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(Revised Edition)

Protected Cultivation of Capsicum

INDIAN INSTITUTE OF HORTICULTURAL RESEARCH

HESSARAGHATTA LAKE POST, BANGALORE 560089

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PREFACE

CAPSICUM (Sweet Pepper or Bell Pepper), also popularly called as Simla Mirch in India is one of the leading vegetables grown in open conditions as well as under protected conditions. Because of its economic importance as a high value vegetable crop both in domestic and overseas markets due to more consumer preferences and use in various culinary products, quality production of capsicum is the need of the day. This has led to production of capsicum under protected conditions to meet the standards of different markets prompting popularity of this crop as an enterprise in urban and peri urban areas. The crop, once the domain of only the rich and elite farmers has today become a successful and profitable enterprise for small and marginal farmers also. The credit of this has to go to the consorted efforts of the scientists from IIHR, Bengaluru and few other stake holders in refining the technology of production of this crop suiting to Indian conditions and making the technology farmer friendly and easily adopted by all categories of farmers.

Of late, production of capsicum in protected conditions under poly/net houses has been facing many production and crop protection problems because of emergence of new challenges like emergence of new pests, soil borne diseases, micro nutrient deficiencies etc and a non organized sector of this crop is also facing the problem of marketability. To overcome many of such problems a team of scientists from IIHR, Bengaluru under took a study on identification problems in production and modify and refine the existing technology with the financial support from NABARD, Bengaluru. This publication is the product of the research and extension efforts of the scientists of the institute in this endeavor. This publication gives an all account of production of capsicum under protected conditions and is a very good hand book to even a beginner of capsicum crop production. I am sure that this publication would serve as a guide book to all capsicum growers, entrepreneurs, extension personnel, researchers and students, input suppliers, marketers and financial institutes. I appreciate the efforts of Dr B Balakrishna, Dr, M Prabhakar Dr Shankar S Hebbar Mr V Srinivas and all other contributors for providing the most required essential input for this publication. I also appreciate the pains taking efforts of Dr B Balakrishna and Shri P.B.Gaddagimath for editing and in bringing out this publication. I place on records the financial assistance provided by NABARD, Bengaluru for this project.

Date: 09.03.2012

Place: Bengaluru

A.S.Sidhu

(Director IIHR, Bengaluru)

CONTENT

Protected Cultivation of Capsicum

1. Introduction

India is a land of diverse agro climatic zones and each of these zones offer a great potential for cultivation of wide range of crops across all seasons. Vegetables form major and important part of our dietary requirements, which are widely grown in the rural and peri-urban areas. Hi-tech horticulture including protected cultivation of high value and exotic vegetables has been on the increase, targeting high end domestic and export market. Of late, due to the population pressure, fragmentation of land holdings and urbanization have led to decline in cultivable area, more so in urban and peri-urban areas. Production of vegetables under protected cultivation system results in effective use of the land resources, besides being able to increase the production of quality vegetables both for the export and domestic markets by offsetting biotic and abiotic stresses to a great extent that otherwise is prevalent in open cultivation. Under protected cultivation, capsicums are widely grown due to higher productivity and economic feasibility.

Capsicum, also known as sweet pepper, bell pepper or Shimla Mirch is one of the popular vegetables grown throughout India. It is rich in Vitamin A (8493 IU), Vitamin C (283 mg) and minerals like Calcium (13.4 mg), Magnesium (14.9 mg) Phosphorus (28.3 mg) Potassium, (263.7 mg) per 100 g fresh weight. Capsicum is a cool season crop, but

it can be grown round the year using protected structures where temperature and relative humidity (RH) can be manipulated. This crop requires day temperature of 25-30^{0}C and night temperature of 18-20^{0}C with relative humidity of 50-60%. If temperature exceeds 35^{0}C or falls below 12^{0}C, fruit setting is affected.

Coloured capsicums are in great demand in urban markets. The demand is mostly driven by hotel and catering industry. The traditionally grown green capsicum, depending upon variety and season, usually yields 20-40 tons per hectare in about 4-5 months. In greenhouse, the crop duration of green and colored capsicums is about 7 -10 months and yields about 80-100 t per hectare. The advantages of protected cultivation are;

- ☞ Higher productivity resulting in increased yield,
- ☞ Provides better growing environment to plants,
- ☞ Protects from rain, wind, high temperatures and minimizes the damage of insect pests and diseases thereby improving the quality and yield,
- ☞ Facilitates year round production coupled with yield enhancement by 2-3 times compared to open cultivation.

Research and development of greenhouse/protected cultivation of vegetables was initiated at IIHR, Bengaluru in the year 2000 and the complete package for protected cultivation of capsicum was developed by 2005. Since then many farmers and entrepreneurs have adopted the

protected cultivation of vegetables, especially coloured capsicum, on commercial scale and are being benefited. Some of the points that have to be considered for successful cultivation of the crop have been enumerated in the following pages.

2. Selection of Site

Selection of site for taking up of protected cultivation is a critical step and this has to be done with utmost care. Places having high rainfall and humidity are not suitable for its cultivation, since this encourages many foliar diseases. Also the areas with high wind velocity are not suitable since they are likely to damage the structure and the polyethylene sheet frequently, thereby enhancing the maintenance cost of the structure. Avoid the location or area where heavy rains accompanied with gusty winds are prevalent to avoid damage to the protected structure. Well drained sandy loam soils having good percolation is most suitable to grow capsicum. The soil pH of 6 to 7 and EC < 1 mm hos/cm is ideal for growing capsicums.

