CHAPTER – V

SUMMARY

Capsicum (*Capsicum annuum* L.) belongs to the botanical family Solanaceae, is one of the highly remunerative vegetables crop cultivated in several parts of the world especially in temperate regions of Central and South America and European countries, tropical and sub-tropical regions of Asian continent. India is the second largest producers of vegetables in the world next to China with an estimated production of about 126.58 million tonnes from an area of 8.51 million hectares with an average yield of 14.87 tonnes per hectares. In Punjab it was grown on an area of 0.31 thousand hectare with annual production of 4.81 thousand MT during the year 2015-16.

In India Capsicum is grouped under non-traditional category of vegetables. Nutritionally it provides Vitamin A, C and minerals like Calcium, Magnesium, Phosphorus, Potassium, Protein, and Carbohydrates. The high market price is attributed to the heavy demand from the consumers. There is a good demand for export too.

Despite its economic importance, it is very difficult to produce good quality Capsicum with high fruit yield due to various biotic (pest and diseases) and abiotic (rainfall, temperature, relative humidity and light intensity) factors. Due to erratic weather behaviour, the crops grown under open fields are often exposed to fluctuating levels of temperature, humidity, and wind flow etc.

The cultivation of Capsicum under different protected structures like polyhouse, net house, walk-in-tunnels, plastic low tunnels are the most suitable solutions to the challenging environmental factors and it prevents spreading of insects, pests, and viral diseases, hence plays a key role in integrated pest management. Greenhouse technology can be utilized for controlling of environmental parameters such as temperature, relative humidity, light intensity & duration, CO₂ level, Irrigation & nutrient supply, spacing, growing medium and root development.

Now-a-days, decreasing land holdings for crop cultivation hinders the vegetable production. Hence, to obtain a good quality produce during off-season, there is a great need to cultivate Capsicum under protected conditions such as
greenhouse or polyhouse. Protected cultivation also ensures the availability of produce in the market, when it is in great demand.

There is a potential and prospects for raising *Capsicum* under protected structures to enhance crop maturity, productivity, prolonged fruiting span and high shelf life. Therefore, the study was planned with the following objectives:

- To evaluate Capsicum hybrids under different protected structures.
- To study the effect and economics of different protected structures on Capsicum cultivation.
- To work out technology for year-round production of Capsicum.

The investigation entitled, ‘Performance of sweet pepper (*Capsicum annuum* L.) cultivars and economics under protected structures in Punjab’ was carried out for the two consecutive cropping seasons, i.e., 2014-15 and 2015-16 under naturally ventilated polyhouse (NVPH), nethouse and walk-in-tunnel at Centre of Excellence for Vegetables (An Indo-Israel project), Kartarpur, Jalandhar, Punjab, India located at 31.44° N (latitude) and 75.50° E (longitude) at the altitude of 228 m above sea level.

The crop nursery for the two consecutive seasons was raised using black plastic pro-trays of 99 cells or cavities in polyhouse (in soilless culture media) during August 2014 and 2015, respectively. One-month old seedlings were transplanted during September 2014 (cropping season Sept 2014 to May 2015) for the first season and September 2015 (cropping season Sept 2015 to May 2016) for the second season.

The experiment was laid out in split plot design keeping naturally ventilated polyhouse, nethouse and walk-in-tunnel as main plot treatments and three different hybrids each of green coloured capsicum (Indra, Pasrella, Starlet), red coloured capsicum (Bomby, Inspiration, Mazillia) and yellow coloured capsicum (Orobelle, Bachata, Sven) as sub plot treatments with three replications each, maintaining plant to plant spacing of 40 cm and row to row spacing of 30 cm to accommodate approximately 1500 plants/500 m² area. The improved package of practices for cultivation was adopted along with improved irrigation/fertigation schedule to raise the crop.

The study the influence of different protected structures on the different colour groups of hybrids, the observations were recorded for plant height (cm), number of
branches per plant, first flower initiation (days), first fruit harvest (days), percent fruit set (%), number of fruits per plant, individual fruit weight (gm), fruit length (cm), fruit diameter (cm), fruits rind thickness (cm), fruit volume (cc), fruit shelf life (days), tolerance to major insect-pest, total fruit yield per plant (kg), total fruit yield per m² (kg), total fruit yield per hectare (tonnes), temperature (°c), relative humidity (%), light intensity (klux), and economics for two continuous seasons. The data was pooled over two seasons and subjected to statistical analysis by using software CPCS1 (Cheema and Singh, 1990).

