

Comparative Study on Yield and Cost of Cultivation of Capsicum in a Greenhouse and Open Field Condition in Warm and Humid Climate of India

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ABSTRACT: The suitability of a low-tech naturally ventilated greenhouse was evaluated for off-season cultivation of capsicum in warm and humid climate i.e. in coastal Orissa, Bhubaneswar because of its high demand during that period. The cultivation of this vegetable was tried in winter days of the year 2011-12. It was observed that the crop yield was more in the greenhouse during off-season as compared to the open field condition. The greenhouse with shade net was observed to be a suitable protected condition for better plant growth and higher yield compared to without shade net for less variation in temperature due to partial elimination of incoming radiation by the shade net during day hours and prevention of the radiative losses to the cold night sky thus maintaining a better heat distribution inside the greenhouse. The yield of capsicum per square meter of the cultivated area in the greenhouse was found to be 2.34 times more than open field condition. Overall growth of capsicum in terms of height of plants and number of leaves per plant inside the greenhouse was more compared to the open field. Early flowering and fruiting were also observed in the greenhouse condition. The benefit cost ratio for capsicum in the greenhouse was 2.98 whereas it was 0.80 in case of open field condition. In this naturally ventilated type of greenhouse, the small and marginal farmers of Orissa will be able to grow other vegetables during off-season which would be quite remunerative.

Key words: Greenhouse, solar energy, capsicum, shade net.

INTRODUCTION

Cultivation of crops is mainly climate dependent in normal conditions. Hence, all vegetables have their own seasons in which they can be grown. But with the introduction of green house technology (Nelson, 1985), farmers can be able to grow various vegetables during off season to fetch a good market value. As there are many small and marginal farmers in Orissa, hence the suitability of a low-tech naturally ventilated greenhouse was evaluated for off-season cultivation of capsicum in coastal Orissa because of its high demand during pre-summer period. The cultivation of this vegetable was tried in winter days of the year 2011 with three dates of sowing under both open field and greenhouse condition to evaluate and compare its different growth parameters, yield and yield attributing characters and to harvest during pre-summer period as an off season vegetable. Looking into the demands of capsicum during off-season and

importance of maintaining suitable temperature inside the greenhouse for the growth of capsicum, experiments were conducted under greenhouse and open field conditions with the following objectives;

1. to compare the growth and yield of capsicum both inside greenhouse and in open field condition
2. to compare the cost of cultivation of capsicum both inside and outside the greenhouse.

MATERIALS AND METHODS

Experimental Site

A semi circular shaped greenhouse (Fig.1) covering the floor space of 4 m x 12 m (48 sq m) oriented in East-West direction (Singh and Tiwari 2000) was used for study. The greenhouse was covered with ultra violet (UV) low density polyethylene (LDPE) film of 200 micron thickness. The greenhouse was covered

