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Effect of different shading factors and irrigation regimes on growth and yield of tomato

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Abstract
The experiment was conducted to evaluate the yield response of tomato (*Solanum lycopersicum* L.) under different shadindg percentages and irrigation regimes through field experiment. The treatment consisted of four shading percentages i.e. 75%, 50%, 35% and 0% (open field) and four irrigation regimes 0.95 ETc, 0.75 ETc, 0.55ETc and 0.35 ETc. The experimental design was split plot with six replications. The biometric attribute plant height was measured at harvest condition and yield attribute viz., average weight of fruit, yield in kg per plant, kg per m^2 and yield in t/ha. The results indicated that the interaction of both the factors in respect of plant height was significantly influenced. It was found that the interaction of 75% shading x 0.95 ETc (S_1 x I_1) recorded the maximum (223.33 cm) plant height of tomato, which was at par with 75% shading x 0.75 ETc (S_1 x I_2) interaction. Considering the results, the study revealed that, shading of 75% (S_1) resulted into maximum and significantly superior yield (186.32 t ha^{-1}) of tomato under shadenet house over 50, 35 and 0% shading. The irrigation level of 0.95 ETc (I_1) resulted into maximum yield (118.88 t ha^{-1}), which was at par with 0.75 ETc (102.75 t ha^{-1}). The interaction effect of 75% shading 0.95 ETc resulted into the maximum yield of 224.73 t ha^{-1} and which was at par with other interactions .The water use efficiency of tomato under the treatment of S_1I_1 (75% x 0.95 ETc) was 36.51 kg m^{-2} m^{-1}.

Keywords: Shading percentages, drip irrigation and water use efficiency

Introduction
Tomato is a warm season plant. It can withstand with severe frost conditions. Temperature and light intensity affect germination, vegetative growth, fruit set, pigmentation and nutritive value of this fruits. The minimum temperature for germination of seeds range from 8^0 to 10 ^{0}C. The night temperature is the critical factor in fruit setting with the optimum range of 16 ^{0}C to 22 ^{0}C. Fruits fail to set at 12 ^{0}C or below. Under greenhouse conditions tomato crop can grown for long duration (10-12 months) by cooling during summer months (April to June or July) and by heating the greenhouse during peak winter months (December and January) in northern parts of the country Singh (2006) [4]. Creating high values for agricultural crops by using low water inputs and high fertilizer efficiencies is one of the methods used in addressing the environmental and resources problems. Protected cultivation techniques including nethouse technology provide optimum environmental medium for better crop growth in order to gain maximum yield and high quality products. These require comparatively less land area for agricultural production system resulting in increased land productivity and facilitate year round production of crops. Many studies were reported on tomato cultivation under green/nethouse conditions with different advantages Dunage *et al.* (2009) [1].

Materials and Methods
The field experiment was conducted at the Instructional Farm of Department of Irrigation and Drainage Engineering, Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri during the period from November 2013 to May 2014 and November 2014 to May 2015. Geographically the farm lies at 74^0 38' 00" E longitudes and 19^0 20' 00" N latitude at 557 m above the mean sea levels in the central campus of Mahatma Phule Krishi Vidyapeeth, Rahuri.

Climatological data
The meteorological data on maximum and minimum temperature, minimum and maximum relative humidity, actual sunshine hour and daily wind speed etc. weather parameter during the crop growth period (30 November 2013 to 5th May 2014) and (1 December 2014 to 5th May 2015) were collected on daily basis from the meteorological observatory situated at the

Instructional Farm of Department of Irrigation and Drainage Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri. Water source the water for the experiment was pumped from an open dug well situated at the Instructional Farm of Department of Irrigation and Drainage Engineering.

Experimental Details

The experiments was conducted under this investigation for two consecutive years. This experiment was carried out in split plot design with sixteen treatments based on different combinations of the shading percentages and irrigation regimes. Crop verity was Hy. Phule Raja. Plot size was 4.5 m X 1 m and plant spacing was 60 cm x 45 cm. Number of plants per bed was 20. The area of each shadenet field was 20 m x 18 m. The soil media in shadenet house consisted of red soil, farm yard manure (FYM) and sand. Irrigation was given at daily basis over the whole crop period of tomato by drip irrigation method. The fogger system had automatic controller to operate the system for 30 second ('ON' period) after the interval of ('OFF' period) period about 8 minute. Fogger system was operate at 2-2.5 kg/cm^2.

