“Influence of different colored shade nets on microenvironmental parameters of various ornamental plants”

ABSTRACT

A field experiment was carried out at Floriculture and Landscaping Block, College of Horticulture, Anantharajupeta during 2022 and 2023. to study the Influence of different colored shade nets on microenvironmental parameters of various ornamental plants.The experiment consists of 25 treatments with three replications which were laid out in FRBD. The treatments were formed with two factors viz.Factor I (Colour shade nets,Green (C_1), White (C_2), Black (C_3), Red nets (C_4) and Open (C_5) condition and Factor II plants(Pandanus veitchii(P_1), Epipremnum aureum(P_2), Sansevieria trifasciata(P_3), Aglaonema commutatumvar. Redgold(P_4),Rhoeospathacea(P_5) were taken. The results shown that the maximum temperature was under black net (32.43, 34.10 ^{0}C in first and second year respectively), maximum RH was under black net(88.09, 83.11 % in first and second year respectively), lowest canopy temperature was under shade nets than open.Maximum light intensity (653.21, 669.4 lux in first and second year respectively), average PAR values were maximum under white net (718.05 µmol m^{-2} s^{-1}) in both years. Mealy bug incidence was maximum under black net in both years during the period of study.

Key words: Color shade nets,light intensity, Ornamental plants,PAR, pest incidence.relative humiditytemperature.

1 INTRODUCTION

Cut foliageand quality indoor plants have a great opportunity in the local as well as foreign markets and can play a valuable role in the economic upliftment of the farmers (El-Ghait*et al.*, 2012). The use of these bio-degradable decorative foliage as fillers in bouquet making has increased substantially from 5% to 20–25% (Bhattacharjee, 2006). In India, commercial production of cut foliage has flourished in recent years because of its huge demand, especially during festivals and functions. Ornamental foliage plants are important component in floricultural industry and are largely used for decoration as fillers in floral arrangements. Indoor plants provide freshness, colour and variety to arrangements and exhibition. The cut foliageis suited for year-round production with low investment, less care and maintenance.Providing shade nets regardless of colour reduce radiation that reaches the crops underneath and is directly proportional to the shade factor and modify micro-environment.

Ornamental plant nursery is today’s lucrative business where we have a wide range of nurseries based on wholesale or retail, indoor/shade loving plants, tissue culture plants, commercial flowering plants, shrubs, climbers and tree seedlings for landscaping, annual plants, bulbous flowers, etc. are flourishing well throughout the country. Efficient and affordable shade structures facilitate the nurserymen in production of quality planting material so that they can get more profit.Use of different coloured shade nets improves the quality and production of cut greens and indoor plants.

2 MATERIAL AND METHODS

The present investigation was carried out during the year 2022 and 2023at Dr. YSRHU-College of Horticulture, Anantharajupeta with 5 types of ornamental plants under five types of color shade treatments*viz*,Green (C_1), White (C_2), Black (C_3), Red nets (C_4) and Open (C_5). The details of materials used, methods adopted and experimental techniques employed during the study are outlined here. Thefive plant species*Pandanus veitchii* (P_1), *Epipremnum aureum* (P_2), *Sansevieria trifasciata* (P_3),*Aglaonema commutatum* var. Redgold(P_4), *Rhoeospathacea*(P_5) of same height and aged plants were takenandplanted in 12/15-inch black polybags.There were 12 poly bags in each treatment and among them 6 plants were selected randomly for recording the observations. The data were analyzed statistically at 0.05level of significance with the help of SPSS-28 software.

2.1 TEMPERATURE AND RELATIVE HUMIDITY INSIDE THE SHADE NET (^{0}C)

Micro-environment parameters under each shade net such as temperature (^{0}C) and relative humidity (%) were recorded with Pocket Weather Tracker (Apogee 4000 NV). Data were collected continuously during crop growing period (July, 2021 to June, 2022 and July, 2022 to June, 2023) twice a day at 8 AM and at 1 PM.