3. Green house structures

The green house is designed depending on the prevailing local climatic conditions. A good number of different types of structures are built for protected cultivation. However, cost effective poly house and net house structures are most commonly used to grow capsicum in our country.

a) Net house (Shade net house):

Growing of vegetables in net house is the cost effective method in

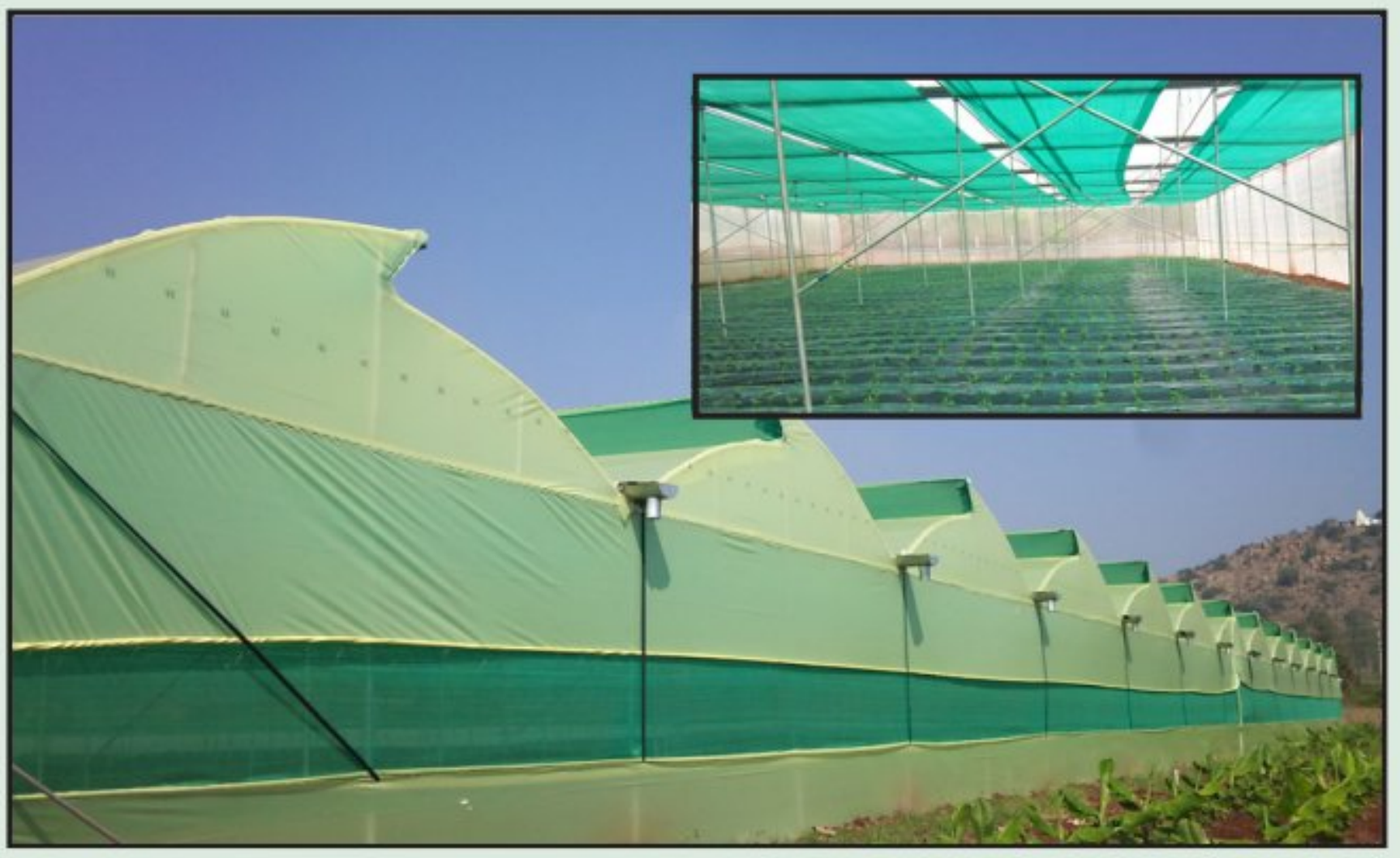
many parts of southern states particularly in and around Bangalore. It is mainly due to easy availability of the granite pillars, which can give good strength to the structure and highly durable. Net houses are constructed using granite stone pillars of 12 feet height, 8 inch X 4 inch thickness. These pillars are placed at 2 feet depth inside the soil with concrete cement grouting. Uneven and sharp edge of stone pillars on the top has to be covered with smooth materials like rubber tubes to avoid tearing of net. A G.I wire grid is provided on the top of granite pillar to support the shade net. Over the GI wire grid, 50% HDPE white shade net is fixed to support another layer of shadenet (green or black with 35% shade), which is movable or retractable. This additional shade net is used during hot summer mid days (Feb-June), sparingly during winter season and whenever the sunlight is more between 11.00 am to 3.00 pm. UV stabilized 40 mesh nylon net is provided on all sides of the net house. Construction of net house costs about Rs.180-200 per sq mtr.

b) Poly house:

Poly house gives better protection compared to net house due to total avoidance of rain water entry into polyhouse; hence leaf diseases can be easily controlled. Yield is normally 15-20 per cent more in polyhouse compared to net house.

GI pipes are used to construct poly house and in some cases farmers use wooden or stone pillars which require less initial investment. Transparent UV stabilized polyethylene film, 200 micron thickness is

used for covering the poly house roof. It is provided with retractable or movable shade nets, at about 11 feet height just below the structures from ground level. The



sides of the polyhouse are covered with 200 micron thick polyethylene film to a height of 3 feet from the ground level, to have better protection from rain splash. Remaining height of side wall is covered with 40 micron white coloured insect proof net from all the four sides. Construction of poly house costs about Rs.500 per sq. mtr.

