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Assessment of growth, yield attributes and economics of King Chilli grown under protected condition in mid hills of Meghalaya

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ABSTRACT

'Bhut Jalokia' or 'Ghost chilli' is one of the types King Chilli (*Capsicum chinense* Jacq.) grown in entire North Eastern states. King chilli once occupied the number one position among the hottest chillies of the world. The unique climatic condition of Meghalaya favours the cultivation of this crop, which could contribute to the economic upliftment of the tribal farmers due to its high value and demand. The cultivation of king chilli under open condition proves to be less remunerative due to long rainy season. The present demonstration was carried out in five villages of Ri Bhoi district of Meghalaya. King chilli was cultivated inside naturally ventilated low cost polyhouse as well as under open field condition consecutively for 3 years. All the horticultural traits studied viz. plant height, number of primary branches, fruit length, fruit width, number of fruits per plant, average fruit weight, number of seeds per fruit, 100 seed weight, average yield per plant and yield showed significant increase in values than that of cultivation under open field condition. The number of days to first flowering (61.35 days) and days to first harvest (85.50) was less than that of crop under open condition. This resulted in early crop maturity (161 days) with more yield (78.40 q/ha) and larger fruit size inside polyhouse. The benefit cost ratio of king chilli cultivated inside polyhouse recorded 1.06, 2.95 and 3.06 in the first, second and third year of demonstration. The extension gap, technology gap, technology index and increase over farmers practice were 25.65 q/ha, 11.60 q/ha, 12.89% and 48.63% respectively. Thus, it can be concluded that cultivation of king chilli under low cost polyhouse is remunerative.

Key words: *Economics, King chilli, Low cost polyhouse, Protected cultivation*

Introduction

The Northeast region of India is recognized as hotspot for chilli diversity (Mathur *et al*., 2000). A number of variants of king chilli are noted in this region with different local names, among the many landraces of chilli that are cultivated in the Northeast, the King Chilli (*Capsicum chinense* Jacq.) is best known worldwide (Kumar *et al*., 2011). It is widely cultivated in this part of India, relished by indigenous peoples for its pungency and aroma. King chilli was formerly recognized as world's hottest pepper with a Scoville Heat Units (SHU's) rating of 1,001,304 (Bosland and Baral, 2007).

The various agro-climatic condition of Meghalaya is suitable for cultivation of King chilli (Devi *et al*., 2018). The altitudinal variation of mid hill region of Meghalaya ranges from 500 – 1000 m above mean sea level, where rainy season starts from end of March and extends upto mid October. This sub tropical humid region receives average annual rainfall of 2900 mm.

King chilli requires warm humid climate and performs well under partial shade for optimal plant growth and development. In Meghalaya, king chilli is grown primarily in kitchen gardens under open field during summer. The cultivation of crop under open condition is often reported to be suffered due to various abiotic and biotic stresses resulting in low yield with inferior fruit quality (Devi *et al*., 2022). The protected structures, specially polyhouses of various sizes either made of bamboo or iron pipe, high tech or naturally ventilated for production of vegetables and spices results in shortening crop duration, improving quality and obtaining better market price (Chemma *et al*., 2004; Dixit, 2007; Singh *et al*., 2004). Polyhouse protects crop from high rainfall, hail stone, frost, insect pests & diseases. Through optimal utilisation of land and water resources, crops can be produced beyond normal season inside polyhouse to fetch higher income. Devi *et al.* (2022) stressed on dissemination of such technologies amongst the farmers of Meghalaya. With the emerging huge demand and subsequent gap in production and supply, there is a need to transfer of this technology to farmers' field as the available agricultural technology does not serve the very purpose until it reaches and adopted by its ultimate users the farmers. Technology transfer refers to the spread of new ideas from originating source to ultimate users (Prasad *et al*. 1987). Keeping the above points in mind, demonstrations were planned at farmers field for organic production of king chilli under low cost polyhouse. The main objective was to show the productivity potentials of the new production technologies under actual farmers' field situation and to prove their economic viability.

