

# Performance of tomato under greenhouse and open field conditions in the trans-Himalayan region of India

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**Abstract:** Production of tomato is limited by harsh climate and a short growing season in the trans-Himalayan Ladakh region of India. The performance of five tomato genotypes was compared under polyhouse and open field conditions. The study revealed that the performance of all tested tomato genotypes is far superior in the polyhouse, as compared to open field conditions, for all the considered characters. 'Shivalik' performed best with respect to yield characters followed by 'Pusa Rohini' under polyhouse conditions. However, in the open field, 'Pusa Rohini' showed the highest values, followed by 'Shivalik'. Cultivation of tomato under the polyhouse produced 136.12% more yield per ha and 188.93% more fruits per plant compared to open field cultivation. Therefore, tomato cultivation under protected conditions is advised for Ladakh growing conditions, employing specific polyhouse-responsive varieties.

## 1. Introduction

Tomato (*Solanum lycopersicon* L.) is available throughout the year in India. However, in the state of Jammu and Kashmir, with the exception of the Jammu region, it is mostly confined to the summer season. In the trans-Himalayan Ladakh region, production of tomato is limited by climate and a short growing season. Ladakh has a harsh climate and extreme temperature fluctuations ranging from -37°C to +38°C. In Ladakh, tomato can be grown in open conditions but yield remains poor with low quality and it remains weather-dependent. Therefore, protected cultivation is a feasible answer for successful cultivation of tomato in this region. Singh and Asrey (2005) also recommended that cultivation of tomato in a greenhouse would help obtain high productivity and better return. Therefore, it is useful to study tomato production potential in the Ladakh region with respect to yield and horticultural traits under protected conditions (preferably in a zero-energy polyhouse) in comparison to the open field.

## 2. Materials and Methods

The experiment was conducted under naturally ventilated polyhouse and open field conditions at the Experimental Farm, Stakna (Leh) of the Regional Agricultural Research Station (SKUAST-K) located at 3319 m amsl with latitude 33°58.551' NS and longitude 77°41.995' EW. The climate of the area is typically dry temperate. Five genotypes including four hybrids (PH-5, Shivalik, Jaya and Naveen 2000<sup>+</sup>) and one OP variety (Pusa Rohini) were transplanted in a naturally ventilated polyhouse and the open field. Planting distance was 60 x 30 cm. The design of the experiment was Factorial RBD and material was replicated thrice. Individual data of each location were also subjected to statistical analysis in RBD to have more authentic information with regard to tomato genotypes. Data recorded on 13 characters were subjected to statistical analysis as per Snedecor and Cochran (1967).

## 3. Results and Discussion

There were significant differences among tomatoes grown under polyhouse and open field condition for all the characters, except for locules per fruit, confirming thereby the certain role of polyhouse in the cultivation of tomato in the trans-Himalayan region. Similar

results were obtained by Singh and Asrey (2005) as they found excellent tomato crops in polyhouses compared to the outside environment. Significant differences were observed among tomato genotypes pooled over locations for number of fruits per plant, yield per plant, yield per ha, fruit length, TSS and locules per fruit. However, no polyhouse x genotype interaction was noted. Comparative performance of tomato genotypes is presented here.

#### Plant characters

In polyhouse and open conditions, 'Naveen 2000+' had significantly higher plant length. Results are in conformity with those of Singh and Singh (2000) under open field conditions. 'Naveen 2000+' also had a significantly greater number of harvests, followed by 'Pusa Rohini' in open field conditions. Under the polyhouse, the number of harvests ranged from 9.50 to 10.25. Cargnelutti *et al.* (2004) obtained 11-14 harvests under plastic greenhouse. The polyhouse had a significant effect on all the plant characters under study (Table 1). Ganesan (2002) also reported better plant height in polyhouses as compared to open field conditions.