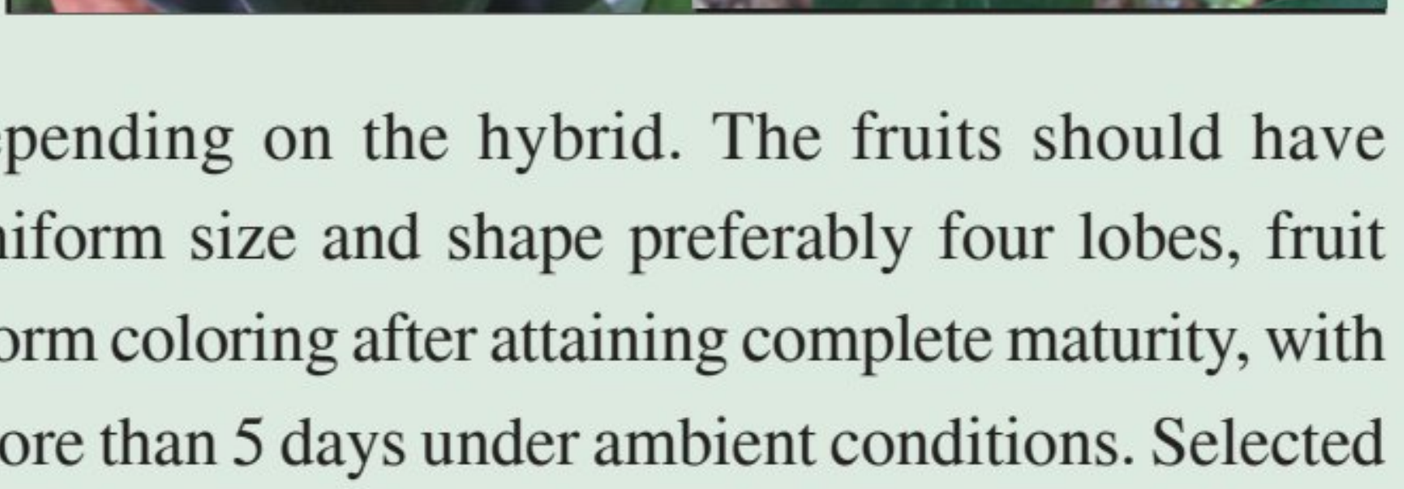
Nethouse and polyhouse is provided with an ante chamber with two doors constructed at opposite directions where entry or exit to the poly/ net-house is made through the first door and then after closing the first door, the second door is opened to make an entry into the polyhouse. Care should be taken not

to open both the doors simultaneously to avoid the entry of pests into the protected structures. A small concrete trough of 2 meter length, 1 meter breadth and 2 inch depth should be prepared between the two doors of antechamber for facilitating washing legs in the disinfectant solution (Potassium permanganate) to prevent any contamination inside the polyhouse/ net-house.

4. Cultural and Nursery practices

4.1. Selection of cultivars

Growing of capsicum hybrids in green house is useful to obtain continuous and regular flower and fruit setting relatively for a long period of 8 to 10 months. Most of the capsicum hybrids produce green fruits that mature to red, orange or yellow depending on the hybrid. The fruits should have characters such as uniform size and shape preferably four lobes, fruit weight of >150g, uniform coloring after attaining complete maturity, with a better shelf life of more than 5 days under ambient conditions. Selected hybrid should be high yielding, with potential yield of >40t/acre. Hybrids should have shorter intermodal lengths (7 to 10 cm), attaining maximum height of 10 feet in a crop period of 10 months. Popularly grown commercial hybrids in India include Indra, Yamuna (Green); Bomby, Triple star, Natasha, Inspiration, Pasarella (Red); Sunnyez, Swarna, Orobelle, Bachata (Yellow). Capsicum hybrids with high yield potential (>100 t/ha) and having uniform size and shape needs to be selected. Hybrids preferably should have long growing period of 8-10 months. Fruits should have



characters such as four lobes, uniform colour and ripening with better shelf life.

4.2. Nursery raising

- Good quality seeds are required for producing better seedlings. The seedlings are raised in pro-trays of 98 cells or cavities. About 16,000 to 20,000 seedlings are required to plant one acre for which 160-200 gm of seeds is required.

- The pro-trays are filled with sterilized cocopeat and seeds are sown, one seed per cell to a depth of ½ cm and covered with the same media

- The filled trays are staked one above the other and covered with plastic sheets till germination of seeds.

- Seeds germinate in about a week's time after sowing. The trays are shifted to net house/ polyhouse and lightly watered. After 15 days of sowing, Mono ammonium phosphate (12:61:0) (3g/L) and 22 days after sowing 19:19:19 (3g/L) solution has to be drenched. The seedlings in protrays are drenched with COC 3g/L before transplanting. The seedlings will be ready for transplanting in 30-35 days.

- Spray imidacloprid @ 0.2 ml/L and chlorothelonil @ 1gm/L before transplanting of seedlings. Always add about 0.3 ml/L of wetting agent per liter of water with each spray of pesticide.

5. Land preparation

The land should be thoroughly ploughed and soil should be brought to fine tilth. Well decomposed organic manure at the rate of 20-25 kg per sq mtr is mixed with soil. One application is sufficient to grow three capsicum crops successively. Raised beds are formed after bringing soil to fine tilth. The bed size should be 90-100 cms wide and 15-22 cms height. Between the beds walking space of 45 cms to 50 cm need to be provided.

6. Fumigation

The crop beds are drenched using 4 per cent formaldehyde (@4 L/ m^2 of bed) and covered with black polyethylene mulch sheet. While treating with formalin, care should be taken to wear mask, gloves and apron. Four days after formalin treatment, the polyethylene cover is removed; the beds are raked repeatedly everyday to remove the trapped formalin fumes completely, prior to transplanting. Formalin treatment can be repeated after three crop cycles or whenever necessary. Fumigation with formaldehyde helps to minimize the soil borne diseases. Basamid can also be used for soil sterilization.

7. Fertilizer application

A basal fertilizer dose of 20:25:20 NPK is required per acre and is applied to the beds uniformly before transplanting in the form of 80 kg calcium ammonium nitrate, 125 kg super phosphate and 32 kg murate of potash or 40 kg sulphate of potash.

