Original Research Article

COMPARATIVE ANALYSIS OF CAPSICUM CROP CULTIVATION UNDER DIFFERENT PROTECTED STRUCTURES

Abstract

India is a region of different Agro-climatic zones, and all of these zones have a high potential for Agricultural development across all seasons. Vegetables, which are extensively grown in rural and peri-urban areas, represent a big and important element of our nutritional requirements. Hi-tech horticulture including protected cultivation of high value and exotic vegetables has been on the raise, targeting high end domestic and export markets.The present investigation was carried out to evaluate the capsicum crop under various protected structures such as Close shade net, Poly house, Sides open shade net, and open fields. The experiment was carried out at the Soil and Water Conservation Engineering research areas at College of Agricultural Engineering, University of Agricultural Sciences, Raichur. The result showed that plant height of capsicum was maximum (65 cm) at 120 DAT under polyhouse and minimum in open field condition (30 cm). The capsicum fruit weight was found to be maximum in Playhouse (60 g) and minimum in open field condition (49.50 g).The capsicum fruit rind thickness was found to be maximum in polyhouse (0.91 cm) and minimum in open field condition is (0.74 cm). The capsicum fruit yield per plant was found to be maximum in Poly house, (2.28 kg) and minimum in Open field condition (0.90 kg). The capsicum fruit yield per ha was (50.66 t ha^{-1}) in the poly house and (20.10 t ha^{-1}) in the open field environment. The volume of water applied through drip irrigation at (80% ET) was maximum in the closed shade net (335.63 mm), followed by the open field (277.20 mm). The maximum WUE was recorded in polyhouse (21.22 kg/m^3) followed by side open shade net (9.92 kg/m^3), closed shade net (9.66 kg/m^3) and open field (7.25 kg/m^3).The benefit cost ratio was found to be maximum under polyhouse condition (1.43).

Keywords: Capsicum, Shade nets, Water use efficiency, Vegetative growth and Yield.

Introduction

India boasts of diverse Agro-climatic conditions, each brimming with the potential to cultivate a wide variety of crops throughout the year. Among these, vegetables play a pivotal role in meeting our dietary needs and are extensively cultivated in both rural and peri-urban areas. Advanced horticultural practices, such as the protected cultivation of valuable and exotic vegetables, have been gaining momentum which is primarily aimed at catering to the premium domestic and international markets. However, recent trends, driven by population growth, land fragmentation, and urbanization, have resulted in a reduction of arable land, especially in urban and peri-urban areas. Engaging in vegetable production within a protected cultivation system offers efficient land resource utilization. This approach not only enhances the output of high-quality vegetables for both domestic consumption and export markets but also mitigates the impact of various biological and environmental stress factors commonly encountered in open-field farming. Within the realm of protected cultivation, capsicum cultivation stands out as a popular choice due to its superior productivity and economic viability. The advent of protected cultivation technology has revolutionized bell pepper farming, elevating it to new heights. The utilization of plastics in horticulture has provided a significant advantage over traditional open-field cultivation. This technology allows for precise control over various environmental factors, including temperature, humidity, light intensity, photoperiod, CO_2 levels, irrigation, nutrient uptake, plant spacing, growing medium, and root development, as highlighted by Baghel *et al*. (2003) and Navale *et al.* (2003).

Capsicum (Capsicum annuum L. var. grossum Sendt), commonly known as bell pepper or sweet pepper, stands out as one of the most favored and economically rewarding herbaceous vegetable crops, as highlighted by Thakur *et al.* (2018). Belonging to the Solanaceae family, sweet pepper cultivation extends across various regions worldwide. It finds its place in temperate areas of Central and South America, European countries, as well as in tropical and subtropical zones within the Asian continent, with a notable presence in India and China. India plays a significant role in the global capsicum production, contributing a quarter of the total output. The country achieves an annual average production of 0.9 million tonne from a cultivated area of 0.885 million hectares, resulting in a commendable productivity of 1266 kilograms per hectare. In India, capsicum cultivation is widespread, with notable presence in states like Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Himachal Pradesh, and hilly regions of Uttar Pradesh. Among these, Andhra Pradesh leads the way with an extensive cultivation area of 236.5 thousand ha, resulting in a production of 748.5 thousand tonne. Karnataka follows closely with an area of approximately 76 thousand hectares, producing around 131 thousand tonnes of capsicum.