Treatment Details

Sr. No.	Factor A: Shading percentage	Factor B: Irrigation levels
1.	S_1 = 75% shading	I_1 = 0.95 ETc
2.	S_2 = 50% shading	I_2 = 0.75 ETc
3.	S_3 = 35% shading	I_3 = 0.55 ETc
4.	S_4 = 0% shading (Open field)	I_4 = 0.35 ETc

In order to study the response of tomato to different shading percentages and irrigation regimes under shadenet house condition, it was necessary to collect data on the plant and yield attributes of the tomato crop. These data were collected during the experimental period and analyzed further for interpretations. The crop growth parameters including plant height were recorded at harvest condition with 5 randomly selected plants from each plot. These plants were properly labeled and growth parameters were monitored on them. The observations include average weight of tomato fruit, total yield of tomato fruit. The water use efficiency for each treatment was determined from the data on corresponding yield and volume of water applied using the following equation:

$$WUE = \frac{\sum Y}{WR} \quad (1)$$

Where, WUE = Water use efficiency (t/ha-cm)
Y = Yield of crop product (t/ha), WR = Total depth of water applied in the field (cm)

In order to compare the treatments of different shading percentages with irrigation levels separate analysis split plot design was prepared.

Result and Discussion

The field investigation was carried out to compare the growth and yield attributing characteristics, water saving and water use efficiency under different shading percentages and irrigation levels. The growth and yield characteristics of tomato were periodically monitored and recorded during the crop growth period.

Plant height: The shading percentages and irrigation levels influenced the plant height of tomato plants significant. The data on plant height of tomato for the year 2013-14 and 2014-15 are presented in Table1.It is seen from the data pooled over two years that the plant height of tomato (209 cm) was maximum and significantly superior due to S_1 (75% shading) over other shading percentages. The minimum plant height (134.62 cm) was recorded in control treatment (0% shading) as presented in Table 1. The pooled data show that the irrigation level of 0.95 ETc (I_1) recorded the maximum plant height (184.31 cm), however the pooled data on plant height was not significant. Crop grown under drip irrigation inside shadenet house with all treatments had more height followed by control field. Similar results were reported by Ramesh and Arumugam (2010) [5]. The interaction of both the factors in respect of plant height was significantly influenced Table 2. It was found that the interaction of 75% shading x 0.95 ETc (S_1 x I_1) recorded the maximum (223.33 cm) plant height of tomato, which was at par with 75% shading x 0.75 ETc (S_1 x I_2) interaction.

Yield Characteristics

Data regarding the average weight of fruit as influenced periodically by different treatments are presented in Table 3 and Table 4. The pooled data show that the average weight of a tomato fruit was maximum (109.57 g) due to S_1 (75%) shading factor, which was at par with S_2 (50%) and S_3 (35%) shading percentages are presented in Table 3. Data on average weight of fruit was not influenced statistically. The irrigation level of 0.95 ETc resulted maximum weight of fruit .The average fruit weight of 75% shadenet house tomato was 50% higher than open field i.e. (0%) shadenet house tomatoes. Results are in accordance with Sahin *et al* (1998) [3]. The interaction of 75% shading x 0.75 ETc (S_1 x I_2) gave the maximum average weight of a fruit, which was at par with (S_1 x I_1), (S_1 x I_3), and (S_1 x I_4) as presented in Table 4. Data regarding the yield kg plant^{-1}, kgm^{-2} and t ha^{-1} as influenced periodically by different treatments are presented in Table 5. The yield of fruits in kg plant^{-1}, kgm^{-2} and t ha^{-1} were found maximum and significantly superior due to 75% shading (S_1) over the other shading percentages. The irrigation level of 0.95 ETc resulted into maximum yield of tomato i.e. 3.155 kg plant^{-1} which was at par with that of 0.75 ETc level of irrigation. Maximum yield of tomato 11.89 kgm^{-2} and 118.88 t ha^{-1} was found in 0.95 ETc. The 0.35 ETc irrigation level resulted into lowest yield of tomato which was statically not significant. The interaction effect of 75% shading x 0.95 ETc gave the maximum yield 6.9 kg plant^{-1}, 22.78 kgm^{-2}, 224.73 t ha^{-1} which was at par with over others interactions. Presented in Table 6,7 and 8. Ilahy *et al* (2013) [2] reported that 50% and 100% shading levels, respectively increased the total plant yield by 5% and 24% relative to non-shaded conditions.