8. Application of neem cake and Microbial Bio-control Agents

Fifteen days before transplanting, neem cake has to be enriched with bio agents like *Trichoderma harzianam* and *Pseudomonas lilacinous*. Neem cake of about 200 Kg is powdered and slightly moistened. *Trichoderma harzianam, Pseudomonas lilacinous* and *Paecilomyces chilmdosporia* each of two kg are mixed thoroughly to the neem cake. The mixture is covered with wet gunny bags or dry grass and left for 8-10 days. Avoid direct exposure to sunlight and rainfall. After 10 days, this enriched mixture of neem cake and bio-agent along with 600 kg of neem cake has to be applied uniformly to the beds for an area of one acre. This is highly useful to reduce the problem of soil borne pathogens and nematodes. *Azospirillum* or *Azoctobacter* or VAM which is a nitrogen fixing bacteria can also be applied to the growing bed.

9. Laying of drip line

Place one 16mm inline drip lateral at the center of the bed having emitting points at every 30 cm interval with discharge rate of 2 ltr/hr or 4 ltr/hr. Run the drip system to check each emitting point for uniform discharge before covering the beds with polythene mulch.

10. Mulching and Spacing

Black polyethylene non-recycled mulch film of 30-100 micron thick, 1.2 m wide, is used to cover the planting beds. Holes of 5 cm diameter are made on the polyethylene film as per the recommended spacing (45cm x 30cm). The planting beds are covered with the film by securing the edges of the sheet firmly in the soil. Mulching practice conserves water, controls weeds, reduces infestation of pests and diseases and results in higher yield and good quality produce.

11. Transplanting

The planting beds are watered to field capacity before transplanting. Seedlings of 30-35 days old are used for transplanting. Care should be taken to see that no damage is occurred to roots, while taking out the seedlings from individual cells of portray. Seedlings are transplanted into holes made in polyethylene mulch film at a depth of 5 cm. After transplanting, seedlings are drenched with 3 g/L copper oxy chloride or 3 g/L captan or 2 g/L copper hydroxide solution to the base of seedlings at the rate of 25-30 ml per plant. Watering

the mulched beds daily during afternoon by using hose pipe for a week continuously is essential to avoid mortality due to heat trapped by mulch sheet.

12. Pruning

Capsicum plants are pruned to retain four stems. The tip of the plant splits into two at 5^{th} or 6^{th} node and are left to grow. These two branches again split in to two giving rise to four branches. At every node the tip splits into two giving rise to one strong branch and one week branch. The pruning is done after 30 days of transplanting at an interval of 8 to 10 days, resulting in bigger fruits with better quality and high productivity. The capsicum plants can also be pruned to two stems and same level of yield can be maintained.

13. Training

The main stem of plant is tied with four plastic twine to train along and tied to GI wire grid provided on the top of the plants. This is practiced after four weeks of transplanting. The new branches and plants are trained along the plastic twines.

14. Drip irrigation and Fertigation

Drip irrigation is given to provide 2-4 liters of water per square meter per day depending on the season.

Water soluble fertilizers are given through fertigation for entire crop growth period, starting from third week after transplanting. Fertigation is to be given twice a week as recommended in the table below.

Sl.No	Required fertilizer	Fertilizer dosage per fertigation (kg/ac)
1.	19:19:19	4 kg
2.	Potassium Nitrate	1.5 kg
3.	Calcium Nitrate	1.5 kg

Capsicum crop is sprayed with water soluble fertilizers like potassium nitrate and calcium nitrate at every 3 week interval after 2 months of transplanting @ 3g/l as foliar application. Apart from these sprays, vegetable special (a micronutrients formulation developed by IIHR, Bengaluru for foliar spray) @ 5g/L are also to be sprayed.

15. Integrated Pests and Diseases Management

Capsicum being relatively long duration (9-10 months) crop in polyhouse, the plant parts (vegetative, floral & fruit) are more exposed to adverse effect on the yield, quality and market value of the produce. Hence their identification and management at right stage of the crop should be given importance. The major pests and diseases, their symptoms and their

management in capsicum are given below. The major focus has been given on adoption of integrated approach in managing pests and diseases, that help to reduce the pesticide load, cost of chemicals and avoid the resurgence of pests and diseases.

15.1. Insect Pest and Management

1. Thrips

Symptoms: Thrips cause upward curling of leaves, sucks sap and reduce leaf growth, plant growth, yield and market value of produce. It also reduces leaf area and hinders absorption of nutrients and water by the plants. Increased infestation leads to blackening and drying of leaves and irregular fruit bearing.

Management: Remove affected plant parts including leaves, flowers and fruits. Keep the plots clean by removing all the dropped plant parts. Spray Pongamia oil (5-8 ml/L) or Neem seeds kernel extract (NSKE 4%) or Pongamia / Neem soap developed by IIHR (7gm/L) or fipronil (1ml/L) or chloropyriphos (2 ml/L) or acephate (1.5g/L) or Imidacloprid (0.5ml/L). Drenching of soil using chloropyriphos (4ml/L) or imidacloprid (0.5ml/L).

2. Mites

Symptoms: Young larvae and adults feed on leaves, bud and fruits, suck sap from plant parts which in turn causes downward curling of leaves. The size of leaf, fruit and plants gets reduced, fruit and flower

drop affecting the market value of the produce. This pest infestation increases with increased temperature coupled with high humidity.

Management: Remove the pest damaged plant parts including leaves, flowers and fruits and spray Pongamia oil (5-8 ml/L) or Pongamia / Neem soap (8-10 g/L) or dicofol (2ml/L) or wettable sulphur (2ml/L) or abamectin (0.5ml/Ll) or ecomite or propargite or chlorophenapyr (1ml/L) or fenazaquin (1 ml/L).

3. Aphids

Symptoms: Nymphs and adult aphids suck sap from leaf veins and younger leaves resulting in reduced plant growth and decrease in yield. Its infestation not only causes curling of leaves but also spreads viral diseases.

Management: Keep a close watch on the plants at regular intervals for aphids' infestation. Spray Pongamia / Neem soap (8-10 g/L) or imidacloprid (0.5ml/L) or thiomethoxam (0.5g/L) or dimethoate (2ml/L).