Capsicum is typically considered a cool-season crop, but with the use of protected structures, it can be cultivated year-round, allowing for precise control of temperature and relative humidity (RH). Ideal conditions for capsicum growth include daytime temperatures between 25-30°C and nighttime temperatures of 18-20°C, with a relative humidity range of

50-60 percent. Fruit setting may be adversely affected if temperature exceeds 35°C or drops below 12°C. Colored capsicums, in particular, enjoy high demand in urban markets, with the hotel and catering industry driving this demand. Traditional green capsicum, usually yields between 20-40 t ha^{-1}depending on the variety and season in approximately 4-5 months. However, in a greenhouse environment, both green and colored capsicum extend their growing season to about 5-6 months and significantly increase yields to approximately 80-100 t ha^{-1}.

Material and methods

This experiment was carried out in various protected structures at research fields of the College of Agricultural Engineering, University of Agricultural Sciences, Raichur. The experiment was designed with six replications. The experiment consisted of different protected structures such as Close shade net, Poly house, Sides open shade net and open field. Raised beds each of 18 m length, 1 m width and 0.15 m height were prepared leaving a space of 1.5 m between two beds as a path, to enable easy cultural operations like weeding, spraying, harvesting etc. The beds were leveled after mixing well rotten farm yard manure and vermicompost. Drip lateral with a discharge capacity of 4 lph was placed on the raised beds.Irrigation was provided to the beds a day before transplanting. The healthy one-month old capsicum seedlings were sown in November, 2021 in the well-prepared beds. Immediately light irrigation was provided with the help of drip system. Then later irrigation was given as per the irrigation schedule. Crop was irrigated by using drip irrigation system as per water requirement of the crop. Crop water requirement was calculated for every week with the help of meteorological data. The observations were recorded on growth, reproductive and quality traits of capsicum, from the five randomely selected and taged plants.

Results and discussion

Weather parametrs recorded different protected structure

Temperature (°C)

The maximum temperature was recorded during March, 2022 were (47.6°C), (36.9°C), (36°C) and (36°C) in polyhouse, control conditions, side open shade net and, closed open shade net respectivelly. The minimu temperature recoded during December, 2021 were (41.6°C), (28°C), (26°C) and (24°C) in polyhouse, closed open shade net, side open shade net and side open shade net, respectivelly. There were noticeable differences between the various protected structures and the control conditions. The maximum temperature was recorded in the polyhouse treatment, while the lowest temperature was observed in the side open shade net and there results were consistent with findings by Ramana *et al.* (2022) and Parvej*et al.* (2010) (Figure 1-4).

Relative humidity (%)

The maximum temperature was recorded during January, 2022 were (63%), (54%),(40%) and (40%) in open field condition, close shade net, poly house and side opened shade net respectivelly. The minimum temperature recoded during February, 2022 were (33.1%), (30%), (23.5%) and (17%) in poly house, close shade net, side opened shade net and open field condition respectivelly. The treatment within the polyhouse exhibited the highest recorded relative humidity, while the lowest relative humidity levels were observed in the open field conditions. These findings align with the research of Ramesh *et al.* (2022) and Rajasekar *et al.* (2013) (Figure 1-4)..