Water use efficiency: The average water use efficiency (WUE) of tomato was in the range from 8.54 to 61.20 kg/m^2-m^{-1}. Presented in Table 9.

Table 1: Plant height of tomato at harvest as affected by different treatments for the year 2013-14, 2014-15 and pooled under shadenet house condition

Treatments	Plant height, cm (At harvest)		
	2013-14	2014-15	Pooled
Shading% (S)			
S_1=75%	196.71	222.83	209.77
S_2=50%	170.38	203.63	187.0
S_3=35%	140.13	181.33	160.7
S_4= 0%	123.21	146.04	134.62
S.E.±	1.631	2.07	4.07
C.D. at 5%	4.91	6.26	18.35
Irrigation level (I)			
I_1=0.95 ETc	167.63	201.0	184.31
I_2=0.75 ETc	161.63	190.9	176.27
I_3= 0.55 ETc	152.63	182.38	167.50
I_4:=0.35 ETc	148.54	179.54	164.0
S.E.±	1.58	1.96	2.49
C.D. at 5%	4.47	5.56	NS
C. Interaction (SxI)			
S.E.±	4.75	5.935	4.83
C.D. at 5%	10.07	NS	14.57

Table 2: Interaction effect of shading percentages and irrigation levels on plant height (cm) at harvest of tomato plant under shadenet house condition

Irrigation levels (I)	Shading% (S)				
	S_1=75%	S_2=50%	S_3=35%	S_4= 0%	Mean
I_1=0.95 ETc	223.33	196.41	170.58	146.91	184.31
I_2=0.75 ETc	212.33	191.58	168.75	132.41	176.27
I_3= 0.55ETc	203.0	182.41	153.66	130.91	167.50
I_4= 0.35ETc	200.42	177.58	149.92	128.25	164.0
Mean	209.77	187.0	160.73	134.62	173.02
S x I	S.E.± = 4.83, C.D. at 5% = 14.5				

Table 3; Average weight of a fruit as affected by different treatments for the year 2013-14, 2014-15 and pooled means under shadenet house condition

Treatments	Average weight of fruit, g		
	2013-14	2014-15	Pooled
Shading% (S)			
S_1= 75%	111.07	108.07	109.57
S_2= 50%	100.72	77.40	89.06
S_3= 35%	101.57	56.28	78.925
S_4= 0%	70.56	30.17	50.365
S.E.±	2.484	1.869	9.57
C.D. at 5%	7.489	5.634	43.0
Irrigation level (I)			
I_1= 0.95 ETc	101.20	76.47	88.33
I_2= 0.75 ETc	96.94	72.04	84.49
I_3 = 0.55 ETc	94.48	64.65	79.56
I_4 = 0.35 ETc	91.29	58.77	75.03
S.E.±	2.114	1.046	1.87
C.D. at 5%	5.980	2.958	NS
C. Interaction (SxI)			
S.E.±	6.475	3.499	9.07
C.D. at 5%	NS	7.804	27.35

Table 4: Interaction effect of shading percentages and irrigation levels on average weight/fruit (g) under shadenet house condition

Irrigation levels (I)	Shading% (S)				
	S_1=75%	S_2=50%	S_3= 35%	S_4 =0%	Mean
I_1= 0.95 ETc	113.93	92.93	87.81	60.605	88.33
I_2= 0.75 ETc	116.60	90.44	81.39	49.53	84.49
I_3 = 0.55ETc	106.59	86.93	75.77	48.97	79.56
I_4= 0.35ETc	101.16	85.86	70.73	42.35	75.03
Mean	109.57	89.06	78.92	50.36	81.97
S x I	S.E.± = 9.07, C.D. at 5% = 27.35				