#### Yield characters

Yield per plant, yield per ha and number of fruits per plant were highest in 'Shivalik' followed by 'Pusa Rohini' under greenhouse conditions (Table 2). Gualberto *et al.* (2007) also recorded significant differences for yield per ha. However, in open field conditions, 'Pusa Rohini' gave the highest value for all three characters, followed by 'Shivalik'. However, the differences were non-significant for yield per ha. The performance of 'Pusa Rohini' was the best, followed by 'Shivalik', for all these characters when data was pooled from the different locations. The performance of tomato was statistically superior in polyhouse cultivation compared to open conditions. Ganesan (2002) observed similar trends for yields per plant in polyhouses respect to open field conditions.

#### Fruit characters

The highest recorded value for fruit length under polyhouse and open conditions, as well as for pooled data, came from 'Naveen 2000+' however this genotype was at par with 'Jaya' and 'Shivalik' in the polyhouse (Table 3). Eklund *et al.* (2005) recorded fruit weight of 147.35 g, fruit length of 57.67 mm, fruit diameter of 69.75 mm and 5.25 locules per fruit for an elite hybrid in a controlled protected structure. All these values were higher than those found in the present study with the probable reason being fluctuating environment at fruit development as the present experiment was conducted under a naturally ventilated polyhouse. In open field and pooled data, 'Naveen 2000+' had statistically superior fruit length. TSS was statistically the highest in 'Pusa Rohini' under polyhouse conditions and in pooled data, while in open conditions 'Shivalik' exhibited the highest TSS, which was at par

Table 1 - Performance of tomato genotypes under polyhouse and open conditions for plant characters

Varieties	Location		Characters																			
			Plant height (cm)				Stem girth (mm)				Days to first harvest				No. of harvesting				Harvest duration (days)			
	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	
Pusa Rohini	91.12	77.50	84.31	10.25	6.25	8.25	91.5	95.25	93.37	10.25	6.25	8.25	68.50	39.00	53.75							
PH-5	98.12	56.25	77.19	9.50	5.50	7.50	89.5	96.25	92.87	9.50	5.50	7.50	67.25	35.50	51.37							
Shivalik	125.70	96.25	111.0	10.00	6.00	8.00	89.5	93.75	91.62	10.00	6.00	8.00	68.75	38.25	53.50							
Jaya	122.90	95.50	109.2	10.00	5.75	7.88	91.00	99.00	95.00	10.00	5.75	7.88	71.50	36.75	54.12							
Naveen 2000+	169.20	115.00	142.1	10.00	6.50	8.25	88.50	94.00	91.25	10.00	6.50	8.25	74.50	39.50	56.88							
Mean	121.40	88.10		9.95	6.00		95.65	90.00		9.95	6.00		70.05	37.80								
CD <sub>0.05</sub> (L)	10.43			1.14			3.30			0.51			4.07									
CD <sub>0.05</sub> (G)	29.95	12.63	NS	NS	NS	NS	NS	NS	NS	NS	0.67	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
CD <sub>0.05</sub> (LxG)	NS			NS			NS			NS			NS									

L1= Poly house.  
L2= Open field.

Table 2 - Performance of tomato genotypes under polyhouse and open conditions for yield characters

Varieties	Characters											
	Location			No. of fruits per plant			Yield per plant (kg)			Yield per ha (Q)		
	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean
Pusa Rohini	25.03	13.00	19.02	1.243	0.657	0.95	690.42	365.14	527.8			
PH-5	22.64	4.49	13.56	1.066	0.213	0.64	592.36	118.34	392.8			
Shivalik	26.81	9.96	18.39	1.282	0.537	0.91	712.22	298.20	505.2			
Jaya	20.72	7.36	14.04	0.994	0.354	0.67	551.25	196.39	373.8			
Naveen 2000+	22.34	8.97	15.65	0.983	0.462	0.72	545.83	256.39	401.1			
Mean	25.31	8.76		1.113	0.444		618.40					
CD <sub>0.05</sub> (L)	1.61				0.087							
CD <sub>0.05</sub> (G)	3.95	2.76	2.53	0.237	0.148	0.137	131.43	NS	90.65	NS	NS	
CD <sub>0.05</sub> (LxG)		NS		NS			NS			NS		

L1= Poly house.  
L2= Open field.

