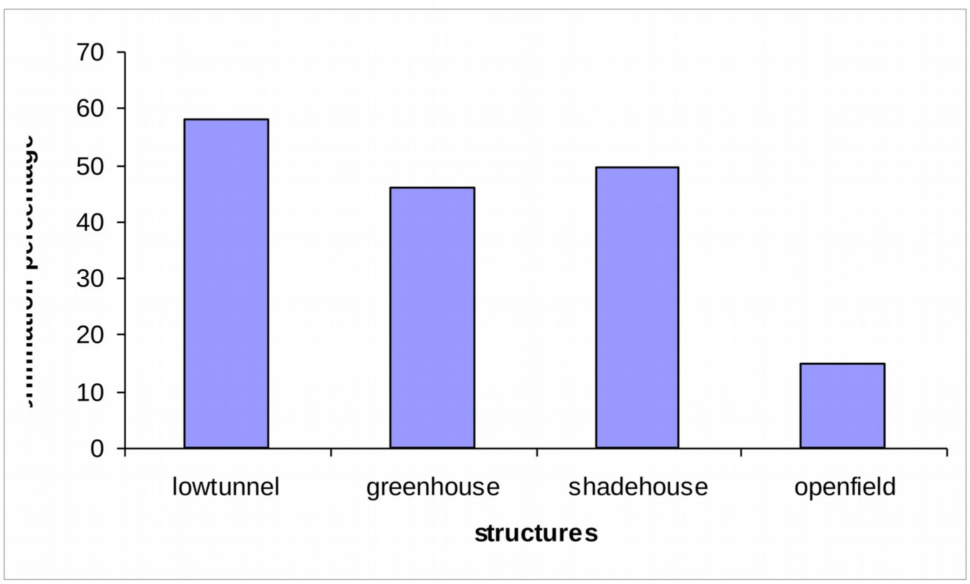

Fig.4.12. Comparison of number of chilli seedlings raised under different field conditions(Trial 2)

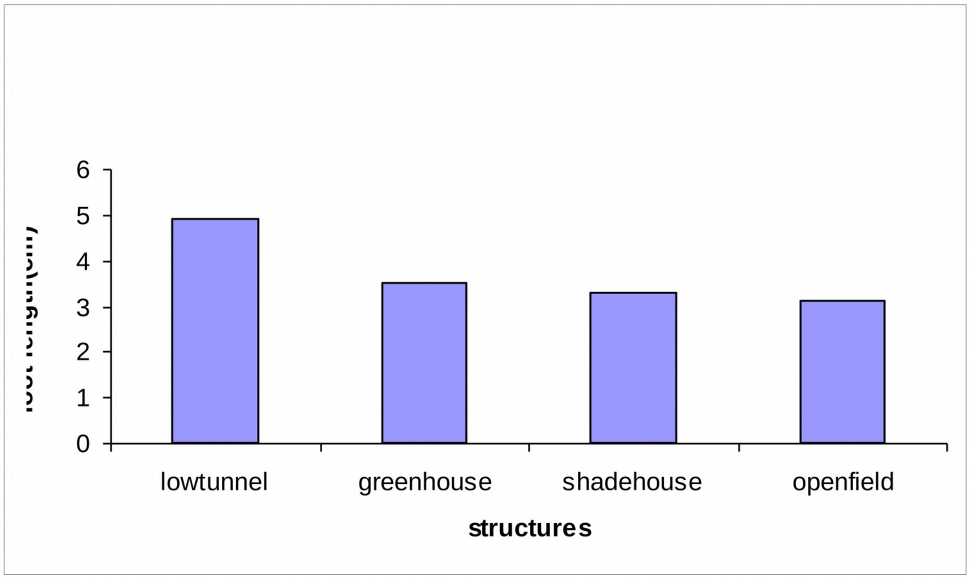

Fig. 4.13. Comparison of shoot length of chilli seedlings raised under different field conditions(Trial 2)

