

Production of Capsicum under Protected Cultivation Practices

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1. Introduction

Capsicum (*Capsicum annuum* L.), commonly known as sweet pepper or bell pepper, is an important commercial vegetable crop cultivated for its nutritional value, attractive appearance and market demand. It is widely used in salads, curries, snacks and processed food products. Capsicum is a good source of vitamin C and other essential nutrients.

The productivity of capsicum is influenced by environmental factors such as temperature, sunlight, humidity, soil moisture and nutrient availability. Under open-field conditions, fluctuations in weather may affect plant growth, flowering, fruit development and yield. Protected cultivation provides an opportunity to create a more favourable growing environment and improve crop production.

Protected structures such as Polyhouse and shade-net houses are increasingly used for cultivating high-value vegetable crops. These structures help manage environmental conditions and protect crops from certain adverse weather conditions. In semi-arid regions such as Raichur, Karnataka, protected cultivation combined with efficient irrigation and appropriate crop management can contribute to improved capsicum productivity.



Figure 1. Capsicum cultivation under protected conditions at Raichur

2. Importance of Protected Cultivation

Protected cultivation involves growing crops under structures designed to modify the growing environment. The commonly used structures for capsicum production include polyhouses, closed shade-net houses and shade-net structures with open sides.

A polyhouse provides a partially controlled growing environment, while a shade-net structure reduces the intensity of incoming sunlight. The suitability of each structure depends on local climatic conditions, crop requirements, investment capacity and market opportunities.

❖ The major advantages of protected cultivation include:

- Improved management of the crop-growing environment.
- Better plant growth and potential for increased fruit production.
- Efficient use of irrigation water when combined with drip irrigation.
- Improved management of crop-support and maintenance operations.
- Opportunities for producing high-value vegetables for commercial markets.

However, protected cultivation requires appropriate structural design, regular maintenance, irrigation management and timely monitoring of pests and diseases.



Figure 2. Different protected structures used for vegetable cultivation.

3. Crop Establishment and Experimental Details

A field experiment was conducted at Raichur, on Protected Structure Design for Small and Marginal Farmers."

Capsicum variety Samridhi was selected for evaluating crop performance under different growing environments. The experiment was laid out in a Randomized Block Design (RBD) with six replications and four treatments. Each treatment covered an area of 400 m². The plant spacing was maintained at 60 cm × 45 cm. The four treatments consisted of a closed shade-net structure, a polyhouse, a shade-net structure with open sides and open-field cultivation. The study evaluated plant growth, number of leaves, number of branches, rind thickness, yield, water-use efficiency and economic performance under the different growing environments.

4. Crop Management Practices

Successful capsicum production requires proper crop establishment, irrigation, nutrient management, plant support and regular field monitoring. Irrigation management through Drip irrigation helps to deliver water near the root zone and supports efficient water application. In the reported experiment, irrigation was scheduled at 80% of crop evapotranspiration (ET).

Plant growth monitoring attributes Plant height, number of leaves and number of branches indicators for evaluating crop growth under different structures.

Harvest management: Fruits should be harvested at the appropriate maturity stage as per the maturity indices and all the yield parameters are recorded.

The specific fertilizer schedule, pest-management are followed as per the specific recommended practices.



Figure 3. Crop establishment and maintenance practices in capsicum

5. Effect of Protected Structures on Plant Growth

The experiment demonstrated differences in capsicum growth under the four growing environments. At 120 days after transplanting (DAT), the maximum plant height of 65 cm was recorded under polyhouse cultivation,

followed by 50 cm under the closed shade-net structure. Plants under the shade-net structure with open sides and in the open field recorded heights of 32 cm and 30 cm, respectively. The number of leaves per plant followed a similar trend. Polyhouse-grown plants recorded 75 leaves per plant at 120 DAT, compared with 59 leaves under the closed shade net, 51 under the shade net with open sides and 45 under open-field conditions. The number of branches was also highest under polyhouse cultivation, with 15 primary branches and 25 secondary branches per plant. In comparison, open-field plants recorded nine primary branches and 13 secondary branches per plant. These findings indicate that the polyhouse provided the most favourable growing environment for vegetative growth among the treatments evaluated in this experiment.



Capsicum in Polyhouse

Capsicum in open shadenet

Figure 4. Differences in capsicum plant growth under protected and open-field conditions.

Table 1 Plant growth and yield of capsicum under different growing environments

Treatment	Plant height (cm)	Number of leaves per plant	Number of primary branches per plant	Number of Secondary branches per plant
Polyhouse	65.00	75.00	15.00	25.00
Closed shade-net house	50.00	59.00	11.00	21.00
Shade net with open sides	32.00	51.00	11.00	17.00
Open field	30.00	45.00	9.00	13.00

6. Effect of Protected Cultivation on Yield parameters.

Fruit yield is one of the most important factors determining the success of commercial capsicum production. In the current experiment, the growing environment influenced both fruit characteristics and crop yield. The maximum recorded rind thickness was 0.91 cm under polyhouse cultivation, followed by 0.85 cm under the closed

shade-net structure. The shade net with open sides recorded 0.83 cm, while the open field recorded 0.74 cm.