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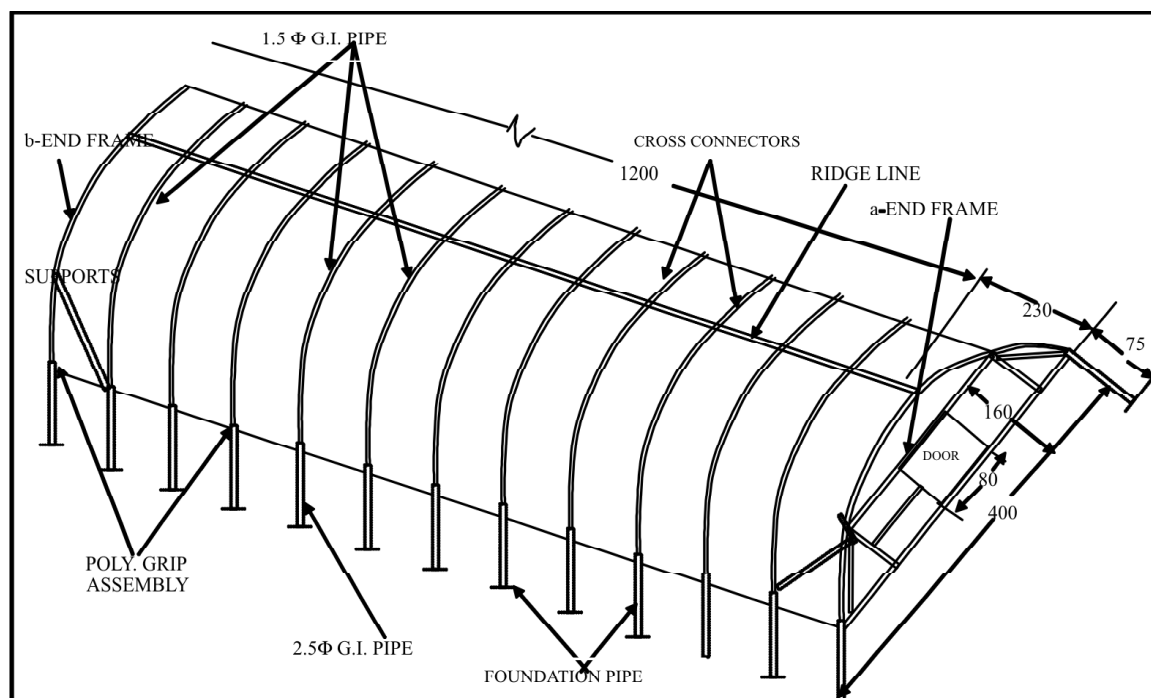


Figure 1: Semi cylindrical greenhouse (all dimensions in cm)

with a netlon make shade net of 50 per cent as a shading device (Sharma 1998) as and when required. The experimental greenhouse is located in the nursery site of the Department of Horticulture, Orissa University of Agriculture and Technology, Bhubaneswar and experimental observations were taken during the year 2011-12. The place is situated at 20°15'N latitude and 85°52'E longitude with an

elevation of 25.9 m above the mean sea level and nearly 64 km west of the Bay of Bengal and coming under the warm and humid climatic condition. The mean air temperature varies from 25 to 37.17 °C in summer, 24.53 to 32.72 °C in rainy and 14.88 to 28.33 °C in winter seasons. The photograph of experimental greenhouse is shown in Fig. 2.



Figure 2: Photograph of experimental greenhouse

Experimental Design

The experiment was laid out in a Complete Randomized Design (CRD) with six different treatment combinations of factor A and factor B in four replications (Das, 2010). The details of layout are shown below.

Greenhouse (G_1)		Sowing date	Open field (G_2)		
R_1	R_3	S_1	R_1	R_3	R_3
R_2	R_4	S_2	R_2	R_4	R_4
R_4	R_1		R_4	R_1	R_1
R_2	R_3	S_3	R_2	R_3	R_3
R_3	R_4		R_3	R_4	R_4
R_1	R_2		R_1	R_2	R_2

Layout for capsicum plantings

Factor A: Growing condition	
Size of the greenhouse: 12m x 4m	G_1 : Naturally ventilated greenhouse
Single plot size: 1.80m x 1.96m	G_2 : Open field as control
Number of plants/plot: 15	Factor B: Date of planting
Spacing: 0.4 m x 0.6m (plant to plant/row to row)	S_1 : 02-09-2009
Variety: California Wonder	S_2 : 21-09-2009
	S_3 : 12-10-2009

RESULTS AND DISCUSSION

Fruit yield per plant

Significant variation with respect to green fruit yield per plant (kg) was observed under various growing conditions irrespective of the dates of planting. The data are presented in Table 1. Perusal of data in the table indicated higher fruit yield per plant (1.08 kg) in G_1 and lower (0.46 kg) in G_2 irrespective of dates of planting. Planting on third date (S_3) recorded higher fruit yield (0.77 kg) whereas lowest yield per plant (0.66 kg) was recorded in S_1 irrespective of growing conditions. Highest yield per plant (1.23 kg) was recorded in G_1S_3 followed by G_1S_2 (1.07 kg) and G_1S_1 (0.96 kg) in descending order. The interaction effect was non-significant.