The experimental results obtained from the present study to find the most promising hybrid for different coloured Capsicum group revealed that, with respect to vegetative growth, reproductive parameters and fruit yield related parameters like number of fruits per plant, average fruit weight, fruit yield per plant, per square metre, per hectare etc. Plants grown in NVPH had maximum plant height, fruit-set percentage, number of fruits/plants, individual fruit weight, lesser infestation of major pests, and higher total fruit yield; per plant, per square metre, and per hectare, whereas, early first flower initiation and first fruit harvest was recorded in all the three different coloured groups of Capsicum under walk-in-tunnel conditions.

Among green coloured Capsicums maximum profitability was recorded with Indra in terms of early first flower initiation (41.93 days), number of fruits/plant (21.49), total fruit yield/plant (3.62 kg) and total fruit yield/sq metre (10.86 kg) over the hybrids Pasrella and Starlet. In red coloured group, early first flowering (42.33 days), first fruit harvest (105.83 days), higher individual fruit weight (216.53 g), and total fruit yield/plant (2.81 kg) was recorded from Inspiration as compared to Bomby and Mazillia. Similarly, Bachata had earliness for first flower initiation (44.93 days), first fruit harvesting (98.19 days), and recorded maximum plant height (113.06 cm), percent fruit set (41.83), individual fruit weight (190.73 g), total fruit yield/plant (3.0 kg) over hybrids Orobelle and Sven in the yellow coloured group.

All the fruit quality parameters under study were significantly influenced by the protected structures along with their interaction effects. Among structures, NVPH cultivation recorded maximum fruit rind thickness, fruit volume and fruit shelf life, whereas, walk-in-tunnel had a great influence on fruit length and fruit diameter for all of green, red, and yellow coloured group hybrids. Green group hybrid namely Indra
had higher fruit length (9.70 cm), fruit diameter (7.50 cm), fruit shelf life (8.59) as compared to Pasrella and Starlet. The red coloured group hybrid Inspiration proved best for fruit length (9.70 cm), fruit diameter (8.23 cm), fruit volume (434 cc), fruit rind thickness (0.89 cm), and fruit shelf life (8.0 days) as compared to Bomby and Mazillia. The yellow coloured group hybrid Bachata recorded maximum fruit length (9.03 cm), fruit volume (388.66 cm), and fruit rind thickness (0.90 cm) as compared to Orobelle and Sven.

When the environmental temperature fell down in the winter months, the protected structures helped to regulate the plant growth and production characters due to improved ambient/micro climatic conditions inside the structure. Protected cultivation created favourable environment for the plant growth which helped getting early and total fruit yields for an extended period.

NVPH unit were established over an area of 2000 m$^2$. For calculating the economics of capsicum cultivation, the fixed and variable costs for the establishment and maintenance of structures for 500 m$^2$ area were calculated from the total costs of 2000 m$^2$. The results revealed that among green group hybrids, Indra had higher net returns of Rs. 65740/- from NVPH which resulted in highest B:C ratio of 1:1.53. Among red group hybrids, Inspiration had higher net returns of Rs. 80190/- from NVPH with highest B:C ratio of 1:1.61. Among the yellow coloured group hybrids, Bachata gained maximum net returns of Rs. 93940/- from NVPH. However, Bachata also gained maximum B:C ratio of 1:1.75 from walk-in-tunnel followed by NVPH having B:C ratio of 1:1.72.

In the present study plant spacings kept as 40 x 30 cm between rows and plants, respectively which was sufficient for proper utilization of land and space over a unit of area for fetching high returns. Maximum fruit yield under protected conditions was the result of increased plant height, fruit length, fruit weight and fruit girth, longer fruiting span etc. It was gained might be due to the high rate of carbon dioxide utilization in the polyhouse. Similarly, Singh et al (2011) and Basavaraja et al (2003) reported that the higher fruit yield in polyhouse, polytunnel may be due to the improved climate in these conditions. They concluded that the temperature range was
found 3-4°C higher in polyhouse, and 1-2°C higher in polytunnel as compared to unprotected cultivation conditions.

It is opined that due to favourable environmental conditions prevailing in polyhouse which helped in gaining better plant growth of roots and shoots, improved the fruit yield attributing parameters like number of fruits per plant, individual fruit weight, fruit rind thickness, fruit length and fruit breadth which led to higher total yield per plant and per square metre/hectare. Protected cultivation of capsicum is the best practice to grow off-season crop to meet the consumer’s demand and daily nutritional requirements. Polyhouse cultivation has thus emerged as a profitable and economically viable option to fetch high returns especially in off-seasons in Punjab.

The present investigation results, therefore, suggest that the naturally ventilated polyhouse (NVPH) was the best as compared to nethouse and walk-in-tunnel for the cultivation of green, red and yellow coloured group hybrids of capsicum for commercial production in Punjab. It is further concluded that Indra, Inspiration, and Bachata hybrids of capsicum ranked first among green, red, and yellow coloured groups respectively for commercial cultivation under protected structures to gain higher net returns per unit area for Punjab conditions.