Table 3 - Performance of tomato genotypes under polyhouse and open conditions for various fruit characters

Varieties	Characters																	
	Location			Fruit weight (g)			Fruit length (mm)			Fruit diameter (mm)			TSS (°B)			Locules/fruit		
	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean	L1	L2	Mean
Pusa Rohini	78.00	60.06	69.03	48.97	44.51	46.74	52.23	47.63	49.99	6.75	5.35	6.05	3.0	3.0	3.00			
PH-5	78.10	54.09	66.09	44.75	40.47	42.61	57.18	48.10	52.64	5.10	5.10	5.10	3.5	3.0	3.25			
Shivalik	67.40	59.23	63.32	49.61	46.49	48.05	48.97	48.43	48.70	5.40	5.55	5.48	3.0	2.5	2.75			
Jaya	71.05	57.86	64.45	49.59	47.36	48.47	51.89	48.08	49.98	5.95	5.10	5.53	3.0	3.0	3.00			
Naveen 2000+	74.70	57.22	65.96	53.74	52.82	53.28	49.27	45.45	47.36	5.05	5.40	5.23	2.25	2.5	2.38			
Mean	73.85	57.69		49.33	46.33		51.91	47.56		5.65	5.30		2.95	2.80				
CD <sub>0.05</sub> (L)	11.49			2.35			3.40			0.12			NS					
CD <sub>0.05</sub> (G)	NS	NS	NS	4.52	4.70	3.72	NS	NS	NS	0.26	0.30	0.18	0.56	NS	0.37			
CD <sub>0.05</sub> (LxG)	NS			NS			NS	NS		NS			NS					

L1= Poly house.  
L2= Open field.

with 'Naveen 2000+' and 'Pusa Rohini'. The statistically lowest number of locules per fruit in polyhouse conditions was recorded for 'Naveen 2000+', while in pooled data 'Naveen 2000+' and 'Shivalik' were at par.

#### Performance improvement

Perusal of data in Table 4 reveals that mean yield per ha, number of fruits per plant, fruit weight, plant height, harvest duration and number of harvests were 136.12, 188.93, 16.16, 37.80, 85.32 and 65.83% more, respectively, under polyhouse conditions compared to the open field. These findings demonstrate the suitability, as well as economic feasibility, of polyhouses in the

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Table 4 - Percent improvement in tomato performance under polyhouse versus open conditions for economic characters

Genotype	Percent increase in					
	Yield per ha	Number of fruits per plant	Fruit weight	Plant height	Harvest duration	No. of harvest
Pusa Rohini	89.08	52.54	29.87	17.57	75.64	64.00
PH-5	400.56	404.23	44.39	74.44	89.44	72.73
Shivalik	138.73	169.18	13.79	30.60	79.74	66.67
Jaya	180.79	181.52	22.80	28.69	94.56	73.91
Naveen 2000+	112.89	149.05	30.55	47.13	88.61	53.85
Mean	136.12	188.93	16.16	37.80	85.32	65.83

trans-Himalyan Ladakh region for tomato cultivation. Gualberto *et al.* (1998) also reported 40-45 % higher marketable yield in greenhouses than with open field conditions. Growth and yield attributes were also recorded as poor in the open field condition.

Therefore, it may be concluded that naturally ventilated polyhouses are a good and less expensive option for tomato cultivation in the trans-Himalayan region to obtain higher yield, number of fruits per plant and longer harvest duration. Varieties like 'Shivalik' and 'Pusa Rohini' are responsive to protected cultivation in this region and may be used for cultivation after further testing to increase the return per unit area.

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