4. Fruit borer

Symptoms: Fruit borers are very active during night. The adults lay eggs on fruits, flowers and leaves in large number and the nymphs that

come out of eggs, feed on fruits and leaves causing heavy destruction of crops and severely affects the quality of the produce. Whenever night temperature is low, coupled with cool and high humidity the infestation is increased. Since eggs are laid in group, the larva also feeds gregariously on leaves at one place, which can be easily identified and destroyed.

Management: Pick and destroy nymphs and adult insects. Generally eggs are laid and hatch in groups, which is easy to identify from a distance. Hence they should be identified and destroyed immediately. Spray thiodicarb (1ml/L) or carbaryl (3g/L) or indoxcarb (1ml/L) or rynaxypyr (0.5ml/L) or chlorofenfur (1.5ml/L) or fipronil (1ml/L). In addition to the sprays, grownup adults should be subjected to methomyl baiting*, which is a safe, healthy and effective practice.

* ***Methomyl baiting procedure:*** Prepare a mixture of 10 kg paddy husk and 1 kg jaggery solution and store for 6-8 hrs. Add ½ kg methomyl to the mixture. Small sized balls of mixture are made which are spread near the root zone of the plants and also around poly house/ nethouse to avoid infestation of fruit borer. It should be applied during night hours, and the domestic or pet animals should not be allowed to move in and around net/ polyhouse over night.

5. Nematodes

Symptoms: Nematodes are commonly seen in solanaceous crops when grown 3-4 times continuously in the same field. Initially yellowing of leaves can be observed followed by reduction in leaf size, count and

drastic reduction in size of fruits. When infected plant is uprooted and observed, small and big nodes filled with large number of nematodes nodules can be observed on roots depending on the level of infestation.

Management: Go for crop rotation with non-solanaceous crops like marigold, sweet corn and cabbage to avoid nematode. Bio-pesticides enriched Neem cake (as explained earlier) is to be applied @ 800 kg/ acre 4-5 days before transplanting to the beds. Apply carbofuran (furadan) granules @ 20kg /acre at the time of planting. Keep a close watch on nematode infestation of the plants, particularly in 2nd and 3rd crop.

The insecticides should always be mixed with spreader or sticker while spraying. The plants from top to bottom should come in contact with spray for better result and care should be taken to compulsorily cover the entire body with full clothes, mask, gloves and aprons while spraying.

15.2. Diseases and Management

1. Damping off

Symptoms: Infection takes place at the base of the young seedlings just above the ground level which leads to wilting and

later death of seedlings. Any damage caused to seedlings while transplanting can also lead to damping off or seedling wilt besides fresh infection in main field or infection that is carried from nursery.

Management: Drench carbendazim (1g/L) or metalaxyl MZ (2g/L) or copper oxychloride (3g/L) or captan (3g/L) drenched to the base of the plant at about 25-50 ml/plant.

2. Powdery mildew

Symptoms: The disease initially appears as tiny yellow spots on surface of leaf and powder like material on the lower surface leading to a powdery growth

covering the entire lower surface of leaf which leads to drying and dropping of leaves at later stages. The disease reduces growth of leaves and fruits leading to low quality and quantity of the produce.

Management: Spray Pongamia /Neem oil (7ml/L) + sulphur WDG-80 (2g/L) or wettable sulphur (2g/L) or hexaconazole (0.5ml/L) or myclobutanil (1g/L) or dinocap (1 ml/L) or azoxystrobin (0.5ml/L) or penconazole (0.5ml/L) or flusilazole (0.5ml/L).

3. Cercospora leaf spot

S y m p t o m s : Cercospora appears initially as tiny yellow spot on leaf surface leading to increased dark grey spots which spreads on entire leaf resulting in dropping of leaf.

Management: Spray chlorothalonil (2.5g/L) or mancozeb (2.5g/L) or carbendazim (1g/L)

4. Phythopthera

Symptoms: This disease appears during fruiting and flowering stage resulting in tiny oil like spot on leaf surface resulting in rottening and blackening of plants. Later plant weakens and dies in 2-3 days. Heavy and continuous rainfalls coupled with high humidity favour

disease appearance and its quick spread. Phythopthera disease is relatively more severe in net houses which may lead to 40-80 per cent crop damage.

Management: Spray copper hydroxy chloride (3g/L) or bordeaux mixture (1%) or metalaxyl MZ (2g/L) or dimethomorph + mancozeb (1 g + 2.5g/L) or fosetyl aluminium (2g/L) or azoxystrobin (0.5ml/L). Severely infected plant parts should be destroyed. It is better to avoid capsicum cultivation in severely affected net-houses.