Materials and Methods

The study was carried out at the farmers' field under naturally ventilated low cost polyhouse and open field condition during 2020-21, 2021-22 and 2022-23 in Ri Bhoi district of Meghalaya (Table 1). Each location is categorized under subtropical climate and received 80 per cent of annual rainfall during end of March till mid October with an average of 1500-2500 mm. The demonstrations plots were prepared inside low cost polyhouse made with bamboo, UV stabilized 200 µ LDPE and shadenet 50%. Organic amendments were used for growing crops both under polyhouse as well as open field condition (Table 2). In case of farmers' practice, local cultivation practices followed. Before conducting demonstration, a list farmer was prepared by discussion at village level and the selected farmers were imparted with specific skill training on different aspects of crop cultivation as suggested by Choudhary (1999). The observations for various growth and yield parameters were recorded by using standard procedures and the recorded data from five plants for each parameter of three consecutive years were converted as an average for both the growing conditions. The data generated from the present study were statistically analyzed as per the method described by Panse and Sukhatme (1985). The extension tools used in the study *viz*., technology gap, extension gap and technology index were worked out using the formulae (Samui *et al*., 2000) as below –

Technology Gap = Potential Yield – Demonstration Yield

Extension Gap = Demonstration Yield – Farmers' Yield

$$\text{Technology Index} = \frac{\text{Potential Yield} - \text{Demonstration Yield}}{\text{Potential Yield}} \times 100$$

$$\text{Increase over farmers' practice (\%)} = \frac{\text{Potential Yield} - \text{Farmers' Yield}}{\text{Farmers' Yield}}$$

Results and Discussion

The results on the performance of king chilli cultivated under open condition as well as naturally ven-

Table 1. Location of demonstration plots, area and beneficiaries

Name of village	Latitude	Longitude	Altitude (m)	No. of beneficiaries	No. of polyhouses (area/polyhouse)	Area under open condition
Kyrdem	N25^{0}41.513/	E92^{0}04.468/	870	10	4 (100 m^2)	400 m^2
Mawkyrdep	N25^{0}41.000/	E92^{0}04.394/	867	10	4 (100 m^2)	400 m^2
Khapmara	N25^{0}41.845/	E92^{0}01.125/	880	10	4 (100 m^2)	400 m^2
Umsohpho	N25^{0}44.253/	E92^{0}03.674/	885	10	4 (100 m^2)	400 m^2
Umeit	N25^{0}42.561/	E91^{0}57.269/	898	10	4 (100 m^2)	400 m^2

tilated polyhouse are presented in Table 3. It is observed performance of king chilli for plant growth characters in all the five locations were significantly different. The performance of these characters were superior in naturally ventilated polyhouse conditions in comparison to open field condition. Leaf length (12.48±0.27), leaf width (5.53±0.27), plant height (124.92±0.48) and number of primary branches/plant (4.65±0.24) were record to be higher than the observation recorded under open field condition. Devi *et al*. (2022) reported higher plant height and number of primary branches/plant in king chilli grown under protected condition as compared to open field. Malshe *et al*. (2016) and Rao *et al*. (2013) also reported similar results in capsicum while comparing cultivation under polyhouse and open field condition. The vigorous growth of the plants inside the protected structure may be due to enhanced photosynthetic activity, thus making more assimilates available for vegetative growth of the plants. The cultivation of king chilli under protected condition resulted in early flowering (61.35±2.64), early harvest (85.50±7.17) and shortening of crop maturity (161.35±2.34). Devi *et al*. (2022) also reported similar findings in king chilli. Rao *et al*. (2013), Singh *et al.* (2011) and Kanwar *et al.* (2014) also reported early harvesting of capsicum grown under protected condition as compared to open field cultivation. Early to flower and harvesting inside naturally ventilated polyhouse may be due to higher photosynthetic activity, protection form abiotic stresses and less incidence of viral diseases, which is very common under open cultivation.