Fruit yield per square meter (m^2)

A significant difference was observed for this trait in different growing conditions as well as dates of planting which has been presented in Table 2. The yield per m^2 ranged in between 4.65 kg (G_1) to 1.98 kg (G_2) irrespective of different dates of planting. It varied from 3.79 kg (S_3) to 2.84 kg (S_1) in different dates of planting irrespective of growing conditions. Highest fruit yield was recorded in G_1S_3 (5.27 kg) followed by G_1S_2 (4.58 kg), G_1S_1 (4.11 kg). Lowest fruit yield per m^2 was recorded in open conditions ranging

from 1.58 kg (G_2S_1) to 2.31 kg (G_2S_3). The interaction effect was non-significant.

Table 1
Effect of growing condition, dates of planting and their interaction on fruit yield per plant in kg after 90 days of planting

Growing condition	Date of planting			Mean
	S_1	S_2	S_3	
G_1	0.96	1.07	1.23	1.08
G_2	0.37	0.48	0.54	0.46
Mean	0.66	0.77	0.88	
	G	S	$G \times S$	
SE(m)±	0.028	0.029	0.047	
CD(5%)	0.085	0.09	0.146	

G_1 (Greenhouse) and G_2 (Open condition); S_1 (date of planting 02-09-09); S_2 (date of planting 21-09-09) and S_3 (date of planting 12-10-09)

Table 2
Effect of growing condition, dates of planting and their interaction on fruit yield per m^2 in kg after 90 days of planting

Growing condition	Date of planting			Mean
	S_1	S_2	S_3	
G_1	4.11	4.58	5.27	4.65
G_2	1.58	2.05	2.31	1.98
Mean	2.84	3.31	3.79	
	G	S	$G \times S$	
SE(m)±	0.120	0.127	0.278	
CD(5%)	0.37	0.39	0.86	

G_1 (Greenhouse) and G_2 (Open condition); S_1 (date of planting 02-09-11); S_2 (date of planting 21-09-11) and S_3 (date of planting 12-10-11)

Other biometric observations

The other biometric observations like days to flowering, days to fruiting, days to first plucking of fruit, period of harvest and number of plucking for both the greenhouse and open conditions has been presented in Table 3. These parameters play significant role towards the yield. From the data recorded in the October planting of capsicum in greenhouse condition gave the best result as per the agronomical point of view followed by the September planting in the same condition. The days to first flowering, days to first plucking from the date of planting were 39 and 50 respectively for the October planting in greenhouse condition. Also the other attributes like period of harvest, number of plucking were most superior to other dates of planting and conditions for which the yield was 52.70 t/ha followed by 45.8 t/ha obtained in greenhouse condition with last week of September planting. For all the three dates of planting, the greenhouse condition gave better result than the open filed condition.

Table 3
Other biometric observations

Sl. No.	Observations	S ₁		S ₂		S ₃	
		G ₁	G ₂	G ₁	G ₂	G ₁	G ₂
1.	Days to first flowering	42	55	41	47	39	46
2.	Days to first fruiting	55	63	53	59	50	56
3.	Days to first plucking	85	96	81	89	78	88
4.	Period of harvest	30	25	25	27	37	30
5.	Number of plucking	05	03	06	03	06	03

G₁ (Greenhouse) and G₂ (Open condition); S₁ (date of planting 02-09-11); S₂ (date of planting 21-09-11) and S₃ (date of planting 12-10-11)

Cost benefit ratio (CBR)

The benefit cost ratio for growing capsicum inside the greenhouse came to be 2.98 (Table 4) whereas it was 0.80 when grown in open field condition (Table 5).