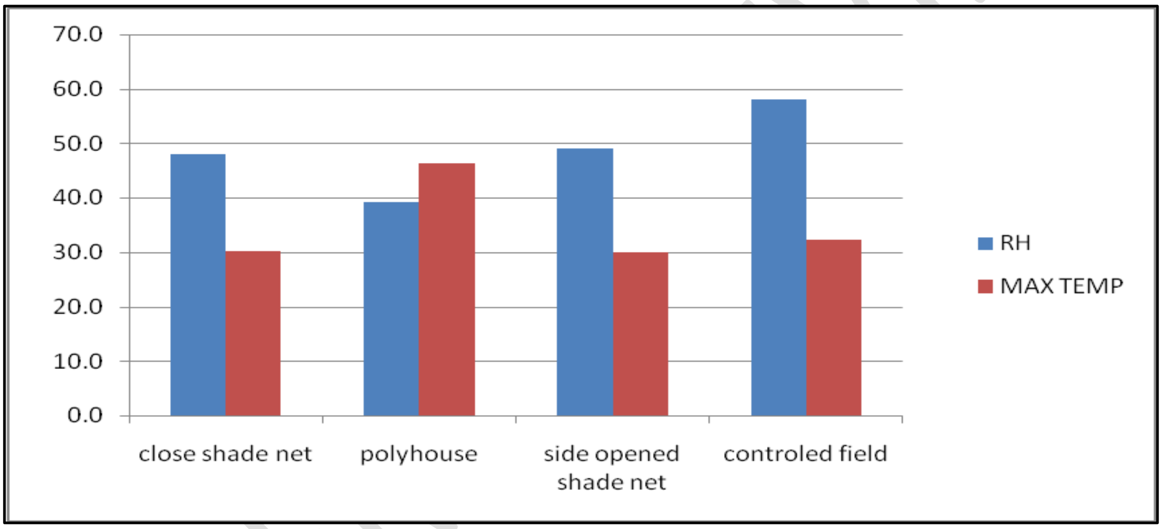

Fig.1 Temperature and Relative humidity recorded in different protededstructures during December, 2021

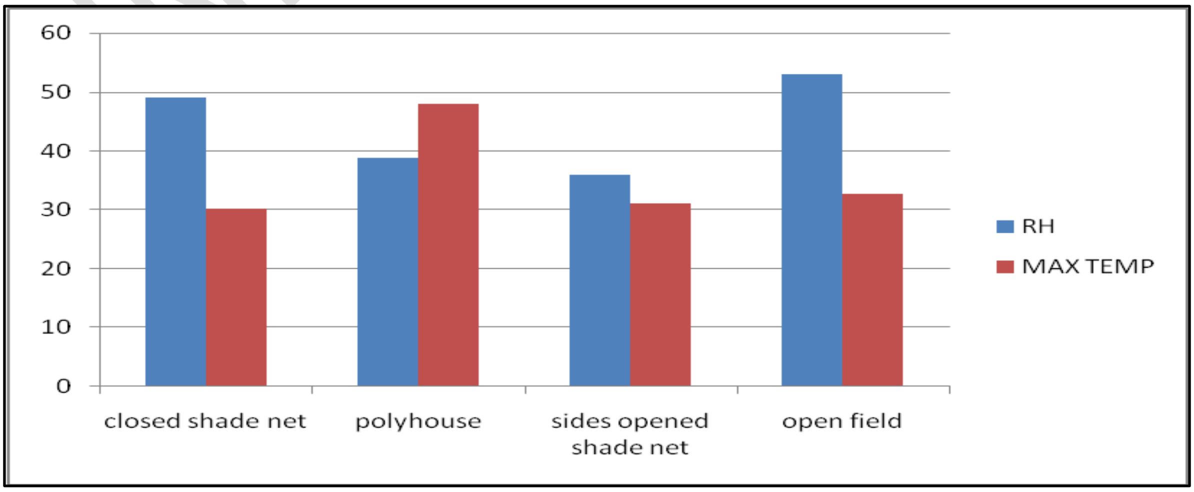

Fig.2 Temperature and Relative humidity recorded in different protededstructuresduring January, 2022