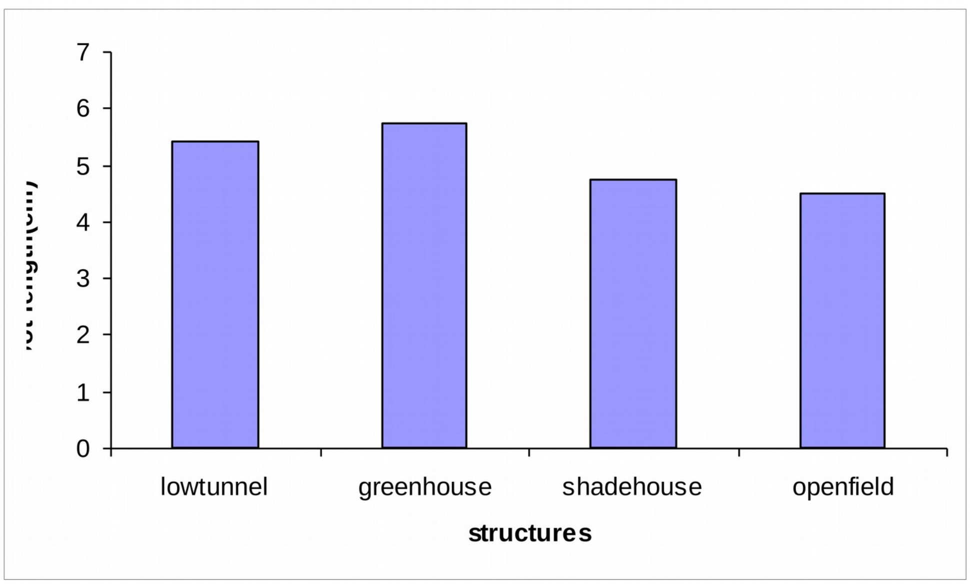

Fig.4.14. Comparison of root length of chilli seedlings raised under different field conditions(Trial 2)

Summary and conclusion

SUMMARY AND CONCLUSION

The study was conducted to evaluate the suitability of different protected structures for nursery raising of solanaceous vegetables under different treatments and to compare its performance with that of the open field conditions. The structures selected were low tunnels under shadenets, greenhouse and shade house. The treatments given were solarization, propagation trays with coco peat as rooting medium and control. The performance of the structures was assessed in terms of germination, shoots and root length and was compared.

The results obtained from the experiments conducted during the present study are summarized below.

During the period of solarization, the maximum average temperature was obtained under solarized bed in open field (53^0C), while that from non-solarized plot was 47.5^0C. Thus, it was found that solarization could increase the soil temperature by around 7^0C. When a shade net was provided above the solarized bed in openfield, the soil temperature of the solarized bed decreased. Under this condition, the maximum soil temperature was recorded from the non solarized plot in the open field (43^0C). Thus it can be interpreted that providing a shadenet decreases the soil temperature to a considerable manner.

The experiment was conducted in two trials, first during August-September and second during September-October. In trial 1, the performance of seedlings (number of seedlings) under Greenhouse was better, followed by that in low tunnels and then shade house. The shoot length of the seedlings was also higher in greenhouse, but the root length performance was better in shade house.

In the case of trial 2, the result was slightly different. From the rainfall data, it is seen that rainfall was less during the 2nd trial period. At that time the performance of the seedling was better in low tunnels than in the other structures. The reason for this difference may be due to the change in the amount or intensity of rainfall.

As a general conclusion from the study in can be concluded that it is better to raise solanaceous vegetable seedlings in greenhouses during the peak rainfall period and to raise them in low tunnels during the rest of the period. The various treatments did not have significant difference in all cases, but the solarized plots were seen to be better in most of the cases.

In general, it was found that for Kerala condition, especially in the rainy season it is better to raise seedlings of solanaceous vegetables under protected structures and that it is more effective than raising seedlings under open field conditions, especially in terms of number of seedlings emerged, shootlength and rootlength.

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RAISING QUALITY VEGETABLE SEEDLING UNDER CONTROLLED ENVIRONMENT CONDITIONS

By

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SANDRA.S

SUMA.M

VISHAL VIKRAMAN

ABSTRACT OF THE PROJECT REPORT

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In
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Faculty of Agricultural Engineering and Technology

Kerala Agricultural University

Department of Irrigation and Drainage Engineering

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR - 679 573, MALAPPURAM

KERALA, INDIA

2009

Abstract

ABSTRACT

The nursery is a place for rearing and multiplying plants with minimal damage and maximum success. Conventionally, vegetable seedlings are grown in open fields which lead to the production of weak seedlings. An attempt was made to raise vegetable seedlings in protected structures. Different structures and media were tried for the same. Greenhouse was found more suitable for nursery raising of solanaceous vegetable crops during the peak rainy season. Seedlings raised in low tunnels showed better performance during the rest of the period. The various treatments did not have significant difference in all cases, but the solarized plots were seen to be better in most of the cases. In general, it was found that nursery raising of solanaceous crops under protected structures are more effective during the monsoon period of Kerala than the open field nursery raising in terms of number of seedlings emerged, shootlength and rootlengh.