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# OPTIMIZING SWEET PEPPER (*CAPSICUM ANNUUM* L.) PRODUCTION UNDER PROTECTED STRUCTURES IN THE INDIAN TRANS-HIMALAYAS

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**ABSTRACT**
Production of sweet pepper is limited by climate and short growing season and people depend upon outside supply for consumption in trans-Himalayas. Protected cultivation plays a crucial role in enhancing the productivity and quality of high-value vegetable crops like sweet pepper. Keeping this in view, promising varieties/hybrids from other parts of country were tried in various protected structures. Performance of 7 hybrids was evaluated under 6 types of protected structures. The results revealed significant variation among protected structures and hybrids for growth, yield, and quality parameters. The LEHO polyhouse recorded superior performance with maximum plant height (125.8 cm), number of fruits per plant (17.85), yield per plant (811.9 g) and yield per hectare (601.4 q/ha). Among hybrids, SH-2 performed best with respect to yield (472.3 q/ha) and plant vigour, while US-181 produced the highest number of fruits per plant (20.04). Early harvesting was observed in NV polyhouse (109.8 days), whereas the longest harvest duration was recorded in mud wall polyhouse (54.06 days). The study concludes that LEHO polyhouse combined with high-yielding hybrids like SH-2 can significantly enhance sweet pepper production under protected conditions.

**KEYWORDS**: Sweet pepper, hybrid, protected structure, trans-Himalayas, yield

## INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is an important vegetable crop valued for its nutritional richness, pleasant flavour, and high market demand. It is considered a high-value crop and has gained prominence in India in recent years due to its increasing use in diverse culinary preparations and its rich content of ascorbic acid, vitamins, and minerals [1]. Despite its economic importance, sweet pepper is categorized as a non-traditional vegetable in India [2], though its cultivation is expanding rapidly under protected environments.

Open field cultivation of sweet pepper, particularly in trans Himalayan regions, is often constrained by abiotic stresses such as low temperature, frost, high wind velocity, and erratic rainfall. These factors lead to poor growth, reduced yield, and inferior fruit quality [3]. In the trans-Himalayan region of India, especially Ladakh, the harsh climate and short growing season severely limit the successful cultivation of sweet pepper, forcing dependence on external supply even during the summer months. Protected cultivation has emerged as an effective approach to overcome these limitations by providing a controlled microenvironment that regulates temperature, humidity, and nutrient availability, thereby improving crop growth, yield, and quality [4]. Studies have demonstrated that protected structures significantly enhance capsicum productivity by improving resource use efficiency and minimizing environmental stress [5, 6]. Furthermore, advancements in fertigation, irrigation scheduling, and integrated nutrient management have contributed to improved growth and yield performance under protected conditions [7, 8].

The trans-Himalayan region, despite its harsh climate, possesses unique advantages such as abundant sunshine and high solar radiation, which can be effectively utilized under protected structures to create favourable growing conditions. With increasing demand from local populations, tourists, and institutional consumers such as the armed forces, protected cultivation of sweet pepper is gaining importance as a remunerative enterprise in the region. It also offers significant potential for improving farmers' income and regional food security.

However, the performance of sweet pepper largely depends on the type of protected structure and the hybrid used. A particular hybrid may respond differently under varying microclimatic conditions. Recent studies have highlighted that polyhouse-based cultivation systems outperform traditional methods in terms of productivity and economic returns [9, 10]. Additionally, factors such as economic feasibility and environmental control play a crucial role in the successful adoption of protected cultivation technologies [11].

Despite the growing importance of protected cultivation, information on suitable hybrids and optimal protected structures for sweet pepper production in the trans-Himalayan region remains limited. Therefore, the present investigation was undertaken to evaluate the performance of different sweet pepper hybrids under various protected structures and to identify suitable combinations for maximizing productivity under such agro-climatic conditions.

