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SHORT COMMUNICATION

Effect of shadenet color and its intensity on tomato crop performance

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ABSTRACT

At the research farm of Central Institute of Agricultural Engineering, Bhopal, India experimental trials were conducted during three rainy seasons (June-October) starting with 2016-2017. In this study red, white, black and green colors shade nets with varying shade intensities (35, 50 and 75 %) were studied by constructing each shadenet of 100 m^2 size. All the tomato crop growth parameters significantly varied with shade net colours and intensities. Crop under red coloured shadenet house was found to have highest plant height and more branches over crop cultivation in other coloured net houses. Among the shade intensifies crop under 50% had highest plant height and more branches per plant as compared to crop under other intensities. Tomato crop under 50% shade intensity with red color shade net gave highest yield and the lowest yield was observed in 75% green colured shadenet house. Reduction in average ambient temperatures over control (outside the shadenet house, which was 30°C) in different shadenets are 3.2-5.9 °C under black shade net, 1.4-3.5 °C under green, 3.0 -5.3 °C under white, 2.0 – 4.4 °C under red coloured shade net house Average light intensity under ambient conditions was highest with 1,10,000 lux whereas in shade net houses the light intensities are much lower than the ambient conditions. The light intensities were found to be highest in green coloured net house for all intensities followed by red, white and black coloured net houses.

Key words: Colored shade net, Light intensity, Temperature, SPAD value, Yield

INTRODUCTION

The popular and nutritious vegetable tomato (*Lycopersicon esculentum* Mill.) belongs is cultivated across India. Singh et.al., 1999 and Ganesan, 2002 reported that the quantity and quality of vegetables can be improved through protected practices. Open field cultivated tomato crop is exposed to different kinds of stresses that leads to poor quality produce and reduction in productivity of the crop. Inorder to reduce the ill effects of different stresses due to living organisms or due to non-living organisms cultivating the crop in protected environment is a possible solution. Since the consumers preferences at domestic and international levels in on the produce quality, cultivating vegetables under protected environment fetch good market value at domestic level as well as in international market. (Sanwal et al., 2004).

Crop growth parameters and biotic stresses incidence in vegetables cultivated during off season under a shadenet house is being studied by Cheema et al., 2004 The distinct advantages such as marketable quality, quantity and better price to cultivators are being reported by Singh and Sirohi (2008).

The cladding material used to cover the shadenet houses are polyethylene inter woven threads. They provide partially modified micro climate for healthy crop growth. To create favourable climatic conditions for enhanced crop yield appropriate selection of shade color and shade intensity are important and the combination is crop specific.

In the photo-selective colored shadenet houses such as red and green net houses the selective filtration of radiation spectrum occurs, where as in black and white colour nets are neutral nets that allow the entire spectra of solar radiation. In the coloured shadenet houses selective radiations penetrate (Oren-Shamir et al., 2001) and influence the microclimate inside the structure that could have impact on pests and insects (Shahak et al., 2004 a). Disorders in the development of tomato fruit is observed by Dorais et.al., 2001 when high intense light penetrated inside a protected structure. A study conducted by Fallik

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et al., 2009 on the sweet pepper indicated that the yellow coloured net houses are superior over other coloured net house in enhancing the keeping quality and market price of the produce. Kittas et al. 2009 concluded that tomato fruit cracking is minimized and marketable yield was more under different coloured shade net houses when compared with open field crop. Tomato quality parameters along with the crop production were studied by Ilic et al., 2012 in different coloured shadenet houses with varying intensities. The study findings include the lycopene content is highest in red coloured shdadenet houses. Various studies have established the fact that the photo-selective nets have bearing influence on crop production, it is therefore, investigations on the effect of shadenet colours and their intensities on micro climate inside the structure and also on tomato crop production.

ABOUT THE STUDY AREA

At the research farm of Central Institute of Agricultural Engineering, Bhopal, India experimental trials were conducted during three rainy seasons(June-October) from 2016-2017 to 2018-19, the pooled data is discussed in this paper. The texture of the soils of study area is vertisols with around 50% clay content and the field capacity of the soil is around 30%. The longitude and latitude of the experimental site is 77° 24' 10" E, 23° 18' 35" N at and is about 495 m above mean level of sea.

METHODOLOGY

Experimental design, treatments and planting material

On the raised beds of 15 cm height with 60 cm top width the healthy seedlings of tomato (variety: *Avinash*) were transplanted at 40 cm x 40 cm spacing. The experiment was laid in split plot design and data were collected and analyzed accordingly. Standard package of practices of irrigation, fertigation, intercultural operations and plant protection measure of tomato crop were followed.

Treatment details

Main plot (Color)

C_1- Black; C_2- Green; C_3- White; C_4- Red

Sub plot (Intensity)

P_1-35 %; P_2-50 %; P_3-75 %

Climatological data

From an automatic weather station installed in the institute research farm, weather parameters of study area during crop season were collected every day. Hygrothermometer (make: testo model: 623) was used to measure temperature and humidity. Light intensity was measured with a lux meter (make: EXTECH, model: SDL470) on clear days at noon. Relative chlorophyll content of leaf was measured by a chlorophyll meter (model SPAD-502). From a sample plant 10-15 such readings were collected and averaged.

