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Efeect of Environmental Parameters on Chrysanthemum Different Colour Low Tunnel Shade Nets and Different Colour Mulches

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ABSTRACT

Shade nets are used for controlling the crop growth and improving crop productivity. A field experiment was conducted under shade net to determine the effect of environmental parameters on chrysanthemum under on different colour low tunnel shade nets. The experiment had split plot design consisting of different colour shade nets as main plots *i.e.,* white shade net, green shade net, black shade net and open field condition and different mulches as a sub plots *i.e.,* white colour plastic mulch, silver colour plastic mulch, black colour plastic mulch, jute mulch and no mulch. White colour shade net significantly increased the soil moisture and lowered the soil temperature compared to other colour shade nets. During the experimental period, maximum temperature (37.90 °C) was recorded under control condition followed by black shade net (35.80 °C) and green shade net (34.60 °C). Minimum temperature (33.00 °C) was recorded under white shade net. Maximum relative humidity (86.20 %) was recorded under white shade net followed by green shade net (82.30 %) and black shade net (79 %). Minimum relative humidity (77 %) was recorded under control condition. Maximum light intensity (49600 Lux) was recorded under control condition followed by white shade net (46800 Lux) and green shade net (37,000 Lux). Minimum light intensity was recorded under black shade net (33210 Lux). The results of biometric parameters depicted higher growth and yield parameters for chrysanthemum grown under white shade net with white plastic mulch. The yield of Chrysanthemum was increased in white shade net (8.75 t ha^{-1}) than the black shade net (4.43 t ha^{-1}). Chrysanthemum grown in open fields and without mulch produced lower growth and yield.

Key words: *Shade net, Plastic mulch, Chrysanthemum, Environmental parameters.*

Introduction

A low tunnel shade net is a structure that uses a metal frame to support shade cloth, which provides some passive environmental control. This includes shading plants from excessive sunlight and wind. Shade net houses are used to maximize the growth of indoor and shade-loving plants, as well as for raising seedlings. In warmer climates, shade houses can be used to grow a wide range of plants that would normally grow in cool temperate regions. In cold conditions, more elaborate shade houses can be

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heated to prevent frost damage to the plants. Chrysanthemums are flowering plants belonging to the family of Asteraceae. Chrysanthemum is widely cultivated throughout warm temperature, tropical and subtropical countries. Application of plastic in agriculture and includes plastic mulches, greenhouse plastic, pots and pug trays, as well as irrigation pipes and tapes. Since, its introduction into agriculture plastic has contributed to economic viability of farmers worldwide. For decades farmers were using various materials such as dry leaf, paddy straw, paddy husk, jowar trash, saw dust, dry grass, dry sugarcane leaves, dry coconut leaves, coconut husk, paper for moisture conservation (reducing water evaporation losses), checking weed growth moderation of soil temperature, humidity, carbon di-oxide enrichment and increased microbial activity in the soil. Thus, mulching is the process of covering around plant root area so as to insulate the plant and its roots from the effect of extreme temperature fluctuations (Verma *et al.,* 2016). Plastic mulching is a practice of covering the soil surface around the plant to make conditions more suitable for plant growth through In-situ moisture conservation, weed control, better CO_2 exchange foot root system and soil structure maintenance.

However, the introduction of plastic film as mulch increases the efficiency and hence increases the yield. The different colour plastic mulches impacts different effect on crop growth, pest management and checks weed growth. Mulching includes moisture and soil conservation, temperature moderation, salinity and weed control *etc.* It exerts a decisive effect on earliness, yield and quality of the crop. Mulching is a popular weed control method that has been used successfully in many countries (Amoghein *et al.,* 2013). Both organic mulches and inorganic mulches are used, although the former is widely used in cropping systems because of its success in keeping weeds under control and reducing the need for soil tillage, as there are less weeds. Since temperature and soil moisture affect weed seed germination, mulch preserves soil moisture, maintaining higher levels of moisture as compared to soil without mulch (Teame *et al.,* 2017). Mulches, spread on soil surfaces lowers the average soil temperature during hot season, thus keeping the temperature in the regular range during the growing season.

Different colored low tunnel shade nets have different effects on crop growth and pest management. These nets conserve soil moisture, moderate temperature, and reduce light intensity. They can also significantly affect the earliness, yield, and quality of the crop. Coloured nets are a new approach that offers additional benefits beyond the protective functions of traditional nettings. These nets are unique in that they both spectrally modify and scatter transmitted light. Photoselective nets include colored nets (*e.g.,* white, red, yellow, green, and blue) as well as color nets (*e.g.,* pearl, white, and gray) that absorb spectral bands shorter or longer than the visible range. The spectral manipulation is aimed at specifically promoting physiological responses, while light scattering improves light penetration into the inner canopy (Shahak *et al.,* 2008).