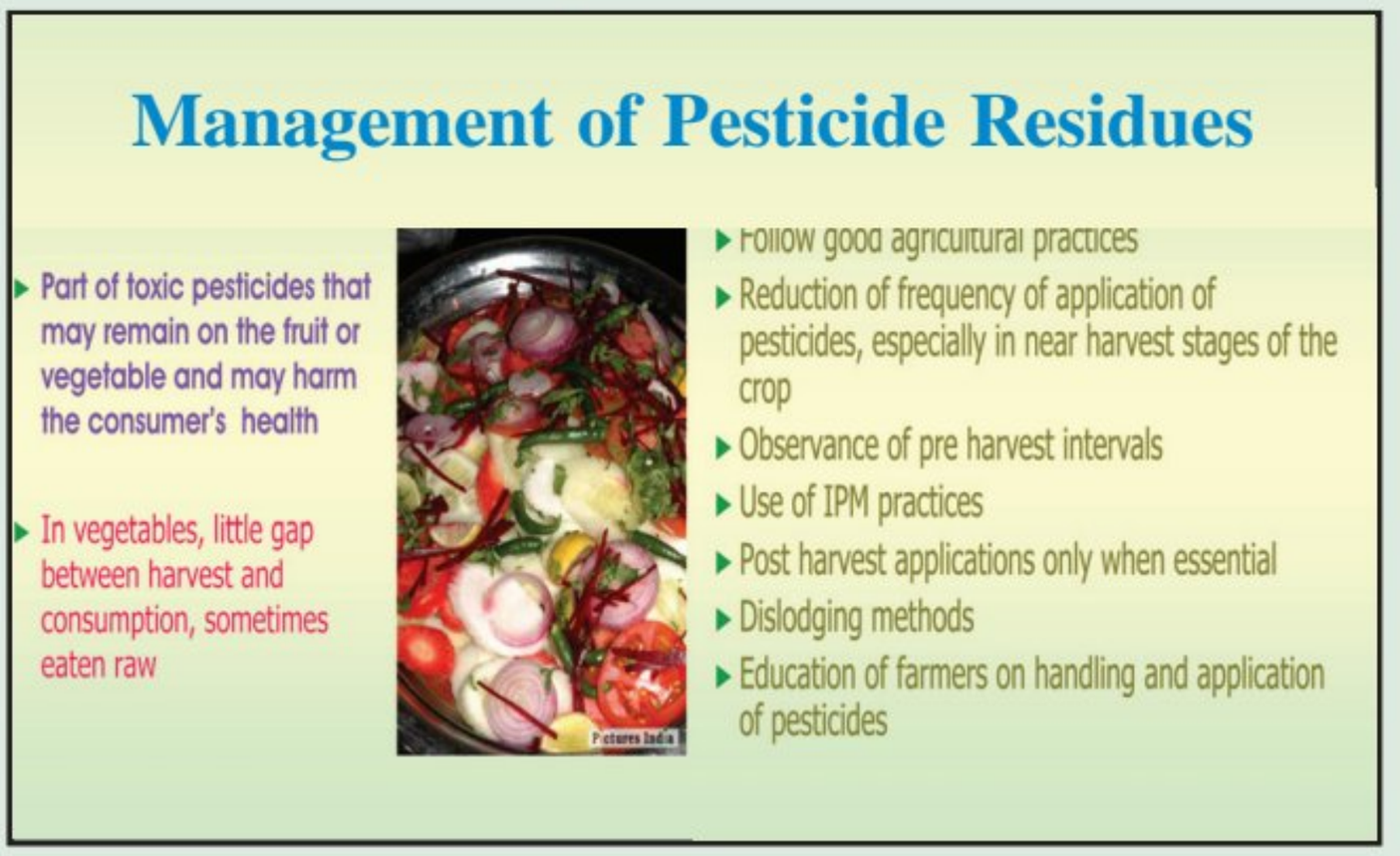
5. Viral diseases

Symptoms: Viral diseases are tramsmitted through aphids and thrips leading to upward and downward curling of leaves with yellow spot in the middle of leaf and sometimes on fruit also. Heavy infestation leads to dropping up of leaves, stunted plant growth and reduces quality and quantity of fruits. Virus affected fruits are unmarketable.

Management: Grow nursery beds under nylon cover (50 mesh), proper management of aphids, mites and thrips which acts as disease transmitting vectors and disposal of diseased/infected plants, control infestations of viral diseases.

c) Steps to be followed during use of pesticides and insecticides

- Pesticide residues in produce sent



for marketing should not cross the safety level (MRL) of the respective pesticides.

- Always cover your body with protective wares viz., masks, gloves and apron while spraying the chemicals to avoid health hazards.

- Go for crop rotation (in net/polyhouse after continuous growing of same crop) with field/ pole beans, marigold, cabbage, cauliflower, sweet corn and also with any other profitable crop including sweet/ European cucumber or green peas as per market value.
- The doors of polyhouse/ nethouse should always be kept closed to protect from pests, diseases and foreign materials.
- Minimum number of entry or exit of the essential working staff and others only need to be entertained.

d) Pesticide residues

In poly house cultivation of capsicum, high plant density, mono cropping of susceptible genotypes and increased labour activities make

plants more prone to pests and diseases like mites, thrips, whiteflies, powdery mildew and nematodes. Thus, chemical control of pests become necessary and often several sprays of insecticides/fungicides are given even at near harvest stages of the crop. In a polyhouse the volatilization and wind drift losses of pesticides are lesser which may result in higher initial deposits of pesticide residues on the plant and soil, while degradation of pesticide residues may be higher due to higher average temperatures. Also, a polyhouse generally reflects back 43% of the net solar radiation incident upon it allowing the transmittance of the "photosynthetically active solar radiation" in the range of 400-700 Nm wave length. Thus there will be lesser UV radiation incident upon the crop in a greenhouse than in open field in the same area, especially if a shade net is also used. Since most pesticides are UV-degradable there is likelihood that pesticides will persist for a longer time. It is thus important to evaluate the persistence of pesticide residues in these crops under polyhouse conditions so that safe waiting period for important pesticides used in polyhouse cultivation may be established. There is no information in this area at national level and very little information is available even at international level. IIHR, Bengaluru has established that pesticides tend to persist for a longer time in crops grown in polyhouse when compared to crops grown in open field in the same season. Thus, it is important that waiting period of pesticides be established specifically for capsicum grown under

Insecticide	Target Pest	Safe waiting period (days)	MRL(EU) ppm
Abamectin	Mites	3	0.01
Acephate	Thrips	16	0.02
Chlorothalonil	Leaf spot	6	2.0
Dimethoate	Thrips,	10	0.02
Ethion	Mites	15	0.01
Imidacloprid	Aphids	7	0.5

polyhouse conditions and accordingly use of pesticides may be recommended for chemical control of pests in this crop and to make the produce safe for human consumption at harvest. Given below is a list of safe waiting period of some pesticides that have been worked out for capsicum grown in poly house.