King chilli grown under protected condition also performed significantly well for various yield and yield contributing characters (Table 4). Fruit length

Table 2. Comparison between demonstration package and existing farmers practice

Particulars	Demonstration package	Farmers practice
Farming situation	Low cost naturally ventilated polyhouse	Open field condition
Variety	Bhut Jalokia	Bhut Jalokia
Time of transplanting	15th April – 20th April	15th April – 20th April
Method of transplanting	Raised bed 15 cm height and 1 m width, spacing 1 x 1 m	Raised bed 15 cm height and 1 m width, spacing 1 x 1 m
Organic Manure	FYM 5 tn/ha + Vermicompost 5 tn/ha enriched with *Trichoderma harzianum* power @ 1kg/100 kg of manure	FYM 5 tn/ha
Plant protection	Damping off, fruit rot, anthracnose, bacterial wilt, aphids, mites - *Trichoderma viriae* 3 ml/lt, *Pseudomonas fluroscence* @ 3ml/lt, neem oil NSKE @ 5ml/lt	Sieved wood ash for aphid, mealy bug. Garlic water for fruit rot

Table 3. Performance of king chilli for plant growth characters

Farming Situation	Location	Leaf Length (Cm)	Leaf Width (Cm)	Plant Height (Cm)	No. of Primary Branches/ Plant	Days to First Flowering	Days to First Harvest	Crop Duration
Low cost polyhouse	Kyrdem	12.35	5.68	123.19	4.25	66.75	94.50	163.75
	Mawkyrdep	13.17	6.25	131.73	5.50	58.75	87.50	155.00
	Khapmara	13.11	5.38	126.35	4.50	56.25	73.50	170.00
	Umsohpho	12.57	5.08	119.65	4.75	63.75	82.00	160.50
	Umeit	11.19	5.25	123.70	4.25	61.25	90.00	157.50
	Mean ± SE	12.48±0.27	5.53±0.27	124.92±0.48	4.65±0.24	61.35±2.64	85.50±7.17	161.35±2.34
	CD 5%	0.589	0.596	1.054	0.512	5.758	15.629	5.088
Farmers practice under open condition)	Mean ± SE (5 locations)	10.53±0.34	4.92±0.19	104.76±2.10	3.55±0.24	72.13±3.12	108.69±2.86	183.20±2.88
	CD 5%	0.73	0.42	4.58	0.53	6.80	6.24	6.28

Table 4. Performance of king chilli for yield and yield contributing characters

Farming Situation	Location	Fruit Length (cm)	Fruit width (cm)	No. of Fruits/ Plant	Av. Fruit Weight (g)	No. of Seeds/ Fruit	100 Seed Weight (g)	Av. Yield/ Plant (Kg)	Yield (q/ha)
Low cost polyhouse	Kyrdem	6.81	2.58	113.00	7.42	33.86	0.44	0.87	83.25
	Mawkyrdep	7.93	2.94	126.39	8.21	40.18	0.53	0.94	89.50
	Khapmara	6.55	2.33	108.25	7.15	29.73	0.36	0.74	73.75
	Umsohpho	6.13	2.07	95.75	6.59	24.82	0.41	0.61	68.75
	Umeit	6.45	2.29	113.50	7.04	25.53	0.30	0.75	76.75
	Mean	6.77± 0.115	2.44± 0.089	111.38± 2.240	7.28± 0.113	30.82± 1.501	0.41± 0.019	0.78± 0.021	78.40± 2.252
	CD 5%	0.251	0.195	4.880	0.246	3.270	0.042	0.046	4.907
Farmers practice under open condition)	Mean ± SE (5 locations)	4.98±0.27	1.86±0.14	94.10±1.34	5.25±0.29	25.00±1.25	0.23±0.009	0.52±0.02	52.75±1.57
	CD 5%	0.58	0.30	2.92	0.62	2.73	0.02	0.04	3.43