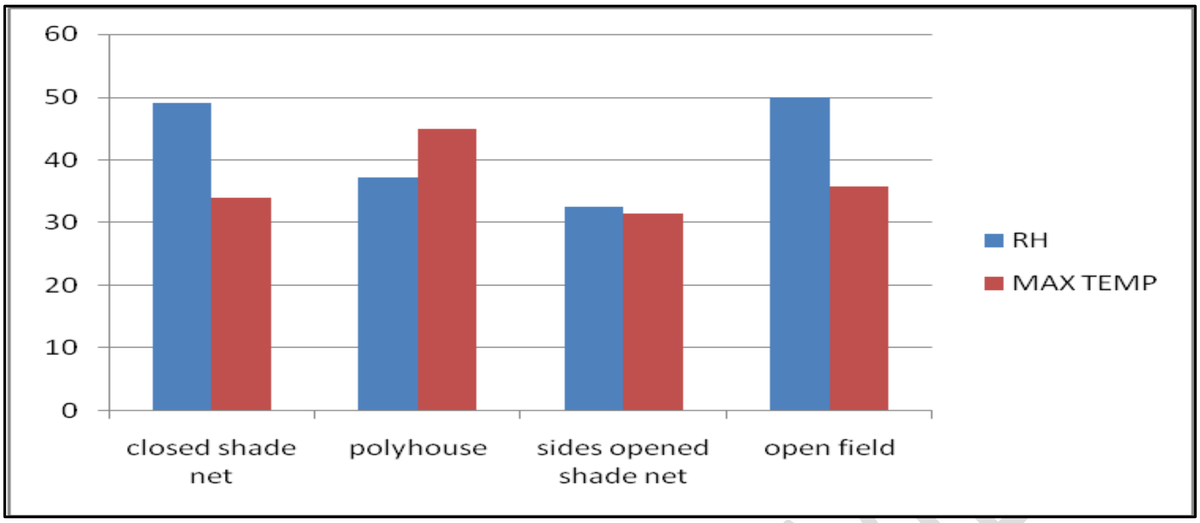

Fig.3 Temperature and Relative humidity recorded in different protededstructures during February, 2022

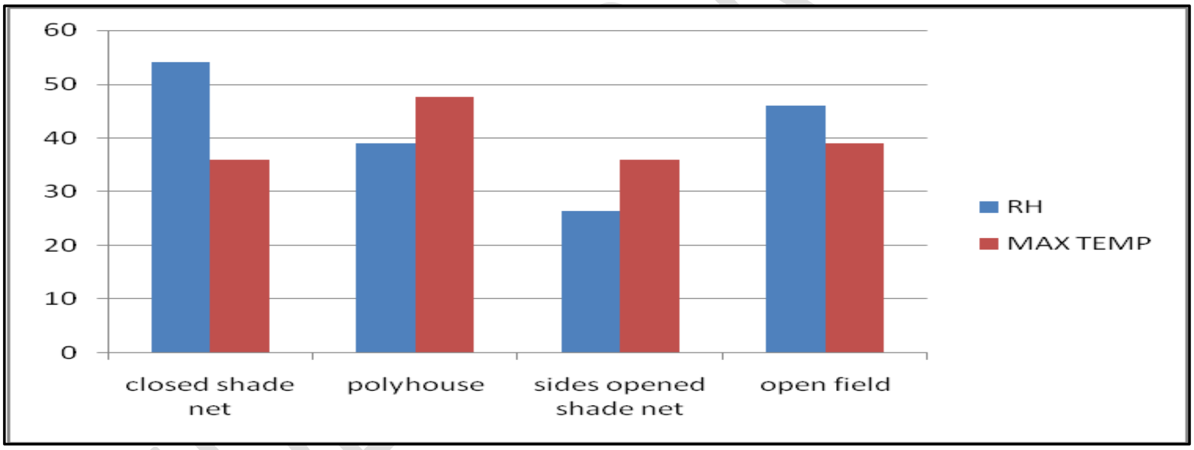

Fig. 4 Temperature and Relative humidity recorded in different protededstructures during March, 2022

Effect of protected structures on plant growth parameters of capsicum

The date protected to growth parameters of capsicum the data are presented in table 1.The plant height (65 cm), number of leaves (75), number of primary branches (15), as well as the number of secondary branches (15) of capsicum plants grown under polyhouse whenwere compared to capsicum grown under closed shade net, side cosed shade net and open field conditions. Lowest plant height (50 cm), number of leaves (59), number of primary branches (11) and number of secondary branches (21) were recorded under open condition.

The enhanced vegetative growth, as indicated by plant height, number of branches, number of leaves per plant, number of primary branches per plant, and secondary branches per plant, werehighest plant heighest in the polyhouse. The improved growth can be attributed to the favorable micro-climatic conditions within the polyhouse, which facilitated higher plant metabolic activities such as photosynthesis and respiration. This observation aligns with similar findings in studies conducted by Challa *et al.* (2022), Kumar *et al.* (2014), Maurer (1981), and Ohigbu and Harris (1989). These studies also reported improved vegetative growth in response to more controlled and favorable growing conditions, further validating the positive impact of such environments on plant development

Table 1: Growth Parameters of capsicum as influenced by different Protected Structures

Treatment	Plant height (cm)	Number leaves per plant (No)	Number of primary branches (No)	Number of secondary branches (No)
Closed shade net	50.00	59.00	11.00	21.00
Polyhouse	65.00	75.00	15.00	25.00
Sides opened shade net	32.00	51.00	11.00	17.00
Open field	30.00	45.00	9.00	13.00
S.Em.±	0.93	0.68	0.41	0.37
C.D. at 5%	2.80	2.06	1.25	1.12

Effect of protected structures on yield and quality parameters of capsicum

Among the different structures, the average fruit weight(60.00 g/fruit), number fruits per plant (38.00 No), yield per plant (2.28 kg), yield per hectare (50.66t ha^{-1}) and rind thickness (0.91 cm) were higher under polyhouse followed by closed shade net. The lowest fruit weight (49.50 g/fruit), number fruits per plant (22.00 No), yield per plant(0.90 kg), yield per hectare (20.10t ha^{-1}) and rind thickness (0.74 cm)were recorded under open field conditions (Table1).