Table 5: Fruit yield of tomato as affected by different treatments for the year 2013-14, 2014-15 and pooled means under shadenet house condition

Treatments	Fruit yield								
	kg plant^{-1}			kg m^{-2}			t ha^{-1}		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Shading% (S)									
S_1=75%	4.35	6.75	5.55	15.47	21.81	18.64	154.65	218	186.325
S_2=50%	2.12	2.54	2.33	9.69	12.43	11.06	96.92	124.23	110.575
S_3=35%	1.50	1.33	1.415	5.80	6.52	6.16	58.00	65.15	61.575
S_4=0%	1.13	0.74	0.935	3.42	3.35	3.385	34.16	33.50	33.83
S.E.±	0.113	0.182	0.635	0.205	0.296	1.430	2.054	2.963	14.29
C.D. at 5%	0.340	0.548	2.86	0.619	0.893	6.43	6.162	8.930	64.32
Irrigation level (I)									
I_1=0.95 ETc	2.69	3.62	3.155	10.24	13.55	11.89	102.35	135.41	118.88
I_2=0.75 ETc	2.54	3.34	2.94	8.96	11.59	10.27	89.61	115.88	102.74
I_3=0.55 ETc	2.07	2.43	2.25	8.04	10.17	9.10	80.43	101.70	91.06
I_4=0.35 ETc	1.79	1.98	1.885	7.13	8.79	7.96	71.34	87.89	79.61
S.E.±	0.070	0.052	0.176	0.190	0.239	0.30	1.903	2.391	3.068
C.D. at 5%	0.198	0.146	0.791	0.538	0.677	NS	5.384	6.764	NS
C. Interaction (SxI)									
S.E.±	0.228	0.233	0.615	0.576	0.739	1.33	5.762	7.383	13.36
C.D. at 5%	0.504	0.551	1.856	1.224	1.589	4.02	12.245	15.88	40.28

Table 6: Interaction effect of shading percentages and irrigation levels on yield per plant (kg) of tomato under shadenet house condition

Irrigation levels (I)	Shading% (S)				
	S_1=75%	S_2=50%	S_3= 35%	S_4 =0%	Mean
I_1= 0.95 ET_C	6.9	3	1.635	1.095	3.155
I_2 =0.75 ET_C	6.84	2.45	1.495	0.99	2.94
I_3=0.55 ET_C	4.71	2.065	1.325	0.89	2.25
I_4=0.35 ET_C	3.765	1.805	1.21	0.765	1.885
Mean	5.55	2.33	1.415	0.935	2.55
S x I	S.E.± = 0.615, C.D. at 5% = 1.856				

Table 7: Interaction effect of shading percentages and irrigation levels on fruit yield (kg m^{-2}) of tomato under shadenet house condition

Irrigation levels (I)	Shading% (S)				
	S_1=75%	S_2=50%	S_3= 35%	S_4 =0%	Mean
I_1= 0.95 ETc	22.48	13.155	7.82	4.11	11.89
I_2 =0.75 ETc	19.27	11.8	6.38	3.65	10.275
I_3=0.55 ETc	17.41	10.265	5.59	3.16	9.10
I_4=0.35 ETc	15.37	9.02	4.84	2.62	7.96
Mean	18.64	11.06	6.16	3.385	9.80
S x I	S.E.± = 1.33, C.D. at 5% = 4.02				

Table 8: Interaction effect of shading percentages and irrigation levels on fruit yield (t ha^{-1}) of tomato under shadenet house condition

Irrigation levels (I)	Shading% (S)				
	S_1=75%	S_2=50%	S_3= 35%	S_4 =0%	Mean
I_1= 0.95 ETc	224.73	131.535	78.17	41.11	118.88
I_2 =0.75 ETc	192.71	117.99	63.825	36.455	102.745
I_3=0.55 ETc	174.14	102.60	55.935	31.585	91.065
I_4=0.35 ETc	153.72	90.18	48.375	26.185	79.615
Mean	186.32	110.57	61.575	33.83	98.07
S x I	S.E.± = 13.36, C.D. at 5% = 40.28				