The highest yield was obtained under the polyhouse, with an average yield of 2.28 kg per plant and 50.66 tonnes per hectare. The closed shade-net structure recorded 1.46 kg per plant and 32.44 tonnes per hectare. The shade-net structure with open sides produced 1.21 kg per plant and 26.66 tonnes per hectare, whereas the open field recorded 0.90 kg per plant and 20.10 tonnes per hectare. Thus, poly house cultivation produced approximately 152% more capsicum per hectare than open-field cultivation in this experiment.

Table 2. Fruit characteristics and yield of capsicum

Growing structure	Rind thickness (cm)	Yield per Plant (kg)	Yield per hectare (t/ha)
Polyhouse	0.91	2.28	50.66
Closed shade-net house	0.85	1.46	32.44
Shade net with open sides	0.83	1.21	26.66
Open field	0.74	0.90	20.10

7. Water-Use Efficiency

Water management is particularly important in semi-arid regions, where irrigation water may be limited. Efficient water use can improve crop productivity and help farmers manage production costs. In the experiment, drip irrigation was scheduled at 80% of crop evapotranspiration. The total recorded water application from November 2017 to March 2018 was 335.63 mm.

The highest water-use efficiency was recorded under polyhouse condition at 21.22 kg/m³. The shade-net structure with open sides recorded 9.92 kg/m³, followed by the closed shade-net structure at 9.66 kg/m³. Open-field cultivation recorded the lowest water-use efficiency at 7.25 kg/m³. The results indicate that the polyhouse treatment produced more capsicum per unit of water used than the other treatments under the experimental conditions.

Table 3. Water-use efficiency of capsicum under different growing environments

Growing structure	Water-use efficiency (kg/m ³)
Polyhouse	21.22
Shade net with open sides	9.92
Closed shade-net house	9.66
Open field	7.25

8. Economics of Capsicum Production

Economic feasibility is an important consideration when farmers choose a protected structure. Although poly houses may provide higher yields, their initial construction costs and maintenance expenses can be substantial. The economic data reported in the presentation showed benefit-cost ratios of 1.48 for the closed shade-net structure, 1.43 for the poly house, 1.34 for the shade-net structure with open sides and 3.01 for open-field condition. These results demonstrate that the highest-yielding treatment which yield high does not necessarily provide the highest benefit-cost ratio. The open-field treatment recorded the highest B:C ratio, while the poly house produced the highest yield. Farmers should therefore assess expected yield, prevailing market prices, structure costs, labour, irrigation expenses and other production costs before making an investment decision.

Table 4: Economics of capsicum production

Treatment	Yield (t/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Benefit - cost ratio
Closed shade-net house	32.44	6,54,000	9,73,200	1.48
Polyhouse	50.66	10,62,2000	15,19,800	1.43
Shade net with open sides	26.66	5,94,000	7,99,800	1.34
Open field	20.10	2,00,000	6,03,000	3.01

9. Relevance to Small and Marginal Farmers

Protected cultivation can provide opportunities for improving the productivity of high-value vegetable crops. However, adoption should be based on the farmer's financial resources, land availability, irrigation facilities, technical knowledge and access to markets.

Farmers may consider suitable shade-net structures or polyhouse depending on local climatic conditions and the expected return on investment. Efficient drip irrigation, balanced nutrient management, regular crop monitoring and timely harvesting should be integrated into the production system. Demonstrations and field-level training can help farmers understand the advantages and limitations of different structures before adopting them on a commercial scale. The findings from Raichur provide useful experimental evidence that protected structures can influence capsicum production in a semi-arid environment. Further evaluation across seasons and locations would help refine recommendations for different farming situations.

10. Conclusion

The experiment conducted at Raichur demonstrated that protected structures significantly influenced the growth, fruit characteristics, yield and water-use efficiency of capsicum. Among the four treatments evaluated, poly house cultivation recorded the highest plant height, number of leaves, number of branches, fruit yield and water-use efficiency. The poly house produced 50.66 tonnes per hectare, compared with 20.10 tonnes per hectare under open-field conditions. Water-use efficiency was also highest

under the poly house treatment, at 21.22 kg/m³. However, the open field recorded the highest benefit-cost ratio. Therefore, the selection of a protected structure should consider both productivity and economic feasibility. Overall, protected cultivation combined with appropriate crop management and efficient irrigation has the potential to improve capsicum production in semi-arid regions. Selecting a structure suited to local conditions and the farmer's investment capacity is essential for sustainable and economically viable production.