Low tunnels modify microclimate by raising soil and air temperatures. In general, low tunnels allow shortwave solar radiation to pass through during the day and the plastic material slows long wave radiation from the surface at night (Snyder and Melo-Abreu, 2005). Row covers or low tunnels can modify crop microclimate by raising temperature and promoting earlier plant growth (Hochmuth *et al.,* 2009). By using beds covered with black plastic mulch together with low tunnels, soil temperatures can be increased, weeds can be controlled, water can be conserved, and fertilizer application is optimized (Schrader, 2000). Plastic materials used for row covers are available in different colors, which impact the light quality and temperature inside the tunnels. However, it is unknown which low tunnel color, type, or configuration will provide the most protection and growth enhancement in temperate climates.

Materials and Methods

This experiment was under taken inthe month of August-December 2020 and 2021 at research fields of AICRP (PEASEM), College of Agricultural Engineering, University of Agricultural Sciences, Raichur. The experiment was laid out in split plot design with two replications. The experiment consisted of different colour shade nets *i.e.,* white, green, black and control as main treatment and different mulches as sub treatments *i.e.,* white plastic mulch, silver plastic mulch, black plastic mulch, jute and no mulch condition.

The experiment was replicated twice. Raised beds of 35 m length, 1 m width and 15 cm height were prepared leaving a space of 1.5 m between two beds as a path, to enable easy cultural operations like weeding, spraying, harvesting etc. The beds were leveled after mixing well rotten farm yard manure and vermicompost. Drip lateral with a discharge capacity of 4 LPH was placed on the raised beds. As per the treatment plan, 30 micron black, white and silver plastic mulch and jute mulches were laid on the bed for every 7 m. After this, holes were made on the mulches at a distance of 30 cm by using a 3 inch diameter of PVC pipe. For erecting the low tunnel shade nets over the individual beds, arches made out of 6 mm iron rods were fixed at a distance of 1.5 m in such a way that the height of the midpoint was 1 m from the bed surface. Then the three different colour shade nets (White, green and black colour) of 50 % light intensity were cladded on the arches to from low tunnels. Irrigation was provided to the beds a day before transplanting. Nearly 28 days old seedlings were transplanted in the main field. Healthy and uniformly grown nursery plants of chrysanthemum cv. marigold were planted at a spacing of 30 cm between rows and 30 cm between plants. Immediately light irrigation was provided with the help of drip system. Subsequent irrigations were provided whenever it was required (1 to 2 hours in aday). The observations were collected on growth, reproductive and quality traits of chrysanthemum flower. To record the various observations, five plants were randomly selected from each replication and in each treatment.

Temperatureandrelative humidity was measured by Pocket Weather Tracker (Kestrel 4000 NV). Data were collected continuously during crop growing period during 11:00 AM and 3:00 PM in a day. Data was not taken during cloudy weather conditions. Light intensity was measured by Lux Light meter (Extech Instruments, 401025). Light measureable range is 1 to 50,000 lux. Data holding function for measuring values and meter was corrected for luminous efficiency. The sensor was put in the upward direction and the intensity of light under different colour low tunnel shade nets was measured in lux. Data was not taken during cloudy weather.

The observations were collected on growth, reproductive and quality traits of chrysanthemum flower. To record various observations, five plants were randomly selected from each replication and in each treatment. Fully bloomed or opened flower from tagged plants were collected and weighed using an electronic balance in each harvest, the arrived value was expressed as weight of flower per plant in grams.This was worked out by totaling the weight of flowers recorded at each harvest from net plots, and yield was expressed in tonnes per hectare.

Results and Discussion

Environmental Parameter

The results discussion of environmental parameter indicates the change in variation of temperature, relative humidity and light intensity. All the parameter was measured in shade net and in open field.

Temperature variation

The average temperature recorded at 11:00 AM and 3:00 PM under different colour low tunnel shade nets and control treatment are presented in Fig. 1 and 2. The highest temperature (28.00 °C) was recorded in control conditions followed by black colour shade net (26.87 °C) and lowest temperature was recorded in white colour shade net (25.16 °C) during the month of August. At 3:00 PM, the average temperature was highest (29.70 °C) in case of control conditions followed by black colour shade net (28.58 °C) and lowest temperature was obtained in case of white colour shade net (26.45 °C) during the month of August.

