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Influence of different coloured and intensities of shade net on reproductive parameters and yield of Tomato (*Solanum lycopersicum* L.) *var.* Arka Rakshak

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Abstract
An experiment was carried out to study the growth parameters of coloured tomato (*Solanum lycopersicum* L.) as influenced by different coloured shade nets with varying shade intensities at the PFDC, Department of Horticulture, GKVK, UAS, Bengaluru during 2013-14. The experiment was laid out with three replications comprising of fifteen treatments. The spacing followed was 60 cm x 45 cm. The data were statistically analysed by using Split plot design. The results revealed that the earliest flower initiation treatment T_9 (C_3P_3: Red colour shade net + 75 per cent shade) (28.10 days), highest number of flowers per plant as observed also in treatment T_9 (C_3P_3: Red color shade net + 75 per cent shade) 118.5 number and maximum per cent fruit set (78.17 %) was obtained under red colour shade net, 75 per cent shade intensity respectively while early fruit set (7.77 days) and harvest (28.1 days) were found to be under red colour shade net, 75 per cent shade intensity respectively. The highest number of fruits per plant (88.15), yield per plant (8.73 kg) and yield per hectare (193.80 t/ha) are obtained under treatment T_9 (C_3P_3: Red color shade net + 75 per cent shade).

Keywords: tomato, coloured shade nets, shade intensities, growth parameters

Introduction
Tomato (*Solanum lycopersicum* L.) belongs to the family *Solanaceae*. It is one of the most important vegetable crops that can be consumed as fresh and used in the processing industry. Tomato is being cultivated throughout the world and more extensively in USA, USSR, Italy, China, Turkey and India. The tomato plants typically grow to 1-3 m height and have weak stem that often sprawls over the ground and twines over other plants. It is native of South America, but is now grown worldwide for its edible fruits with thousands of cultivars having been selected with varying fruit types and for optimum growth in differing growth conditions.

Tomato has several medicinal values as it promotes gastric secretion, blood purification, intestinal antiseptic, cures cancer of the mouth and sore throat, apart from improving quality of the prepared foods. It is highly nutritious with good amount of vitamins. It is a good appetizer having pleasing taste (Ram, 1991) [6]. Tomato juice contains *lycopene*, one of the most powerful antioxidant and vitamin C which are most beneficial to human beings.

The crop grown under open conditions will not fulfil the export standards, so the search for new avenues has lead to development of Hi-Tech precision agricultural systems. Growing of tomato crops under cover has been reported to give good quality produce with higher productivity in several countries. Recently, few entrepreneurs have started its cultivation under protected structures like shade net houses, to get higher productivity and quality, adopting the hybrids supplied by the private companies.

Shade nets are made of 100 per cent polyethylene inter-woven thread with specialised UV treatment having different shade percentages. It provides partially controlled atmosphere and environment by reducing light intensity and effective heat during day time to crops grown under it. To create optimum climatic conditions, selection of the correct percentage of shade factor plays an important role to enhance plant's productivity to its optimum.

The photo selective, light-dispersive shade nets provide a new, multi-benefit tool for crop protection. Changing the light intensity and radiation spectrum has a large impact on the total production system. Coloured shade netting not only exhibit special optical properties that allow the control of light, but also have the advantage of influencing the microclimate to

which The plant is exposed to (Oren-Shamir *et al*., 2001) [5] and offer physical protection against excessive radiation, insect pests and environmental changes (Shahak *et al*., 2004) [9]. Presently shade nets are available in different colours i.e. white, black, red, blue, yellow and green and in combinations. However, there is a need to study the performance of coloured capsicum under shade net house conditions.

Material and methods

The experiment was conducted under different coloured shade nets with varying shade intensities at the PFDC, Department of Horticulture, GKVK, UAS, Bangalore during 2013-14. The experimental station is located at an altitude of 930 m above mean sea level between a latitude of 12º58^{l} North and a longitude of 77º35^{l} East. The experiment was laid out in a split plot design with three replications. The total number of treatments was fifteen. The dimensions of each flat roofed shade net house were16 m length (East-West) and 12 m breadth (North-South) with a size of 192 m^2.

The seedlings of IIHR Bengaluru has developed tomato F1 hybrid Arka Rakshak were planted in two rows on 0.9 m wide bed having 45 cm path between two beds (mulched with 30 µ thick black mulch) and the spacing maintained was 60 cm x 45 cm. Irrigation and fertigation were done as per there commendations. Plants were trained along a plastic thread tied to galvonised iron wire stretched over head along the bed. The observations were recorded on reproductive parameters like days taken for first flowering, number of flowers per plant, days taken for fruit set from first flowering, per cent fruit set, days taken for first harvest and yield parameters like number of fruits per plant, yield per plant (kg) and yield per hectare (t).

Results and discussion

The number of days taken for first flowering was lesser (29.77, 30.97 days) under red colour shade net (C_5), 75 per cent shade intensity (P_3) respectively. This could be due to the favourable proportion of R/FR (red/far red) radiation that decreased the periods of mild temperatures required for the flower induction and also due to accumulation of maximum photosynthates by fast growth which triggered early initiation of flowers. Similar results were obtained by Rui *et al*., (1989) [7] in capsicum.

The highest number of flowers per plant (115.08, 110.72) was obtained under red colour shade net (C_5), 75 per cent shade intensity (P_3) respectively. This could be attributed to the favourable climatic conditions coupled with higher number of secondary branches and sufficient accumulation of photosynthates. Similar findings were recorded by Deli and Tiessen (1969) [2] and Bhatt and Rao (1993) [1] in capsicum.