## MATERIALS AND METHODS

### *Experimental area and climate*

The present study was conducted under protected conditions at Experimental Farm, Stakna (Leh) of Precision Farming Development Centre which is situated on the left bank of ancient river Indus at 3319 m amsl latitude $33^0$58.551' NS and

longitude $77^0$41.995' EW. Climate of the area is typically dry temperate with extreme fluctuations in the temperature. Weather parameters during experiment period are represented in Fig 1, thereby showing the necessity of growing sweet pepper in the protected structures in trans Himalayan Ladakh region. The climatic parameters (Fig. 1) exhibited clear seasonal trends during the cropping period. Maximum and minimum temperatures increased progressively from May and reached a peak in July, followed by a gradual decline towards November. Though the weather parameters inside the protected structures could not be recorded, it was observed that protected structures showed increase to the tune of 20-25°C in maximum temperature, 8-10°C in minimum temperature and 25-30% in relative humidity in general.

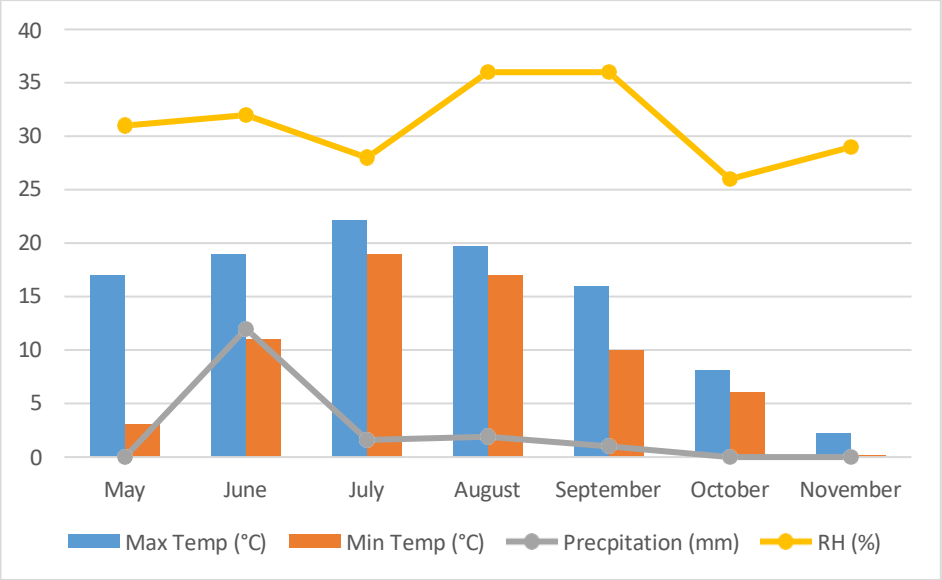


**Fig. 1: Weather parameters of experimental area**

These conditions provided a favourable thermal regime for crop growth during mid-summer. Precipitation was minimal and confined mainly to June, indicating the predominance of dry conditions throughout the growing season. Relative humidity remained moderate, with slightly higher values observed during August and September, which may have supported physiological processes such as flowering and fruit development. The overall climatic pattern suggests a short growing window with limited moisture availability, emphasizing the importance of protected cultivation for microclimate regulation and improved crop productivity [5].

***Experimental material and design***

Performance of seven genotypes of public and private sectors *viz.* Bharath, US-181, SH-1, SH-2, Super Gold, Navratna and Spinx were evaluated under six protected structures *viz.* Chinese polyhouse, Mud wall polyhouse, LEHO polyhouse, Local polyhouse, NV polyhouse and Trench. Design of the experiment was split plot and material was replicated 3 times. Crop geometry was 45x30 cm. Transplanting was done on 20$^{th}$ May, 2011 in all the protected structures. Standard package of practices followed to raise healthy crop. Data were recorded on 8 randomly taken plants/fruits per replication with respect to yield and horticultural characters and subjected to statistical analysis [12]. Main effects of protected structures as well genotypes along with their interaction were studied to find out promising greenhouse and genotype for cold arid regions.

## RESULTS AND DISCUSSION

Greenhouses can boost sweet production in the cold arids. Singh and Asrey [13] found excellent quality and productivity of capsicum in medium cost greenhouse. Six protected structures were compared with respect to plant, fruit, yield and maturity characters in seven hybirds of sweet peppers.

***Plant Growth Parameters***

Significant variation in plant growth traits (Table 1) was observed among different protected structures and hybrids, highlighting the influence of microenvironmental conditions on vegetative development. Protected structure, hybrids as well the interaction effects were significant for plant height in sweet peppers. Chinese polyhouse produced maximum plant height (131.2 cm) which is significantly superior to all the other protected structures except LEHO polyhouse. Hybrids SH-2 with maximum plant height (106.3 cm) showed significant superiority over all other hybrids except hybrid Navratna, Spinx and Super Gold. LEHO greenhouse with hybrid SH-1 produced maximum plant height.