2.2 LIGHT INTENSITY (LUX)

Light intensity was recorded with the lux meter. Data were collected continuously during crop growing period (July, 2021 to June, 2022 and July, 2022 to June, 2023) twice a day at 12 pm to 1 pm.

2.3PLANT CANOPY TEMPERATURE (^{0}C)

A hand-held infrared thermometer (ARK 9999 IR THERMO GUN) was used to measure canopy temperature (^{0}C). The average of three readings, obtained from, beneath each treatment and control, at 45^o to the horizontal, in a variety of directions so as to shoot plant canopy, served as the basis for each treatment's data. Data were collected continuously during crop growing period (July, 2021 to June, 2022 and July, 2022 to June, 2023) twice a day at 8 AM and at 1 PM.

2.4 PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR) (µMOL M^{-2} S^{-1})

Incoming Photosynthetically Active Radiation (PAR) values were measured at top of crop canopy using line quantum sensor (LICOR-3000). Intercepted PAR also taken above the shade cover. The above measurements were taken at 60,120 and 180 days after planting on clear sunny days between 12:00 and 13:00 hours IST when disturbances due to leaf shading and leaf curling and solar angle were lesser. These PAR values were recorded throughout the period of study.

2.5 LIGHT INTERCEPTION (%)

The lite interception was derived from the PAR values under the shade net and above the shade net. Data were collected continuously during crop growing period (July, 2021 to June, 2022 and July, 2022 to June, 2023) during 12 pm to 1 pm.

$$\text{Light interception} = \frac{\text{PAR above the shade net} - \text{PAR below canopy}}{\text{PAR above the shade net}} x100$$

2.6 PEST INCIDENCE (%)

Pest incidence was recorded by calculating percentage of the total number of plants in the treatment and pest infested plants, as per the guidelines given for PDI calculated as mentioned here under. The data recorded at 180 DAP in both years.

$$\text{Pest incidence} = \frac{\text{Total number of infested plants}}{\text{Total number of plants in the plot}} \times 100$$

RESULT AND DISCUSSION

Various observations pertaining to the microclimatic parametersare presented in Table.1 to 7.

The temperature under different colored shade-nets variedsignificantly the data of the information made available in Table 1 indicated that temperature recorded was maximum (32.43 ^{0}C and 34.10 ^{0}C) during first and second year, respectively in black shade net environment. During two years of study, an average temperature of

33.26 ^{0}C under black net and 33.74 ^{0}C was recorded under green net. Our results get strengthened from the previously published reports of Gaurav *et al*., (2016) in cordyline. Shading contributed to reflecting solar radiation and lowering the heat dispersion, thereby reducing the air temperature under the colored shading net treatments, which agrees with Diaz-Perez (2013), who suggested shading nets promote temperature reduction. Our results agreed with those of a previous work in which lower air temperature under the shading net treatments was observed compared with the treatment with no shading nets (Ilic *et al*., 2017).

Among multiple shade net colors, relative humidity recorded was highest in green net (88.93 and 84.04%) followed by under black net (88.17 %) during the study, lowest was (43.26 %)under open (Table 2). Mditshwa*et al*. (2019) noted that relative humidity is often significantly greater under shade netting.

Plant canopy temperature measured under different color shade nets had lowest canopy temperature as compared to corresponding value in control. Similar findings were furnished by Meena and Vashist (2014) in spinach. The information pertaining to this attribute was presented in (Chart 1).

Among various shade net treatments, maximum light intensity of 653.62 lux and 642.86 lux in open field condition (Table 4) was recorded during first and second year, respectively. The lowest lux was recorded under 129.75 lux and 129.62 lux under black net in first and second year of study respectively (Table 4). Gaurav (2014) found that the without shade treatment had the greatest light intensity and temperature measurements compared with the other shade net treatments.