However, there are a lot of other insecticides viz. thiamethoxam, rynaxypyr, indoxacarb, ecomite, dicofol, fipronil, propargite etc. and fungicides viz. mancozeb, metalaxyl, hexaconazole, dimethomorph, carbendazim, difenaconazole, azoxystrobin which are used in this crop or are recommended for use. Currently no data exist anywhere, even in literature, on residue persistence and waiting period for these pesticides in polyhouse grown capsicum. Since poly house cultivation of capsicum is gaining importance, there is an urgent need to generate residue dissipation data for these pesticides, and thereby establish safe waiting periods required for harvest. At IIHR, Bengaluru work has been initiated to determine the persistence pattern of pesticides and their waiting periods in polyhouse grown vegetables, especially, capsicum and tomato. Accordingly, persistence of residues of acephate, iprodione, chlorothalonil, abamectin etc. have been determined under polyhouse conditions.

16. Harvesting and yield

Early morning hours are best suited for capsicum harvest. Green capsicum can be harvested at 55 to 60 days after transplanting, yellow capsicum at 70-75 days whereas red capsicum at 80-90 days. Fruits can be harvested once in 3 to 4 days. Yellow and red fruits can be harvested when they have gained

50-80 per cent of the colour development. After harvest fruits should be kept in cool place and avoid direct exposure to sunlight. The fruits should be handled carefully by adopting clip harvest technique and scuffing should be minimized. The average yield of capsicum per acre is 30-40 tons.

17. Post Harvest Management

17.1 Grading

Capsicums are highly perishable in nature and lose water very rapidly due to shrivelling, drying & softening of the fruit which accelerates deterioration. Good quality fruits are selected and are cleaned with clean, dry and soft cloth to remove water drops or wetness or powdery residues of pesticides/ fungicides, if any, found on the fruits. Good quality fruits with 2-3 lobes weighing < 150 gram are graded as B grade fruits. Good quality fruits with uniform maturity, color, shape, size and free from defects spots, bruises or decay and pesticide residues should be used for packing while fruits showing signs of sunscald, mechanical or insect damage, or diseased misshaped and damaged fruits should be discarded. Generally fruits with 3-4 lobes weighing 150 gram and more are grouped as A grade fruits.

Only the graded fruits are packed in the cartoon boxes.

17.2. Packing and storage

Graded fruits should be packed in CFB cartons (5/7 ply thick) in single or in multiple layers with paper shreds as cushioning material for long distance transport. The optimum conditions for storage of capsicum is 7- 8°C temperature with high relative humidity (90 to 95 %) where the shelf life of fruits can be extended for 2 to 3 weeks. Capsicums are sensitive to chilling injury below 5° C which leads to softening, pitting, and decay of fruits. Capsicum fruits should not be stored with other ripening fruits especially mangoes, papayas and tomatoes to prevent faster ripening and spoilage.

17.3. Shrink wrapping technology of capsicum

Capsicum fruits are shrink wrapped individually. Freshly harvested capsicum fruits are sorted/ graded, washed thoroughly with water or disinfectants, surface dried, stalks are trimmed, and individual fruits are packed loosely in flexible film before passing through shrink tunnel (150-170°C) for 8 to 10

seconds. Thus shrink wrapped fruits are collected, packed and stored at room temperature or at optimum storage conditions. Film gets shrink wrapped tightly around each fruit and acts as another layer of protective cover. This technology helps in extending the shelf life of fruits, which can be used to transport for long distance market and also for export.

Shrink wrapping technology is useful only when it is coupled with low temperature storage, as otherwise it aggravates spoiling of fruits. It is advantageous over normal storage as it reduces weight loss, maintains firmness and reduces chilling injury, blemishes and secondary infection of fruits. Under low temperature storage (8-12°C), the shelf life of shrink wrapped fruits can be extended upto 6 weeks. It also delays ripening & senescence and thereby extends storage life of fruits. It provides improved sanitation where spoiled ones can be discarded easily and also facilitates for consumer appeal variety and brand identification.

18. Special Tips to Achieve Higher and Quality Yield

- The organic manure/compost applied to the soil should be enriched with Microbial Bio-control Agents like *Pseudomonas fluorescens, Paecilomyces lillacinus*, *Trichoderma harzianum* etc. and bio-fertilizers like, PSB, *Azospirillum Azotobacter,* etc. to enhance soil health.
- Any damage of net or polysheet in the structure should be immediately repaired to prevent entry of pests and diseases.
- The polyhouse/ nethouse should have double door system which is

the safest way to prevent the entry of pests and diseases. The doors should be constructed preferably away from roadside.

- Seedlings raised in protrays have to be transplanted within 30-35 days after sowing on the main raised planting beds (1/2 ft above the ground level).
- Regular pruning has to be followed to retain two-third healthy branches and retain one fruit with good shape and size in each branch and remove deformed fruits, if any, at a very early stage.
- Branches are properly tied with plastic twine and other end tied to the supporting GI grid to give strong support and to avoid breakage of branches/ fruits.
- Drip irrigation and fertigation schedules should be followed regularly.
- Avoid pests and disease incidence for adopting prophylactic measures. Use proper and recommended quantity and dosage of pesticides and insecticides to control the incidence.
- Maintain hygiene condition in green house and dispose off the rotten, fallen and infected plant debris/ fruits and regularly, preferably everyday during evening hours, after completing all the operations of the day. Use clean plastic bags to collect and carry these materials to the place of disposal, to avoid the spread of infection.
- Care should be taken not to pinch the apical bud and protect it from the mite infestation.
- Botanicals, Microbial Bio-control Agents, biological agents and biofertilizers should be used as an integrated pest, disease and nutrient management practice.
- Yield should constitute 85-90 percent of A grade fruits (3-4 lobes, 150-180 gms). Deformed and irregular shaped fruits are pinched out at younger stage and fruits with 50-70 per cent colour should be harvested, graded and packed properly.