Table 9: Average daily water requirement and water use efficiency (kg/m^2-m^{-1}) of tomato under different treatments of shading percentages and irrigation levels

Treatments	Average daily water requirement								Water use efficiency, kg/m^{2}m^{-1}		
	Yield, kgm^{-2}		lit/ plant			lit/m^2					
	2013-14	2014-15	2013-14	2014-15	Avg	2013-14	2014-15	Avg	2013-14	2014-15	Avg
T_1	18.37	26.59	0.70	0.74	0.72	3.09	3.30	3.20	34.55	38.47	36.51
T_2	15.95	22.59	0.55	0.60	0.58	2.46	2.67	2.57	37.61	40.48	39.05
T_3	14.54	20.29	0.41	0.46	0.44	1.84	2.03	1.94	45.91	47.73	46.82
T_4	13.00	17.75	0.27	0.32	0.30	1.22	1.41	1.31	62.07	60.33	61.20
T_5	11.32	14.99	0.67	0.73	0.70	2.99	3.23	3.11	21.96	23.55	22.75

T_6	10.26	13.34	0.55	0.59	0.57	2.46	2.60	2.53	24.93	26.03	25.48
T_7	9.08	11.45	0.41	0.44	0.43	1.84	1.97	1.91	29.50	29.45	29.48
T_8	8.11	9.93	0.27	0.30	0.29	1.22	1.35	1.29	39.85	37.19	38.52
T_9	7.18	8.46	0.69	0.72	0.70	3.08	3.18	3.13	14.48	13.83	14.15
T_{10}	5.96	6.80	0.55	0.62	0.59	2.46	2.76	2.61	15.06	12.81	13.94
T_{11}	5.36	5.83	0.41	0.43	0.42	1.84	1.93	1.88	18.10	15.74	16.92
T_{12}	4.70	4.98	0.27	0.29	0.28	1.22	1.31	1.26	23.95	19.82	21.89
T_{13}	4.08	4.14	0.68	0.65	0.67	3.03	2.90	2.96	8.68	8.39	8.54
T_{14}	3.67	3.63	0.55	0.52	0.53	2.42	2.32	2.37	9.76	9.21	9.49
T_{15}	3.20	3.12	0.41	0.39	0.40	1.81	1.73	1.77	11.36	10.57	10.97
T_{16}	2.72	2.52	0.27	0.26	0.27	1.20	1.16	1.18	14.57	12.79	13.68

Conclusion

The experiments were conducted to know the influence of different shadenet house, with irrigation levels on growth and yield of tomato. The results of the experiments were analyzed and following specific conclusions were derived. The growth characteristics of tomato such as plant height, was better in 75% shading than other shading percentages. Significantly better crop growth can be achieved if drip irrigation is scheduled at 0.95 ETc as compared to other irrigation levels. The yield of tomato is enhanced when cultivated in shadenet houses of different shading percentages compared to open field condition. The yield of tomato is more in 75% (S_1) shadenet house as compared to 50% (S_2), 35% (S_3) and 0% (S_4) shadenet house. The irrigations to the tomato should be scheduled daily 0.95 ETc in shadenet house. Sahin *et al.* (1998) [3]

References

1. Dunage VS, Balakrishnan P Patil MG. Water use efficiency and economics of tomato using drip irrigation under net house conditions. Karnataka J Agric. Sci. 2009; 22(1):133-136.
2. Ilahy R, Thouraya R, Tlili I, Jebari H. Effect of different shading levels on growth and yield parameters of a Hot Pepper (*Capsicum annuum* L.) cultuvar 'Beldi' grown in Tunisia. Global science books, 2013.
3. Sahin U, Ozdeniz A, Zulkadir A, Alan R. The effects of different growing media on yield, quality and growth of tomato (*Lycopersicon esculentum* Mill.) grown and irrigated by drip irrigation method under the greenhouse conditions. J Agricultural Forestry. 1998; 22:71-79.
4. Singh B. Protected Cultivation of Vegetable Crops. Kalyani publishers, New Delhi-110012. 2006, 8.
5. Ramesh KS, Arumugam T. Performance of vegetables under naturally ventilated polyhouse condition. Mysore J Agric. Sci. 2010; 44(4):770-776.