Stem diameter (16.91 mm) was observed maximum in LEHO green house and statistically superior to all the other protected structures. SH-1 produced thicket and statistically superior stem (15.17 mm). LEHO Polyhouse in combination with SH-2 produced thickest stem (18.41 mm) but at par with other hybrids in the same polyhouse; Chinese polyhouse with SH-1, SH-2; and Local polyhouse with SH-2.

The Chinese polyhouse recorded superior plant height and LEHO polyhouse stem diameter, which can be attributed to its favourable microclimatic conditions, including optimal temperature, humidity, and light intensity. These conditions enhance physiological processes such as photosynthesis and cell elongation, ultimately promoting vigorous vegetative growth. Similar findings were reported by Singh et al. [14] and Manjunath et al. [15], who observed improved growth performance of capsicum under controlled environmental conditions.

Among the evaluated hybrids, SH-2 exhibited maximum plant vigour, suggesting its better adaptability and stability across

varying environments. Increased stem girth observed under protected structures indicates efficient translocation of nutrients and assimilates, along with reduced exposure to abiotic stresses such as temperature fluctuations and moisture deficits. This is in agreement with the findings of Jovicich et al. [16], who reported that favourable growing conditions significantly enhance plant structural development and biomass accumulation. The superior growth observed under LEHO and Chinese polyhouses may be attributed to favourable microclimatic conditions that enhance vegetative development. Similar findings have been reported where controlled environments significantly improved plant height and biomass accumulation in capsicum [8].

***Yield Attributes***

The number of fruits per plant and yield per plant (Table 2) were significantly influenced by the type of growing environment, indicating the critical role of controlled conditions in reproductive success. Maximum number of fruits (17.85) were recorded in LEHO polyhouse which was at par with Trench and Local polyhouses. Hybrid US-181 recorded highest number of fruits per plant (20.04). However, Yield per plant was also recorded highest (811.9 g) in LEHO polyhouse house which was at par with Mud wall and Local polyhouses. Similar results were recorded by Kanwar et al. [5]. SH-1 exhibited highest yield per plant (637.7g) and found at par with Super Gold and SH-1.

The LEHO polyhouse recorded the highest number of fruits per plant and maximum yield per plant. This superior performance may be due to improved pollination efficiency, reduced flower drop, and better retention of fruits under stable environmental conditions. Singh et al. [14] also reported enhanced productivity of capsicum under protected cultivation systems.

The higher fruit number and yield under the LEHO polyhouse can be further explained by improved nutrient uptake, precise water management, and reduced physiological stress. Controlled fertigation practices and optimized irrigation scheduling ensure a continuous supply of nutrients during critical growth stages, which promotes better fruit set and development. Recent studies [6, 7] support these observations, emphasizing the importance of stage-wise fertigation in enhancing yield attributes under protected cultivation.

Among the hybrids, US-181 produced the highest number of fruits per plant, while SH-2 recorded the maximum yield per plant. This indicates that both genetic potential and environmental conditions interact to determine overall productivity. While US-181 may possess traits favouring higher fruit set, SH-2 likely excels in fruit size, weight, or overall biomass allocation, resulting in higher yield.

***Fruit Characters***

Fruit length and diameter (Table 3) showed significant variation among the different treatments, reflecting the combined effects of environmental conditions and genetic makeup. Maximum fruit length (88.51 mm) was recorded in Local polyhouse which is in consonance with the findings of Kanwar et al. [5]. Hybrid Spinx recorded statistically longest fruits (107.4) significantly longest fruits. LEHO polyhouse with Spinx could able to produce statistically lengthy fruits (132.7 mm). However, fruit diameter (62.23 mm) was maximum in Mud Wall polyhouse which was statistically superior to trench produced sweet peppers. Similar results were recorded by Kanwar et al. [5]. Hybrid SH-1 had statistically highest fruit diameter (68.93 mm). Mud wall polyhouse with hybrid SH-1 recorded maximum fruit diameter (75.11 mm)

Protected structures such as mud wall (91.03 g) and NV polyhouses (94.65g ) produced larger fruits in terms of weight at par in both the structures. This may be due to a more stable microclimate that minimizes stress and supports uninterrupted cell division and expansion during fruit development. Hybrid SH-1 showed statically superior fruit weight (114.6 g) among the hybrid studied (Table 4).