Table 1. List of some of the pesticides and chemicals used in commercial cultivation of capsicum

Sl. No.	Chemicals	Formulations	Trade names/ Products
A	**Pesticides**		
1	Imidachloprid	200 SL/ 17.8% SL 17.8% 35.6	Confidor Potent (SI) Super
2	Fipronil	5 EC	Regent
3	Chlorpyriphos	20% EC	Durmet (Insecticide + termiticide)
4	Acephate	75% SP	Dhruvtara, Starwin
5	Dicofol	18.5% EC	Fatal (Contact + Acaricide)
6	Ecomite (Biological product)		Agrigold Ecomite
7	Chlorofenapyr	20% EC	Interprid
8	Fenazaquin	10% EC	Magister
9	Propargite	30% WP	Omite
10	Abamectin	1.9% (w/w) 1.9 EC	Tagmec (BSI & agaricide) Vertimec (Syngenta)
11	Thiomethoxam	25 WG	Actara
12	Dimethoate	30% EC	Rogor
13	Thiodicarb	75 WP	Larvin
14	Carbaryl	50% WDP	Sevin
15	Indoxacarb	14.5 SC	Avaunt
16	Rengxypyr	20% EC	Coragen
17	Methomyl	40 SP	Lannate, Steward
18	Phorate	10G	Thimet
B	**Fungicides/ Bactericides**		
1	Mancozeb	75 WP	Dithane M-45, Indofil M-45

Sl. No.	Chemicals	Formulations	Trade names/ Products
3	Myclobutanil	10 WP	Systhane
4	Hexaconazole	5 EC	Contaf, Sitara, Anvil
5	Copper Oxychloride	50 WP	Blitox
6	Copper Hydroxy-chloride	77% WP	Kocide
7	Captan	50 WP	Captaf
8	Metalaxyl + Mancozeb	72 WP	Ridomil MZ
9	Sulphur	40 SC ,WDG 80 (80:80)	Sulfex (Systemic fungicide, Acaricide)
10	Dimethomorph	50 WP	Acrobat
11	Difenaconazole	25 EC	Score
12	Dinocap	46 EC	Karathane
13	Penconazole	100 EC	Topas
14	Chlorothalonil	75 WP	Kavach, Delan
15	Copper sulphate + hydrated lime Bordeaux mixture	1%	Bordeaux mixture
16	Fosetyl Aluminium	80 WP	Aliette
17	Azoxystrobin	25 EC	Amistar
18	Flusilalzole	40EC	Nustar, Olymp

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Taking Rural Karnataka Forward with following initiatives :

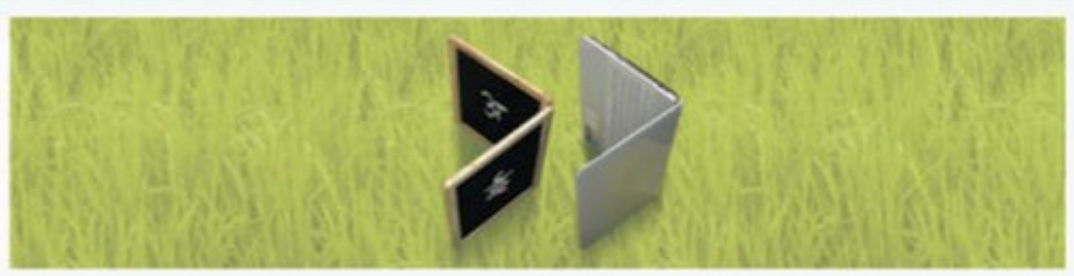
- **Funding Critical Rural Infrastructure**
  - Rs.4200 crore sanctioned for rural roads, bridges, irrigation, soil and water conservation, flood control, rural schools, Anganwadis,
  - Public Health Centes, ITIs, etc.
- **Sustainable Livelihood for Resource Poor Regions and Tribals**
  - 3.03 lakh ha. area treated under Watershed Development Fund including 1.86 lakh ha. exclusively in 6 distressed districts of Karnataka
  - 14400 tribal families supported under Tribal Development Fund in 10 districts for Wadi development for tribal groups like Kammara,
  - Nayak, Beda, Bedar, Valmiki, etc. with an outlay of Rs.59.70 crore for 18 projects
- **Helping Banks for Farm Credit**
  - Rs.3000.00 crore to SCB/District Central Cooperative Banks & Regional Rural Banks for crop loans.
  - Assisted 14.00 lakh farmers through Kisan Credit Cards
  - Refinance to Banks for disbursement of term loans Rs.980.14 crore.
- **Promoting Farm Proadductivity**
  - System of Rice Intensification in 7 projects in 5 districts.
  - Pilot Project on Augmenting Productivity of Lead Crops in 6 districts.
  - Pilot Project on Technology Transfer, Credit Counseling & Market Advocacy through Farmers' Clubs,
- **Pilot Project on Technology Transfer, Credit Counseling and Market Advocacy through.**
  - Farm Innovation Promotion Fund to support innovations in agriculture.
  - Supporting Seminars/Conferences on agriculture development through Research and Development Fund.
  - Promoting 6800 Farmers Clubs as platform for technology transfer and enhancing credit flow for agriculture in villages.
- **Promoting Banking for the Poor:**
  - Promoting Self Help Groups (SHGs)
  - Joint Liability Groups(JLGs)
- **Partnering with Government of India for its Priority Programmes**
  - Development of Agriculture Marketing Infrastructure, Rural Godown
  - Jawaharlal Nehru National Solar Mission
  - Agri-Clinic & Agri- Business Centre
  - Dairy Entrepreneurship Development Programme
  - National Project on Organic Farming

Rural innovation fund (RIF) - Rural Development Through Innovations

- RIF is designed to support innovative, risk friendly, unconventional experiments in Farm, Non-Farm and micro-Finance sectors for promoting livelihood opportunities for rural poor
- RIF supports innovative, experimental and demonstrative activities which are replicable and commercially viable
- Supports activities which improve efficiency of credit delivery for rural poor
- Creation of sustainable employment opportunities in rural areas

NABARD 30 YEAR NATION BUILDING

Taking Rural India Forward >>



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