The marketable fruit yield of capsicum exhibited significant variation, with the highest yield recorded under polyhouse conditions and the lowest in the open field.The favorable microclimatic conditions that prevailed in polyhouse lead to increased vegetative growth, and this, in turn, resulted in higher number of flowers, higher number of fruits, a higher percentage of fruit set, maximum fruit weight and volume. These findings are consistent with similar results obtained in studies conducted by Nagendra Prasad (2001), Satpute *et al.* (2013), and Brahma *et al.* (2012). These studies also noted the positive impact of controlled environments, such as polyhouses, on capsicum yield, emphasizing the role of favorable climatic conditions in enhancing crop productivity(Table2).

Table 2: Yield parameters of capsicum as influenced by different protected structures

Treatment	Fruit weight (g)	Numberfruits per plant (No)	Yield per plant (kg)	Yield per hectare (t)	Rind thickness (cm)
Closed shade net	56.45	26.00	1.46	32.44	0.85
Polyhouse	60.00	38.00	2.28	50.66	0.91
Sides opened shade net	53.00	23.00	1.21	26.66	0.83
Open field	49.50	22.00	0.90	20.10	0.74
S.Em.±	2.24	0.08	0.07	1.59	0.09
C.D. at 5%	3.53	0.24	0.21	4.82	0.20

Water requirement and water use efficiency of capsicum cropunderdifferent protected structures

The result indicates that maximum amount of water applied through drip irrigation at 80 % ET in closed shade net (335.63 mm) followed by open field (277.20 mm), sides open shade net (266.60 mm) and polyhouse (238.39 mm). The result indicates that season wise maximum amount of water applied through drip irrigation at 80 % ET in closed shade net (335.63 mm) followed by open field (277.20 mm), sides open shade net (266.60 mm) and polyhouse (238.39 mm) (Table 3). Similar results were obtained by Santosh *et al.*,(2017).

Water use efficiency is a measure that quantifies the yield produced per unit volume of water utilized. The findings reveal that the highest water use efficiency was observed in the polyhouse conditions, recording 21.22 kg/m³, followed by side-open shade net (9.92 kg/m³), closed shade net (9.66 kg/m³), and open field (7.25 kg/m³) as shown in table 4. These results align with those obtained in studies conducted by Babar *et al.* (2015), Kumar *et al.* (2016), Gupta *et al.* (2010), and Kumar *et al.* (2017), emphasizing the consistency of these findings across various research efforts.

Table.3 Amount of water applied through drip irrigation at 80% ET for capsicum under different protected structures.

Water applied(mm)				
Month	**Closed shade net**	**Polyhouse**	**Sides open shade net**	**Open field**
November, 2021	2.20	2.08	2.33	2.42
December, 2021	27.01	22.37	24.29	26.01
January, 2022	121.52	65.98	75.04	76.72
February, 2022	102.82	77.37	84.97	89.96
March, 2022	82.08	70.59	79.97	82.08
Total	**335.63**	**238.39**	**266.60**	**277.20**

Table. 4 Water use efficiency of capsicum under different protected structure

Treatment	WUE (kg/m^3)
Close shade net	9.66
Polyhouse	21.22
Side open shade net	9.92
Open field	7.25

Conclusion

The study demonstrated that, high-tech horticulture practices, including protected cultivation, can significantly impact the growth and yield of capsicum crops. This research underscores the importance of adopting protected cultivation techniques, especially polyhouse cultivation, to enhance the production, quality, and economic returns of capsicum in India's diverse Agro-climatic zones. These findings provide valuable guidance for farmers and policymakers in promoting sustainable agriculture and enhancing food security, both at the domestic and export levels. It is clear that the integration of modern agricultural practices can play a crucial role in harnessing the full potential of India's agricultural landscape.

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