These findings are consistent with the results of Aminifard et al. [17], who reported that favourable environmental conditions significantly improve fruit size and quality in sweet pepper. Enhanced availability of nutrients and optimal moisture levels under protected structures contribute to better fruit growth and uniformity.

Among the hybrids, Spinx and SH-1 performed better with respect to fruit size traits, indicating a strong genetic influence on fruit morphology. These hybrids may possess inherent traits such as better sink strength and efficient assimilate partitioning towards fruits.

***Yield Performance***

Yield per hectare was significantly higher under the LEHO polyhouse (601.4 q/ha), followed by the mud wall polyhouse (481.9 q/ha), confirming the advantages of protected cultivation over less controlled environments (Table 4). Higher yields under protected structures can be attributed to improved photosynthetic efficiency, efficient utilization of water and nutrients, and reduced incidence of pests and diseases. Singh and Sirohi [18] also reported similar benefits of protected cultivation in enhancing vegetable crop productivity.

The higher yield observed under the LEHO polyhouse aligns with recent findings [4, 9] which indicate that polyhouse cultivation significantly boosts productivity compared to open field or less regulated systems. The controlled environment minimizes environmental stress, thereby allowing plants to achieve their full genetic potential.

Among the hybrids, SH-2 and Super Gold exhibited superior yield performance, suggesting their suitability for cultivation under protected conditions. Their consistent performance across environments indicates better adaptability and higher efficiency in resource utilization.

***Earliness and Harvesting***

In cold arids, early maturity by one week may play an important role in enhancing farm income of an individual to a considerable extent. Interestingly, significantly earliest harvest was achieved in naturally ventilated green house. Hybrids did not show significant difference for days to first harvest [5,19].

Harvest duration will be longest in the protected structures having favourable conditions for plant growth and production. Longest harvest duration (54.06 days) was recorded in Mud wall polyhouse which was at par with LEHO and Local polyhouses. Super Gold recorded longest harvest duration (40.11 days) at par with SH-1 and SH-2.

Earliness and harvesting duration varied significantly among the different protected structures. Early harvesting observed

under the naturally ventilated (NV) polyhouse may be attributed to relatively higher temperature fluctuations, which accelerate crop growth and maturity. In contrast, the longer harvesting duration recorded under the mud wall polyhouse suggests sustained productivity over an extended period, likely due to more stable temperature and moisture conditions. These observations are in line with the findings of Jovicich et al. [16], who reported that environmental conditions play a crucial role in determining crop phenology. Variations in earliness and harvesting duration among different structures can be primarily attributed to differences in temperature regimes, humidity levels, and overall microclimatic conditions.

Recent studies [11] have further demonstrated that environmental manipulation under protected structures can significantly influence flowering time, fruit maturity, and overall harvesting period. Proper selection of protected structures can therefore help in achieving desired production windows and market advantages.

The results clearly demonstrate that protected cultivation significantly enhances the growth, yield, and quality of sweet pepper. LEHO polyhouse proved most efficient among structures, while SH-2 emerged as the best-performing hybrid. The non-significant interaction effects indicate stable hybrid performance across environments.

## CONCLUSION

The study concludes that protected structures play a vital role in improving sweet pepper productivity. Among the evaluated structures, LEHO polyhouse was found to be the most effective in enhancing growth and yield. Among hybrids, SH-2 proved to be the most promising for high productivity, while US-181 showed superior fruiting ability. The combination of LEHO polyhouse and SH-2 hybrid is recommended for achieving higher yield and profitability under protected cultivation conditions. Overall, the results of the present study are in strong agreement with recent research trends indicating that protected cultivation, combined with appropriate hybrid selection and management practices, significantly enhances capsicum productivity and profitability.

## DECLARATION OF COMPETING INTERESTS

The author declares that there are no conflicts of interest regarding the publication of this manuscript.