Table 4
Cost of cultivation of capsicum inside the greenhouse (45 m² area)

S. No	Particulars	Quantity	Rate (Rs.)	Amount (Rs.)
1	Seed	15 gm.		30.00
2	Nursery management	1 man-day	100/man-day	100.00
3	Main field (land preparation)	3 man-day	100/man-day	300.00
4	FYM & Fertilizer (Urea) (55 kg/ha)	0.25 kg	15.00/kg	3.75
5	Single super phosphate (20 kg/ha)	0.09 kg	20.00/kg	1.80
6	Murate of potash (30 kg/ha)	0.15kg	20.00/kg	3.00
7	Compost preparation			70.00
8	Transplanting	1 man-day	100/man-day	100.00
9	Fertilizer application	1 man-day	100/man-day	100.00
10	Intercultural operations	3 man-day	100/man-day	300.00
11	Plant protection chemicals			200.00
12	Harvesting (10 harvests)	3 man-day	100/man-day	300.00
13	Miscellaneous expenses			500.00
14	Total cost of cultivation			2008.55
15	Average yield (kg/45 m ²)	200 kg	40/kg	8,000.00
16	Net return for 4 months (8,000-2008.55)			5991.45
17	Benefit-cost ratio (5991.45/2008.55)			2.98

Table 5
Cost of cultivation of capsicum outside the greenhouse (45 m² area)

S. No	Particulars	Quantity	Rate (Rs.)	Amount (Rs.)
1	Seed	15 gm.		30.00
2	Nursery management	1 man-day	100/man-day	100.00
3	Main field (land preparation)	3 man-day	100/man-day	300.00
4	FYM & Fertilizer (Urea) (55 kg/ha)	0.25 kg	15.00/kg	3.75
5	Single super phosphate (20 kg/ha)	0.09 kg	20.00/kg	1.80
6	Murate of potash (30 kg/ha)	0.15kg	20.00/kg	3.00
7	Compost preparation			100.00
8	Transplanting	1 man-day	100/man-day	100.00
9	Fertilizer application	1 man-day	100/man-day	100.00
10	Intercultural operations	3 man-day	100/man-day	300.00
11	Plant protection chemicals			370.00
12	Harvesting (8 harvests)	2 man-day	100/man-day	200.00
13	Miscellaneous expenses			500.00
14	Total cost of cultivation			2108.55
15	Average yield (kg/45 m ²)	95 kg	40/kg	3800.00
16	Net return for 4 months (3800-2108.55)			1691.45
17	Benefit cost ratio (1691.45/2108.55)			0.80

CONCLUSIONS

On the basis of the above study, the following conclusions are drawn.

1. During peak sunny hours, the greenhouse air temperature inside the shade net was 2 to 3 °C higher than the ambient air temperature and in the night hours, the inside air temperature is 3 to 5 °C higher than the ambient air temperature
2. The observed plant temperature inside the greenhouse with shade net during peak sunny hours is 1 to 2 °C lower than ambient air temperature and during night hours it is observed that, the plant temperature is 2 to 4 °C more than the ambient air temperature.
3. Natural ventilation was done (10 am to 4 pm) to keep the greenhouse air temperature within 3 to 4 °C lower than the ambient air temperature to make it suitable for the growth of the crops inside the greenhouse.

4. The variation of temperature is less in case of greenhouse with shade net than without shade net due to partial elimination of incoming radiation during sunny hours and preservation of the radiative heat losses to the cold night sky for maintaining better heat distribution inside the greenhouse during night hours due to shade.
5. The yield of capsicum per square meter of the cultivated area in the greenhouse was found to be 2.34 times more than open field condition irrespective of the date of planting. The same for October planting was observed to be 1.28 and 1.15 times more than the planting during first week of September and last week of September. Also for October planting, the yield (46.53 t/ha) inside the greenhouse was 2.28 times more than open field condition (19.80 t/ha). Early flowering and fruiting were also observed in greenhouse condition.
6. The benefit cost ratio for capsicum in the greenhouse was 2.98 whereas it was 0.80 in case of open field condition.

Considering the yield, environmental parameters and cost of cultivation, the naturally ventilated greenhouse with shade net is suitable for the cultivation of capsicum during off-season in coastal Odisha.

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