At 11:00 AM, the highest temperature (32.29 °C) was recorded in control conditions followed by black colour shade net (30.29 °C) and lowest temperature was recorded in white colour shade net (29.21 °C) during the month of September. At 3:00 PM, the average temperature was highest (32.03 °C) in case of control conditions followed by black colour shade net (31.22 °C) and lowest temperature was obtained in case of white colour shade net (30.03 °C) during the month of September. At 11:00 AM, the highest temperature (32.13 °C) was recorded in control conditions followed by black

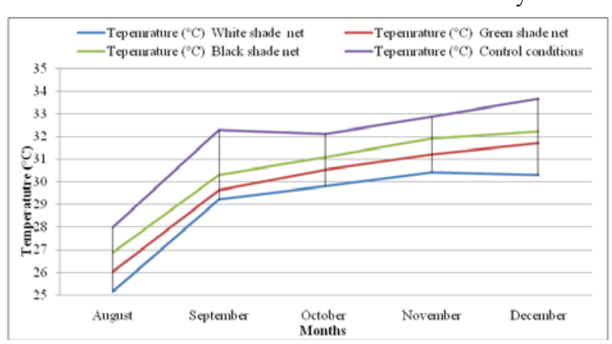

Fig. 1. Monthly average temperature was recorded at 11:00 AM during the experimental period from August to December 2020

colour shade net (31.08 °C) and lowest temperature was recorded in white colour shade net (29.80 °C) during the month of October. At 3:00 PM, the average temperature was highest (32.11 °C) in case of control conditions and followed by black colour shade net (31.26 °C) and lowest temperature was obtained in case of white colour shade net (29.95 °C) during the month of October.

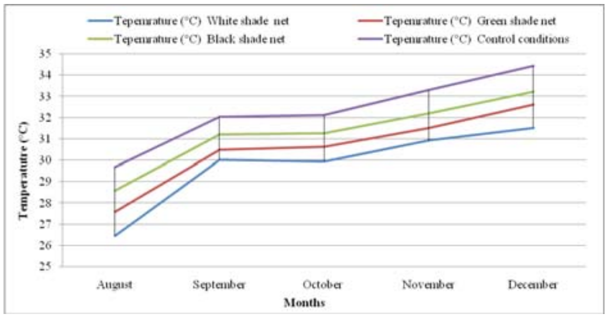

Fig. 2. Monthly average temperature was recorded at 3:00 PM during the experimental period from August to December 2020

At 11:00 AM, the highest temperature (32.86 °C) was recorded in control conditions followed by black colour shade net (31.90 °C) and lowest temperature was recorded in white colour shade net (30.41 °C) during the month of November. At 3:00 PM, the average temperature was highest (33.30 °C) in case of control conditions followed by black colour shade net (32.21 °C) and lowest temperature was obtained in case of white colour shade net (30.92 °C) during the month of November. At 11:00 AM, the highest temperature (33.67 °C) was recorded in control conditions followed by black colour shade net (32.22 °C) and lowest temperature was recorded in white colour shade net (30.29 °C) during the month of December. At 3:00 PM, the average temperature was highest (34.43 °C) in case of control conditions followed by black colour shade net (33.22 °C) and lowest temperature was obtained in case of white colour shade net (31.52 °C) during the month of December.

Significant difference in temperature was observed among different colour low tunnel shade net and control conditions. In control conditions maximum temperature was observed. This was followed by black colour shade net. The lowest temperature was in white shade net. This was in agreement with (Meena *et al.*, 2014 and Meena *et al.*, 2015).

Relative Humidity variation

The average relative humidity recorded at 11:00 AM and 3:00 PM under different colour low tunnel shade nets and control treatment are presented in Fig. 3 and 4. The highest relative humidity (54.40 %) was recorded in white colour shade net followed by green colour shade net (52.06 %) and lowest relative humidity was recorded in control condition (48.27 %) during the month of August. At 3:00 PM, the average relative humidity was highest (56.43 %) in case of white colour shade net followed by green colour shade net (53.76 %) and lowest relative humidity was obtained in case of control conditions (49.26 %) during the month of August.