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**Table 1**. Performance of sweet hybrids under different polyhouses for plant characters

| **Protected structures** | Plant height (cm) | | | | | | | | Stem diameter (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hybrids | | | | | | | | Hybrids | | | | | | | |
| | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean |
| Chinese polyhouse | 114.7 | 133.6 | 134.8 | 130.4 | 132.2 | 136.8 | 135.8 | 131.2 | 12.54 | 13.76 | 15.22 | 15.79 | 14.80 | 14.39 | 14.23 | 14.43 |
| Mud Wall polyhouse | 100.8 | 98.39 | 103.0 | 113.4 | 105.8 | 99.22 | 95.08 | 102.2 | 10.83 | 11.85 | 13.41 | 14.59 | 13.40 | 11.80 | 11.23 | 12.44 |
| LEHO polyhouse | 114.4 | 121.8 | 118.7 | 134.4 | 128.7 | 129.4 | 133.2 | 125.8 | 15.65 | 16.42 | 15.86 | 18.41 | 17.34 | 17.02 | 17.66 | 16.91 |
| Local polyhouse | 95.83 | 90.50 | 86.92 | 122.9 | 107.2 | 110.0 | 94.75 | 101.2 | 11.00 | 11.53 | 14.68 | 17.91 | 14.72 | 13.59 | 10.91 | 13.48 |
| Trench | 47.58 | 53.17 | 46.42 | 50.33 | 53.08 | 54.00 | 52.75 | 51.05 | 11.64 | 11.48 | 11.72 | 10.85 | 12.23 | 11.97 | 11.52 | 11.63 |
| NV polyhouse | 81.50 | 70.61 | 73.72 | 86.44 | 72.22 | 83.83 | 93.78 | 80.30 | 13.43 | 13.14 | 11.33 | 13.49 | 11.39 | 12.42 | 13.78 | 12.71 |
| Mean | 92.46 | 94.69 | 93.92 | 106.3 | 99.87 | 102.2 | 100.9 | 98.62 | 12.57 | 13.03 | 13.70 | 15.17 | 13.98 | 13.53 | 13.22 | 13.60 |
| CD-$P_{0.05}$ | 18.891 | | | | | | | | 2.459 | | | | | | | |
| CD-$V_{0.05}$ | 7.969 | | | | | | | | 1.042 | | | | | | | |
| CD-$P_{0.05}$ at same or different level of V | NS | | | | | | | | 3.227 | | | | | | | |
| CD-$V_{0.05}$ at same level of P | NS | | | | | | | | 2.551 | | | | | | | |

P: Protected structure; V: Hybrid

**Table 2**. Performance of sweet hybrids under different polyhouses for plant characters

| **Protected structures** | Number of fruits per plant | | | | | | | | Yield per plant (g) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hybrids | | | | | | | | Hybrids | | | | | | | |
| | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean |
| Chinese polyhouse | 11.97 | 20.17 | 6.77 | 10.25 | 9.58 | 8.02 | 5.69 | 10.35 | 226.0 | 378.2 | 527.6 | 510.4 | 434.3 | 291.4 | 163.8 | 361.7 |
| Mud Wall polyhouse | 9.02 | 16.42 | 8.92 | 9.10 | 9.42 | 9.03 | 10.42 | 10.33 | 479.1 | 642.8 | 829.7 | 869.8 | 741.8 | 541.4 | 449.2 | 650.5 |
| LEHO polyhouse | 16.83 | 37.25 | 10.98 | 14.00 | 14.33 | 15.93 | 15.58 | 17.85 | 624.0 | 848.6 | 753.3 | 1131 | 1028 | 736.0 | 562.9 | 811.9 |
| Local polyhouse | 10.33 | 20.33 | 9.25 | 13.08 | 10.92 | 14.72 | 9.50 | 12.59 | 395.7 | 509.8 | 642.2 | 781.0 | 672.9 | 645.5 | 436.8 | 583.4 |
| Trench | 8.50 | 17.25 | 9.08 | 10.75 | 18.11 | 14.50 | 13.08 | 13.04 | 173.2 | 186.9 | 225.1 | 246.3 | 377.3 | 349.5 | 231.5 | 255.7 |
| NV polyhouse | 5.58 | 8.83 | 3.33 | 3.42 | 4.42 | 6.99 | 4.56 | 5.31 | 258.1 | 298.2 | 309.4 | 288.1 | 322.5 | 337.7 | 234.6 | 292.7 |
| Mean | 10.37 | 20.04 | 8.06 | 10.10 | 11.13 | 11.53 | 9.81 | 11.58 | 359.3 | 477.4 | 547.9 | 637.7 | 596.2 | 483.6 | 346.7 | 492.6 |
| CD-$P_{0.05}$ | 6.788 | | | | | | | | 252.97 | | | | | | | |
| CD-$V_{0.05}$ | 2.933 | | | | | | | | 96.04 | | | | | | | |
| CD-$P_{0.05}$ at same or different level of V | NS | | | | | | | | NS | | | | | | | |
| CD-$V_{0.05}$ at same level of P | NS | | | | | | | | NS | | | | | | | |