Biometric observations recorded

From randomly selected five sample plants in the initial stage of crop biometric observations were collected using standard scale during different crop growth stages. Per plant observations such as number of branches, flowers, fruits were collected along with, dry matter accumulation and total yield data.

RESULTS AND DISCUSSION

Micro environment under different colour shade nets

The microclimate under shadenet houses is influenced by its color (Smith et al 1984 and Oren-Shamir et al. 2001). The shadenet colour and its intensity influences the absorption, emission and transmission wavelengths of incident solar radiation. Lowest temperature and light intensity were observed in black coloured shadenet houses. From the figure 1 it can be observed that light intensities in coloured shadenet houses was lower over open field conditions.

Under shadenet houses the lower temperatures were observed over outside ambient conditions. This reduction

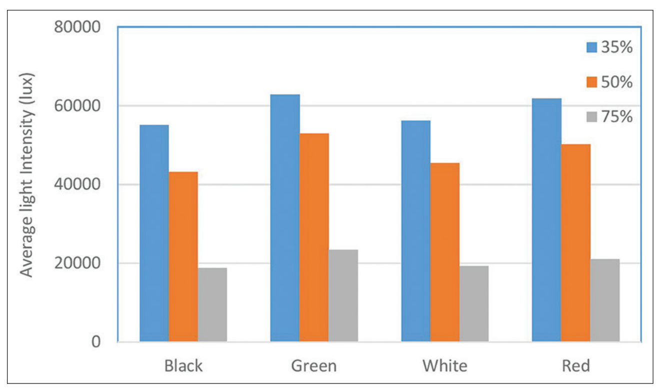

Fig 1. Average light intensity under different coloured nets.

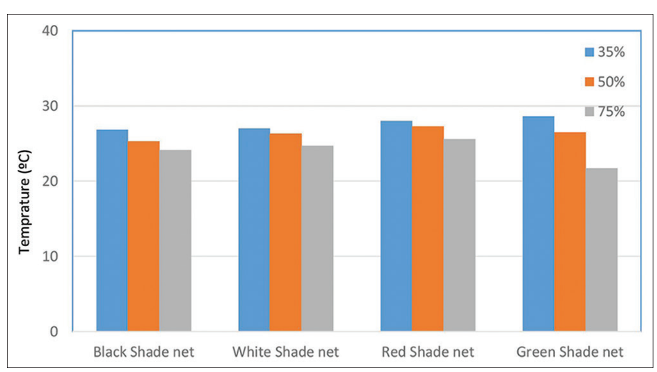

Fig 2. Average temperatures under different coloured shades net houses

Table 1: Growth and yield parameters as influenced by shadenet colour and its intensity

Treatments	Plant Height	No of branches	Dry matter accumulation per plants	No of flower per plant	No of fruits per plant	Yield per hectare (t)
Shade net colour (C)						
C1-Black	132.6	10.0	186.39	98.50	76.30	65.3
C2-Green	130.0	9.7	176.50	90.30	73.21	47.5
C3-White	150.4	10.3	192.00	102.20	80.50	71.8
C4- Red	152.2	11.2	205.10	105.32	82.12	81.9
SEM±CD	0.630	0.053	0.603	0.321	0.213	0.189
at 5%	1.820	0.155	1.802	0.953	0.635	0.560
Shade Intensity (p)						
P1-35%	142.4	10.9	190.32	92.30	75.69	67.42
P2-50%	149.2	11.4	201.39	103.40	81.45	68.97
P3-75%	138.6	9.3	184.56	96.98	77.41	63.50
SEM±CD	0.057	0.014	0.205	0.197	0.031	0.043
at 5%	0.178	0.048	0.610	0.580	0.090	0.125
Interaction (CXP)						
C1P1	126.3	10.02	184.50	87.40	70.56	66.49
C1P2	142.8	10.21	200.10	96.18	75.05	67.14
C1P3	121.4	9.56	183.90	85.32	70.25	64.40
C2P1	120.6	9.42	181.30	82.40	70.03	57.44
C2P2	136.5	9.62	190.30	90.40	74.13	58.22
C2P3	112.7	9.14	179.80	82.10	69.93	55.48
C3P1	139.3	10.12	196.70	94.32	75.60	69.63
C3P2	147.6	11.10	214.50	101.42	78.15	70.40
C3P3	130.4	9.51	187.80	90.10	72.14	67.67
C4P1	151.6	11.22	216.10	105.30	81.10	74.68
C4P2	154.4	11.72	223.40	108.20	82.85	75.45
C4P3	144.4	10.42	209.05	97.32	77.23	72.72
SEM±CD at 5%	0.130	0.042	0.423	0.142	0.138	0.142
	0.408	0.122	1.263	0.417	0.410	0.420

varied from 1.6°C to 6.4°C in black shadenet houses with 35% shade intensity, 1.3-5°C under green with 35% shade intensity, 1.2-5.7°C under white with 35 % shade intensity, and 1.9-6.7°C under red shade net with 35 % shade intensity. The temperature difference was maximum in red coloured shadenet house. Net photosynthesis is mostly influenced by higher temperatures over lower temperatures as net photosynthetic rate decreases (Reddy et al., 1999). According to Kittas et al. (2009), temperature variations have also been noted in various colour net houses.