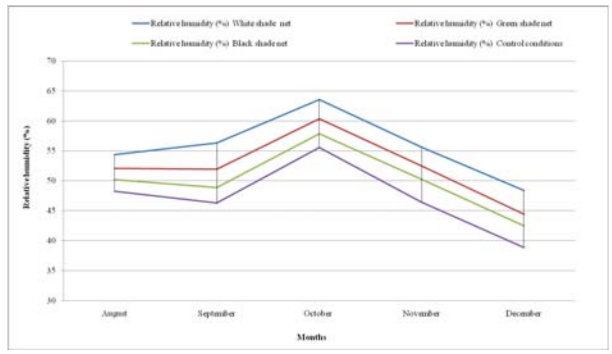

Fig. 3. Monthly average relative humidity was recorded at 11:00 AM during the experimental period from August to December 2020

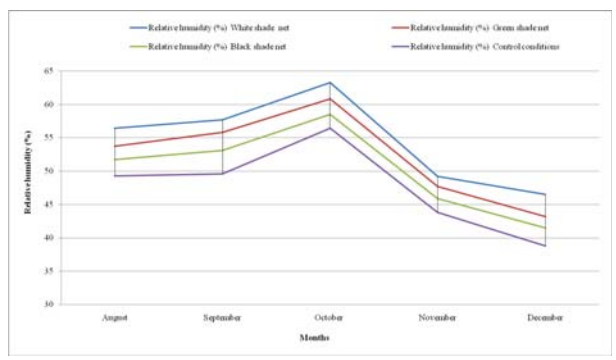

Fig. 4. Monthly average relative humidity was recorded at 3:00 PM during the experimental period from August to December 2020

At 11:00 AM, the highest relative humidity (63.56 %) was recorded in white colour shade net followed by green colour shade net (60.34 %) and lowest relative humidity was recorded in control condition (46.29 %) during the month ofSeptember. At 3:00 PM, the average relative humidity was highest

(57.69 %) in case of white colour shade net followed by green colour shade net (55.81 %) and lowest relative humidity was obtained in case of control conditions (49.58 %) during the month of September. At 11:00 AM, the highest relative humidity (63.56 %) was recorded in white colour shade net followed by green colour shade net (60.34 %) and lowest relative humidity was recorded in control condition (55.54 %) during the month of October. At 3:00 PM, the average relative humidity was highest (63.25 %) in case of white colour shade net followed by green colour shade net (60.82 %) and lowest relative humidity was obtained in case of control conditions (56.43 %) during the month of October.

At 11:00 AM, the highest relative humidity (55.61 %) was recorded in white colour shade net followed by green colour shade net (52.52 %) and lowest relative humidity was recorded in control condition (46.42 %) during the month of November. At 3:00 PM, the average relative humidity was highest (49.18 %) in case of white colour shade net followed by green colour shade net (47.69 %) and lowest relative humidity was obtained in case of control conditions (43.81 %) during the month of November. At 11:00 AM, the relative humidity (48.35 %) was recorded in white colour shade net followed by green colour shade net (44.39 %) and lowest relative humidity was recorded in control condition (38.86 %) during the month of December. At 3:00 PM, the average relative humidity was highest (46.48 %) in case of white colour shade net followed by green colour shade net (43.17 %) and lowest relative humidity was obtained in case of control conditions (38.76 %) during the month of December.

Significant difference among different colour low tunnel shade net and control conditions were observed. The treatment with white shade net exhibited maximum relative humidity. This was followed by green colour shade net. The lowest relative humidity was recordedin control conditions. This was in agreement with (Meena *et al.,* 2014 and Meena *et al.,* 2015).

Variation in light intensity

The average light intensity recorded at 11:00 AM and 3:00 PM under different colour shade nets and control treatment are presented in Fig. 5 and 6. The highest light intensity (27405 lux) was recorded in control conditions followed by white colour shade net (9850 lux) and lowest light intensity was recorded in black colour shade net (13211 lux) during the month of August. At 3:00 PM, the average light intensity was highest (22750 lux) in control conditions followed by white colour shade net (16724 lux) and lowest light intensity was obtained in black

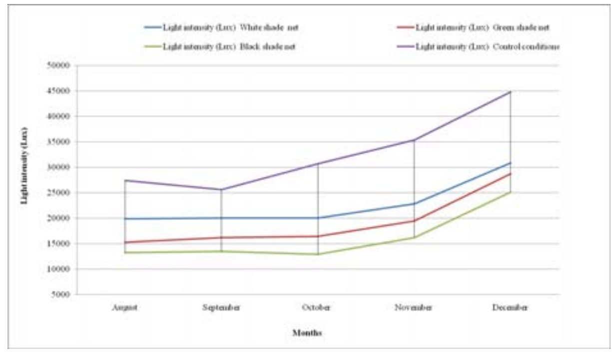

Fig. 5. Monthly average light intensity was recorded at 11:00 AM during the experimental period from August to December 2020