P: Protected structure; V: Hybrid

**Table 3**. Performance of sweet hybrids under different polyhouses for fruit characters

| Protected structures | Fruit length (mm) | | | | | | | | Fruit diameter (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hybrids | | | | | | | | Hybrids | | | | | | | |
| | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean |
| Chinese polyhouse | 99.21 | 62.27 | 78.38 | 84.34 | 81.36 | 86.90 | 123.8 | 88.04 | 57.87 | 50.67 | 72.86 | 66.04 | 69.26 | 55.76 | 41.35 | 59.12 |
| Mud Wall polyhouse | 81.86 | 81.60 | 80.67 | 85.17 | 87.77 | 90.78 | 110.1 | 88.28 | 60.07 | 54.68 | 75.11 | 72.92 | 66.65 | 59.41 | 46.78 | 62.23 |
| LEHO polyhouse | 82.34 | 64.15 | 78.91 | 83.64 | 84.64 | 87.17 | 132.7 | 87.64 | 51.47 | 50.16 | 73.42 | 70.79 | 65.65 | 55.01 | 46.92 | 59.06 |
| Local polyhouse | 80.45 | 85.13 | 88.66 | 86.19 | 79.54 | 87.29 | 112.3 | 88.51 | 60.38 | 58.21 | 73.15 | 64.79 | 67.45 | 58.89 | 46.70 | 61.37 |
| Trench | 70.71 | 58.09 | 61.97 | 54.03 | 57.86 | 64.96 | 93.04 | 65.81 | 52.70 | 39.43 | 50.87 | 44.69 | 49.86 | 52.34 | 37.09 | 46.71 |
| NV polyhouse | 62.31 | 61.44 | 72.99 | 65.33 | 72.35 | 99.87 | 72.46 | 72.39 | 55.95 | 51.33 | 68.17 | 69.10 | 59.36 | 56.64 | 58.79 | 59.91 |
| Mean | 79.48 | 68.78 | 76.93 | 76.45 | 77.25 | 86.16 | 107.4 | 81.78 | 56.41 | 50.75 | 68.93 | 64.72 | 63.04 | 56.34 | 46.27 | 58.07 |
| CD-$P_{0.05}$ | 6.716 | | | | | | | | 5.005 | | | | | | | |
| CD-$V_{0.05}$ | 6.336 | | | | | | | | 3.196 | | | | | | | |
| CD-$P_{0.05}$ at same or different level of V | 15.575 | | | | | | | | 8.520 | | | | | | | |
| CD-$V_{0.05}$ at same level of P | 15.519 | | | | | | | | 7.828 | | | | | | | |