Chlorophyll value

Leaf chlorophyll content (SPAD value) of tomato crop was also found improved under all the shadenet houses. Under different colours of shadnet houses the SPAD reading was found significant with maximum value found under red colour (42.10) shade net, followed by white shadenet house with 40.19, green with 38.60 and black shadenet house with 38.15. This trend is also being reported by Costa et al. 2010. Because of the higher chlorophyll content and moderate light intensities, the net photosynthetic rate is higher in red coloured shadenet house which is being reflected in the higher crop yield.

Growth under different colour shade nets

Plant growth parameters varied significantly in coloured shade nets with varying shade intensities. Height of a plant and number of branches found maximum (152. 2 cm & 11.2, 150.4 cm & 10.3, 132.6cm & 10.0 and 130.0 cm & 9.7) at 90 DAT respectively were obtained under red, white, black and green colour shade net. Fifty per cent shade intensity obtained highest plant height and more number of branches/plant (149.2 cm & 11.4) when compared with 35 % (142.4 cm & 10.9) and 75% (138.6 cm & 9.3) shade intensity. A close perusal of Table 1 these plant growth parameters were significantly high due to different shade net color and intensity. Interaction effect of different shade net color and intensity was found significant. Godi et.al. 2018 reported that plants cultivated in low light environments were shown to be more apical dominant over high light environments, this increased auxin transport caused cell elongation below the zone of the apical meristem, resulting in taller plants under shade net. house. The favourable microclimatic conditions could be to the reason for this. Ramesh and Arumugam (2010) observed similar findings.

Solid matter present in a leaf can be estimated from dry leaf weight. Dry matter was found highest in red coloured shadenet house and least in green color net (Table 1). The higher growth parameters of plant observed in red shadenet house might be due to optimum ratio of source and sink. Maximum dry matter (201.39 g) was observed in 50 per cent when compared with 35 and 75% shading intensities.

Significant number of flowers, fruit set per cent (105.32 & 71.70) were observed in red colour net house as compared to white (102.20 & 68.23), black (98.50 & 67.12) and green (90.20 & 62.45) colored shadenet and these observations are similar to the findings of Shahak et al. (2008c) for ornamental crop. These parameters viz., no of flower per plant and percent fruit set (103.40 & 72.30) were recorded highest in 50% shading intensity net houses over 35 and 75% net houses with lowest being observed in observed in 35% shade intensity net house. Singh et al. (2000) and Swagatika et al. (2006) reported similarly in other crops.

Yield of tomato as influenced by colures & intensity of shade nets

Shadenet colours considerably influenced fruits number and fruit yield of tomato. Per net house with 50% shade intensity, as compared to white black and green shade net colors with 50 % shade intensity. Under 35 % shade net intensity with red color found maximum no of fruits and highest yield as compared to white, black and green color shade net. Similarly, 75 % shade net intensity with red color found maximum no of fruits and highest yield as compared to white, black and green color shade net. Highest marketable yield under red coloured shadenet houses is also being observed by Kittas etal., 2009.

CONCLUSIONS

Quality and marketable vegetable production can be achieved when they are cultivated under photoselective shadenets houses. In the present investigation conducted for consecutive three years for assessing the performance of tomato crop under different colors of shadenet with varying shade intensities concluded that red colored shade net with all the selected shade intensities gave statistically significant yields when compared with other colored net houses and intensities. This is due to more favourable micro climatic and growth contributing parameters observed in red coloured shadenet houses over other colour net houses. The second best color net house was black color with 50 per cent shade intensity. The inferior performance of the crop was found for green color under all the shade intensities. Hence, the study recommends to adopt red colored shadenets for tomato cultivation. The study also suggest for further investigation on the photo selective nature of red coloured net along with radiometric properties inside red coloured shadenet houses.

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Contribution of authors

K.V.Ramana Rao: Conceptualization of research problem and planning the experiment, day to day monitoring of progress of project, analysis of data and interpretation of data and manuscript preparation. Suchi Gangwar: Planting material preparation, layout, monitoring and collecting crop growth parameters, statistical analysis of data, draft preparation. Pushpalata Aherwar: Design and installation of drip irrigation systems as per layout and implementing irrigation schedules. Deepika Yadav: Environmental parameters monitoring, measuring SPAD values and analysis of data

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