and fruit width are important fruit characters that determine the appearance and market price. Parameters fruit length (6.77±0.115) and fruit width (2.44±0.089) were significantly higher than the data recorded under open field condition. This may be due to the favourable microclimate prevailing inside the naturally ventilated polyhouse. Devi *et al.* (2022), Singh *et al.* (2011) and Nkansah *et al.* (2017) also reported similar results for capsicum and king chilli. Number of fruits per plant, and average fruit weight are important horticultural traits that directly contribute to average fruit yield per plant and ultimately contribute to overall yield of the crop. King chilli grown under naturally ventilated polyhouse recorded higher values for number of fruits/plant (111.38±2.240), average fruit weight (7.28±0.113), average yield/plant (0.78±0.021) and overall yield (78.40±2.252) than the crop grown under open condition. Similarly number of seeds per fruit and 100 seed weight was also recorded to be more inside polyhouse than that of crop grown in open field. Devi *et al.* (2022) also reported similar type of results while comparing performance of king chilli under open and polyhouse condition.

The yield gap and yield index analysis gives an idea of potentiality of the technology at farmers field (Table 5). The findings revealed that a gap exists between the actual farmers yield and realizable yield of the crop. The potential yield of king chilli is 90 q/ha. There was an increase of 48.63 per cent in yield of king chilli under naturally ventilated polyhouse than cultivation under open condition. The result clearly indicate the positive effect of improved cultivation practice over the existing practice towards enhancing the yield of king chilli. The technology gap (11.60 q/ha) observed might be attributing to dissimilarity in soil fertility status and weather conditions. However, low technology gap also reflects the farmers' cooperation in carrying out such demonstrations. The extension gap (25.65 q/ha) suggests that there is definite advantage of cultivating king chilli under polyhouse and emphasizes the need educate farmers through various means for adoption of improved production technology. The technology index (12.89%) showed the feasibility of the evolved technology at the farmers' field. The lower value of technology index, the more is the feasibility of technology. Gogoi *et al.* 2021 reported similar trend of results in chilli.

Table 5. Yield gap and Yield index analysis of king chilli

Parameters	Values
Mean Yield of King Chilli	78.40 q/ha
Mean Yield of Farmers Practice	52.75 q/ha
Potential Yield	90.0 q/ha
Increase over farmers practice (%)	48.63 %
Technology Gap	11.60 q/ha
Extension Gap	25.65 q/ha
Technology Index (%)	12.89 %

The economics of production of king chilli inside naturally ventilated polyhouse was estimated keeping into account the fixed and variable costs involved in the production of the crop (Table 6). The benefit cost ratio calculated to be 1.06, 2.95 and 3.06 in three consecutive years. During the first year due to fixed costs, the benefit cost ratio was less compared to second and third year. Favourable benefit

Table 6. Cost and returns from King Chilli cultivation under naturally ventilated low cost polyhouse (size 100 m^2)

Type of cost	Item	1st Year Amount (Rs.)	2nd Year Amount (Rs.)	3rd Year Amount (Rs.)
Cost (A)				
1	Polyhouse material Shade net (50%) and UV stabilized LDPE	26500.00	0	0
2	Other construction materials (bamboo, wire, nails, etc.)	2850.00	0	0
3	Construction labour 6 mandays @ 500 per day	3000.00	0	0
4	Labour for land preparation, sowing, Harvesting and other intercultural operations 20 mandays @ 500 per day	10000.00	10500.00	11000.00
5	Planting material	800.00	840.00	882.00
6	Organic Plant protection materials, manure & fertilizer	7850.00	8243.00	8655.00
7	Miscellaneous expenditure	1500.00	1575.00	1654.00
Total Expenditure		52500.00	21168.00	22191.00
Income (B)				
1	Income from selling of fruits	40000.00	44500.00	48000.00
2.	Income from selling of seedlings (2000 nos.)	16000.00	18000.00	20000.00
Gross Income from 100m^2 size polyhouse		56000.00	62500.00	68000.00
Net Profit		3500.00	41332.00	45809.00
BCR		1.06	2.95	3.06

cost ratio proved the economic viability of the demonstrated technology.

Conclusion

The present study has proved that the cultivation of king chilli under low cost naturally ventilated polyhouse enhances production and productivity. The quality of fruits also improved with earliness to crop harvest as compared to cultivation under open field condition.

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