P: Protected structure; V: Hybrid

**Table 4**. Performance of sweet hybrids under different polyhouses for yield characters

| **Protected structures** | Fruit weight (g) | | | | | | | | Yield per ha (Q) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hybrids | | | | | | | | Hybrids | | | | | | | |
| | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean |
| Chinese polyhouse | 68.33 | 53.50 | 122.5 | 93.92 | 97.08 | 67.00 | 43.17 | 77.92 | 167.4 | 280.1 | 390.8 | 378.1 | 321.7 | 215.8 | 121.3 | 267.9 |
| Mud Wall polyhouse | 72.81 | 61.79 | 138.1 | 124.6 | 115.4 | 76.25 | 48.29 | 91.03 | 354.9 | 476.2 | 614.6 | 644.3 | 549.4 | 401.0 | 332.8 | 481.9 |
| LEHO polyhouse | 56.66 | 45.17 | 134.4 | 116.7 | 89.67 | 57.83 | 53.17 | 79.09 | 462.2 | 628.6 | 558.0 | 837.4 | 761.6 | 545.2 | 416.9 | 601.4 |
| Local polyhouse | 68.04 | 66.75 | 127.5 | 92.03 | 96.25 | 64.17 | 50.00 | 80.68 | 293.1 | 377.7 | 475.7 | 578.5 | 498.4 | 478.1 | 323.6 | 432.2 |
| Trench | 48.17 | 27.67 | 32.62 | 29.50 | 33.50 | 50.50 | 34.22 | 36.60 | 128.3 | 138.4 | 166.7 | 182.4 | 279.5 | 258.9 | 171.5 | 189.4 |
| NV polyhouse | 75.28 | 58.94 | 132.3 | 107.0 | 114.5 | 90.22 | 84.39 | 94.65 | 191.2 | 220.9 | 229.2 | 213.4 | 238.9 | 250.2 | 173.8 | 216.8 |
| Mean | 64.88 | 52.30 | 114.6 | 93.95 | 91.06 | 67.66 | 52.21 | 76.66 | 266.2 | 353.6 | 405.8 | 472.3 | 441.6 | 358.2 | 256.6 | 364.9 |
| CD-$P_{0.05}$ | 12.170 | | | | | | | | 187.38 | | | | | | | |
| CD-$V_{0.05}$ | 8.891 | | | | | | | | 71.14 | | | | | | | |
| CD-$P_{0.05}$ at same or different level of V | 22.915 | | | | | | | | NS | | | | | | | |
| CD-$V_{0.05}$ at same level of P | 21.779 | | | | | | | | NS | | | | | | | |

P: Protected structure; V: Hybrid

**Table 5**. Performance of sweet hybrids under different polyhouses for yield characters

| **Protected structures** | Days to first harvest | | | | | | | | Harvest duration (days) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hybrids | | | | | | | | Hybrids | | | | | | | |
| | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean | Bharath | US-181 | SH-1 | SH-2 | Super Gold | Navratna | Spinx | Mean |
| Chinese polyhouse | 165.0 | 152.6 | 136.9 | 148.7 | 131.6 | 153.1 | 162.6 | 150.1 | 19.81 | 31.89 | 43.83 | 35.67 | 50.75 | 39.61 | 7.92 | 32.78 |
| Mud Wall polyhouse | 131.3 | 135.2 | 121.2 | 118.9 | 126.6 | 139.9 | 133.5 | 129.5 | 58.69 | 52.75 | 61.00 | 63.39 | 59.75 | 44.39 | 38.42 | 54.06 |
| LEHO polyhouse | 145.6 | 101.1 | 129.1 | 145.3 | 124.1 | 140.7 | 149.6 | 133.6 | 36.42 | 36.58 | 40.36 | 34.14 | 45.50 | 33.08 | 32.58 | 36.95 |
| Local polyhouse | 147.6 | 146.2 | 138.2 | 139.1 | 145.7 | 142.8 | 154.4 | 144.9 | 33.92 | 30.17 | 46.17 | 49.08 | 34.67 | 33.25 | 30.08 | 36.76 |
| Trench | 148.0 | 148.0 | 148.6 | 158.9 | 138.1 | 148.0 | 156.5 | 149.5 | 19.17 | 17.33 | 16.81 | 6.81 | 27.06 | 17.33 | 9.17 | 25.55 |
| NV polyhouse | 109.9 | 112.7 | 95.33 | 99.28 | 104.1 | 114.0 | 133.2 | 109.8 | 25.50 | 26.67 | 22.75 | 26.92 | 22.92 | 28.17 | 25.92 | 16.24 |
| Mean | 141.2 | 132.6 | 128.2 | 135.0 | 128.4 | 139.8 | 148.3 | 136.2 | 32.25 | 32.56 | 38.49 | 36.00 | 40.11 | 32.64 | 24.01 | 33.72 |
| CD-$P_{0.05}$ | 17.688 | | | | | | | | 20.115 | | | | | | | |
| CD-$V_{0.05}$ | 11.021 | | | | | | | | 7.416 | | | | | | | |
| CD-$P_{0.05}$ at same or different level of V | NS | | | | | | | | NS | | | | | | | |
| CD-$V_{0.05}$ at same level of P | NS | | | | | | | | NS | | | | | | | |

P: Protected structure; V: Hybrid