The environmental condition available under black color shade net had maximum light interception (80.01 and 79.81%) followed by red net (63.75 and 62.95%) during both years of study and lowest was recorded under white 40.28 % in first year, 38.87 % was in second year (Table 4). Shade nets not only decreased light quantity but also alter light quality to a varying extent and might also change other environmental conditions. The results are in accordance with the investigations of Ilic *et al*. (2015) in tomato.

In both years, an investigation to study on PAR (Table 5) revealed that it was recorded maximum (715.74 and 721.55 µmol m^{-2} s^{-1}) under white net and minimum PAR values were recorded under 240.28 and 240.04 µmol m^{-2} s^{-1} under black net in first and second year respectively.Similar results found in tomato plants grown in south Serbia, where PAR in open field in summer was reported to be approximately 1,600 µmol m^{-2} s^{-1}, resulting in high light stress in unshaded tomato plants (Ilic *et al.,* 2012). Similarly, Abdel-Ghany and Al-Helal (2010) observed that the shading screens with more shiny colors had raised the levels of reflection, reflecting almost all the incident PAR spectrum, in relation to the dark screens, that reflect the incident PAR only in the spectral band of the color and absorb the incident PAR of the remaining complementary colors of the spectrum.

Durin the first year, snail attack was maximum under black net. During the second-year study, black net showed the highest (6.67 %) mealy bugs incidence followed by red (5.00 %). Remaining nets reported no mealy bug pest incidence during the study. In plants, P_4 recorded the highest mealy bugs incidence (14.58 %). Remaining plants registered zero incidence. In the interactions, black x P_4 exhibited highest incidence (33.33 %) followed by red x P_4 (25.00 %). Remaining treatments has no evidence of pest.

CONCLUSION

Various colour shade nets were used to alter the microclimate. The air temperatures, soil temperatures at various depths, canopy temperature, light intensity, and radiation were all found to be lower under varied colour shades than the comparable value under control. Whether the relative humidity was greater beneath colour shade netting than it was in the control. Green had the highest percentage reflectance and value of several spectral indices such as normalised difference vegetation index and ratio vegetation index, followed by red, black, white, and control. When compared to other colour nets, the black shade net was shown to be superior in enhancing most of the microenvironmental factors.

Table 1 Temperature ^{0}C under different color shade nets during the investigation period.

Month	Green net		White net		Black net		Red net	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
July, 2021	23.51	33.03	22.39	31.73	22.56	33.23	24.18	32.53
September	19.59	26.82	18.47	25.54	18.75	27.34	20.26	26.4
November	19.38	26.31	18.26	24.41	18.54	27.44	20.05	27.75
January, 2022	20.95	29.87	20.4	28.57	20.6	30.07	20.91	29.37
March	24.3	36.5	24.31	36.49	24.15	36.86	24.62	35.68
May	25.9	38.46	24.78	37.16	25.9	38.66	26.57	37.96
Average	**22.25**	**31.92**	**21.4**	**30.9**	**21.68**	**32.43**	**22.82**	**31.82**
July, 2022	22.3	31.82	21.18	30.52	21.35	32.02	22.97	31.32
September	18.75	25.98	17.63	24.7	17.91	26.5	19.42	25.56
November	18.74	25.67	17.62	23.77	17.9	26.8	19.41	27.11
January, 2023	20.92	33.2	20.43	32.52	20.59	33.68	20.92	33
March	23.01	40.01	23.02	39.51	22.86	40.67	23.33	41.09
May	25.12	42.56	24.56	39.92	24.95	42.28	24.86	42.13
Average	**21.27**	**33.57**	**20.58**	**32.49**	**20.7**	**34.1**	**21.64**	**34.02**
Total Average	**21.76**	**32.74**	**20.99**	**31.69**	**21.19**	**33.26**	**22.23**	**32.92**

Table 2 Relative humidity (%) under different color shade nets during the investigation period.