Early fruit set (7.90, 8.06 days) was found to be under red colour shade net (C_3), 75 per cent shade intensity (P_3) respectively. This could be due to the congenial temperature and relative humidity that lead to early fruit set.

The maximum per cent fruit set (75.42, 72.34 %) was obtained under red colour shade net (C_5), 75 per cent shade intensity (P_3) respectively. This might be due to good vegetative growth, more number of flowers, besides effective pollination, fertilization and lower abscission rate of flowers. It was also a consequence of production of more flowers per plant and less interference of adverse climatic conditions like rainfall and wind velocity during crop growth and development.

Early harvest (29.62, 31.16 days) was found to be under red colour shade net (C_2), 75 per cent shade intensity (P_3) respectively. This might be due to the enhanced conversion of chlorophyll pigment into anthocyanins and xanthophylls due to the prevailing temperature forcing the plants to complete their life cycle at faster rate.

The highest number of fruits per plant (83.15, 77.59), yield per plant (8.36, 7.44 kg) and yield per hectare (185.62, 165.25 t/ha) are under red colour shade net (C_5), 75 per cent shade intensity (P_3) respectively. This could be attributed to highest extent of fruit set leading to more number of fruits per plant due to the favourable climatic conditions like optimum temperature, light intensity and relative humidity that prevailed inside the shade net. This is in agreement with Mashego (2001) [4] in tomato and Ilic *et al*., (2011) [3] in capsicum.

Table 1: Number of flowers per plant, days taken for fruit set from flowering, per cent fruit set and days taken for first harvest as influenced by colour of the shade net and shade intensity at different stages of crop growth in tomato *var.* Arka Rakshak

Treatments	Number of flowers per plant	Days taken for fruit set from flowering	Per cent fruit set	Days taken for first harvest
Shade net colour (C)				
C_1 - Green & black interwoven	104.99	8.31	68.89	33.69
C_2 - Blue	107.99	8.22	69.23	33.27
C_3 - Red	115.08	7.90	75.42	29.62
C_4 - Black	100.39	8.52	68.16	35.37
C_5 – White	111.61	8.08	74.12	30.61
S.Em±	0.329	0.013	0.193	0.136
C.D at 5 %	1.073	0.044	0.630	0.443
Shade intensity (P)				
P_1- 35 per cent	105.39	8.35	70.21	33.86
P_2- 50 per cent	107.93	8.20	70.94	32.53
P_3- 75 percent	110.72	8.06	72.34	31.16
S.Em±	0.071	0.004	0.040	0.036
C.D at 5 %	0.211	0.011	0.117	0.105
Interaction (C x P)				
C_1P_1	102.2	8.45	68.74	35.25
C_1P_2	104.0	8.32	69.79	33.74
C_1P_3	108.8	8.15	68.15	32.09
C_2P_1	105.1	8.37	68.55	34.89
C_2P_2	108.4	8.24	69.32	33.15
C_2P_3	110.5	8.05	69.82	31.79

C_3P_1	112.5	8.02	73.95	31.01
C_3P_2	113.5	7.90	74.13	29.75
C_3P_3	118.5	7.77	78.17	28.1
C_4P_1	98.0	8.65	66.44	36.24
C_4P_2	100.8	8.5	67.63	35.72
C_4P_3	102.4	8.4	70.41	34.17
C_5P_1	109.2	8.25	73.95	31.9
C_5P_2	112.2	8.05	74.13	30.29
C_5P_3	114.3	7.95	78.17	29.64
F test (p= 0.05)	*	*	*	*
S. Em±	0.16	0.008	0.089	0.08
C.D at 5%	0.471	0.024	0.262	0.235

Table 2: Number of fruits per plant, yield perplant and yield per hectare as influenced by colour of the shade net and shade intensity at different stages of crop growth in tomato *var*. Arka Rakshak

Treatments	Number of fruits per plant	Yield per plant (kg)	Yield per hector (tons)
Shade net colour(C)			
C_1 - Green & black interwoven	70.73	6.05	134.22
C_2 - Blue	66.58	7.15	158.63
C_3 - Red	83.15	8.36	185.62
C_4 - Black	75.17	5.74	127.41
C_5 – White	81.32	8.20	182.10
S.Em±	0.238	0.043	965.4
C.D at 5 %	0.776	0.142	3148.64
Shade intensity (P)			
P_1- 35 per cent	73.52	6.76	150.09
P_2- 50 per cent	75.06	7.09	157.45
P_3- 75 percent	77.59	7.44	165.25
S.Em±	0.035	0.006	128.14
C.D at 5 %	0.102	0.017	378.01
Interaction(C x P)			
C_1P_1	70.25	5.82	129.20
C_1P_2	72.58	6.01	133.51
C_1P_3	74.15	6.31	139.97
C_2P_1	72.05	6.89	152.89
C_2P_2	75.14	7.18	159.35
C_2P_3	77.15	7.37	163.65
C_3P_1	82.15	8.05	178.73
C_3P_2	84.98	8.30	184.33
C_3P_3	88.15	8.73	193.80
C_4P_1	65.12	5.29	117.36
C_4P_2	68.17	5.82	129.20
C_4P_3	72.10	6.11	135.66
C_5P_1	80.10	7.76	172.27
C_5P_2	82.85	8.15	180.88
C_5P_3	85.02	8.70	193.16
F test (p= 0.05)	*	*	*
S. Em±	0.159	0.013	286.53
C.D at 5%	0.468	0.038	845.26

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