RH %										
	Green net		White net		Black net		Red net		Open field	
Month	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
July, 2021	48.91	86.71	48.65	86.2	48.2	86.39	48.69	79.63	48.99	81.53
September	44.58	93.61	42.91	92.26	44.17	93.46	43.83	91.12	42.4	87.26
November	45.6	82.8	44.3	82.6	45.3	80.7	45	79.6	44.4	76.4
January, 2022	43.71	91.52	42	90.12	43.6	89.98	42.42	89.91	40.51	82.51
March	41.14	90.17	39.47	88.82	40.73	90.02	40.39	87.68	38.96	83.82
May	42.36	79.56	41.06	79.36	42.06	77.46	41.76	76.36	41.16	73.16
Average	**45.49**	**89.33**	**44.22**	**88.36**	**45.1**	**88.5**	**44.7**	**85.87**	**43.7**	**83.15**
July,2022	47.7	85.5	47.44	84.99	46.99	85.18	47.48	78.42	47.78	80.32
September	43.74	92.77	42.07	91.42	43.33	92.62	42.99	90.28	41.56	86.42
November	44.96	82.16	43.66	81.96	44.66	80.06	44.36	78.96	43.76	75.76
January, 2023	43.74	91.53	42	90.08	43.53	90.58	42.38	89.92	40.52	85.59
March	45.37	83.17	45.11	82.66	44.66	82.85	45.15	76.09	45.45	77.99
May	42.3	79.51	39.13	75.24	43.1	78.36	42.18	76.36	38.99	72.11
Average	**44.6**	**87**	**43.22**	**85.8**	**44.29**	**86.14**	**43.91**	**83.31**	**42.82**	**80.98**
Total average	**45.05**	**88.17**	**43.72**	**87.08**	**44.7**	**87.32**	**44.31**	**84.59**	**43.26**	**82.06**

Chart 1. Response of shade net colors, ornamental plants and their interaction on canopy temperature (^{0}C) at 180DAP during second year.

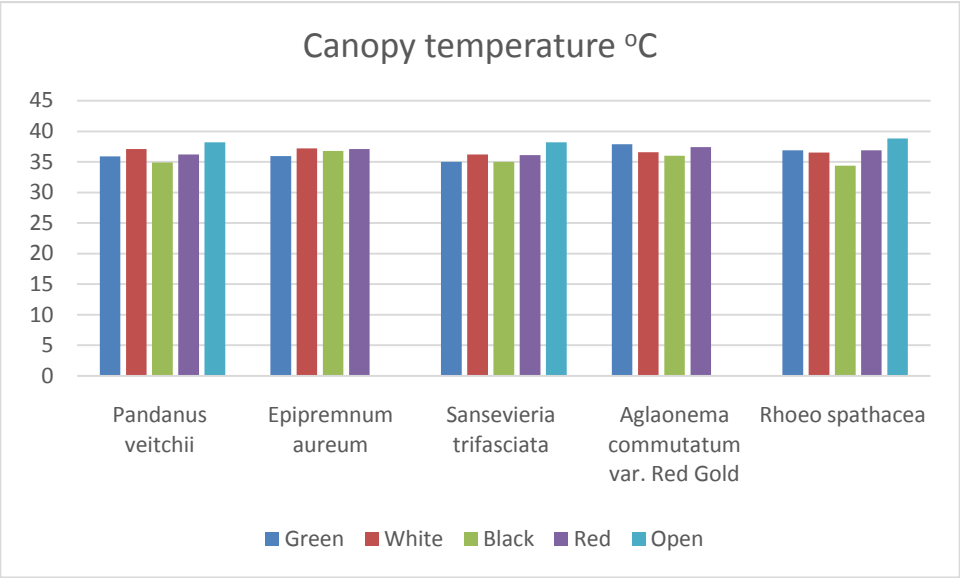

Table 3Light intensity (Lux) under different color shade nets during the study the study period.

Light intensity (LUX)					
Month	**Green net**	**White net**	**Black net**	**Red net**	**Open condition**
July, 2021	301.01	392.29	135.31	234.71	632.24
September	298.45	389.73	132.75	232.15	629.68
November	280.88	372.16	115.18	214.58	612.11
January, 2022	274.35	370.41	116.38	230.18	740.34
March	299.27	344.45	124.27	247.27	760
May	305.1	396.38	139.4	238.8	636.33
Average	**296.51**	**386.5**	**129.75**	**235.79**	**653.62**
July, 2022	299.8	391.08	134.1	233.5	631.03
September	297.61	388.89	131.91	231.31	628.84
November	280.24	371.52	114.54	213.94	611.47
January, 2023	275.75	370.75	114.5	237.75	751
March	301.1	392.38	135.4	234.8	632.33
May	329.17	431.5	155.67	264	611.5
Average	**299.82**	**389.64**	**129.62**	**236.28**	**642.86**
Total average	**298.17**	**388.07**	**129.69**	**236.04**	**648.24**

Table 4 Light interception (**%**) under different color shade net treatments during the study from first year to second year.

Light interception (%)				
Month	**Green net**	**White net**	**Black net**	**Red net**
July,2021	52.39	37.95	78.6	62.88
September	52.6	38.11	78.92	63.13
November	54.11	39.2	81.18	64.94
January, 2022	62.94	49.97	84.28	68.91
March	60.62	54.68	83.65	67.46
May	52.05	37.71	78.09	62.47
Average	**54.24**	**40.28**	**79.96**	**63.71**
July,2022	52.49	38.03	78.75	63
September	52.67	38.16	79.02	63.22
November	54.17	39.24	81.27	65.01
January, 2023	63.28	50.63	84.75	68.34
March	52.38	37.95	78.59	62.87
May	46.17	29.44	74.54	56.83
Average	**53.03**	**38.87**	**79.68**	**63.06**
Total average	**53.64**	**39.57**	**79.82**	**63.39**

Table 5 Photosynthetically Active Radiation (PAR) under different color shade nets during the study

Photosynthetically Active Radiation (PAR) (µmol m^{-2} s^{-1})				
Month	**Green net**	**White net**	**Black net**	**Red net**
July,2021	557.43	726.47	250.57	434.65
September	552.69	721.73	245.83	429.91
November	520.15	689.19	213.29	397.37
January,2022	508.06	685.94	215.52	426.26
March	554.21	637.88	230.13	457.91
May	565.01	734.04	258.14	442.22
Average	**549.1**	**715.74**	**240.28**	**436.65**
July, 2022	555.19	724.23	248.33	432.41
September	551.14	720.17	244.27	428.35
November	518.97	688	212.11	396.18
January, 2023	510.65	686.57	212.04	440.28
March	557.6	726.63	250.74	434.81
May	609.57	799.07	288.27	488.89
Average	**555.23**	**721.55**	**240.04**	**437.56**
Total average	**552.16**	**718.65**	**240.16**	**437.11**

Table 6Response of shade net colors, ornamental plants and their interaction on pest incidence (%) at 180 DAP (Mealy bugs) during second year.

Shade color (C)	**Name of Ornamental foliage plant (P)**					**Mean**
	***Pandanus veitchii* (P_1)**	**Epipremnum aureum (P_2)**	***Sansevieria trifasciata* (P_3)**	**Aglaonema var. Red gold(P_4)**	***Rhoeo spathacea* (P_5)**	
Green (C_1)	0.00	0.00	0.00	0.00	0.00	0.00
White (C_2)	0.00	0.00	0.00	0.00	0.00	0.00
Black (C_3)	0.00	0.00	0.00	33.33[a]	0.00	6.67[a]
Red (C_4)	0.00	0.00	0.00	25.00	0.00	5.00[b]
Open (C_5)	0.00	0.00	0.00	0.00	0.00	0.00
Mean	0.00	0.00	0.00	14.58[a]	0.00	
Source	Shade net color (C)		Ornamental plants (P)		CxP	
S. Em±	0.13		0.13		0.29	
CD (P=0.05)	0.37		0.37		0.83	

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