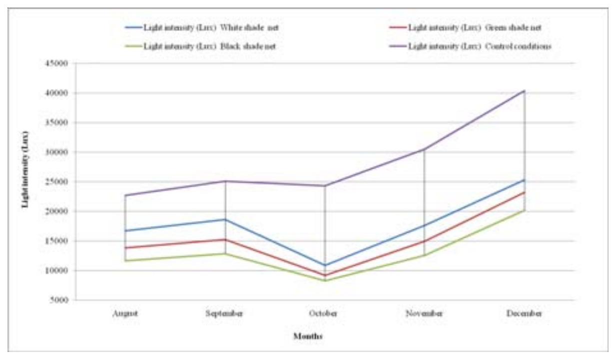

Fig. 6. Monthly average light intensity was recorded at 3:00 PM during the experimental period from August to December 2020

colour shade net (11678 lux) during the month of August.

At 11:00 AM, the highest light intensity (25604 lux) was recorded in control conditions followed by white colour shade net (20043 lux) and lowest temperature was recorded in black colour shade net (1475 lux) during the month of September. At 3:00 PM, the average light intensity was highest (25100 lux) in case of control conditions followed by white colour shade net (18628 lux) and lowest light intensity was obtained in black colour shade net (12893 lux) during the month of September. At 11:00 AM, the highest light intensity (30686 lux).

was recorded in control conditions followed by white colour shade net (20040 lux) and lowest temperature was recorded in black colour shade net (12895 lux) during the month of October. At 3:00

PM, the average light intensity was highest (24345 lux) in control conditions followed by white colour shade net (10916 lux) and lowest light intensity was obtained in black colour shade net (8329 lux) during the month of October.

At 11:00 AM, the highest light intensity (35322 lux) was recorded in control conditions followed by white colour shade net (22795 lux) and lowest temperature was recorded in black colour shade net (16227 lux) during the month of November. At 3:00 PM, the average light intensity was highest (30513 lux) in case of control conditions followed by white colour shade net (17674 lux) and lowest light intensity was obtained in black colour shade net (12599 lux) during the month of November. At 11:00 AM, the highest light intensity (44748 lux) was recorded in control conditions followed by white colour shade net (30849 lux) and lowest temperature was recorded in black colour shade net (25127 lux) during the month of December. At 3:00 PM, the average light intensity was highest (40418 lux) in control conditions and followed by white colour shade net (25362 lux) and lowest light intensity was obtained in black colour shade net (20207 lux) during the month of December.

Significant difference was recorded in light intensity among different colour low tunnel shade net and control conditions. The treatment with control conditions recorded maximum light intensity. This was followed by white colour shade net. The lowest light intensity was recorded in black shade net. This was in agreement with (Meena *et al.*, 2014 and Meena *et al.,* 2015).

Growth Parameters

Data depicted in Table 1 indicates that there were significant differences in vegetative parameters *i.e.* plant height, the number of branches, plant spread, leaf area index and chlorophyll content of chrysanthemum when grown under different coloured low tunnel shade nets.

The growth parameters i.e. plant height (41.68 cm), number of branches (11.28), plant spread (42.70 cm), leaf area index (2.11), chlorophyll content (48.78) of chrysanthemum grown under white coloured low tunnel shade net was significantly higher followed by plants grown under green shade net at all stages of growth. Lowest growth param-

Table 1. Effect of different colour low tunnel shade nets and mulches on plant vegetative parameters of chrysanthemum

Treatment	Plant height (cm)	Number of branches (No's)	Plant Spreads (cm)	Leaf Area index	Plant chlorophyll content
Shade nets (S)					
S_1	38.52	10.70	40.88	2.04	45.46
S_2	41.68	11.28	42.70	2.11	48.78
S_3	34.41	7.96	35.20	1.71	42.69
S_4	36.19	8.44	39.32	1.92	44.86
SE m±	0.04	0.08	0.21	0.08	0.25
C.D. at 5%	0.16	0.29	0.75	0.02	0.86
Mulches (M)					
M_1	39.89	11.70	40.88	2.04	47.38
M_2	37.29	9.53	39.17	1.87	45.79
M_3	38.46	10.28	40.58	1.96	47.88
M_4	36.71	10.75	38.68	1.79	44.24
M_5	35.88	10.17	37.74	1.66	41.00
SE m±	0.13	0.09	0.09	0.01	0.30
C.D. at 5%	0.39	0.17	0.28	0.03	0.86
Interaction	NS	NS	NS	NS	NS

Main treatments (S):
S_1 - Green shade net
S_2 - White shade net
S_3 - Black shade net
S_4 - Control

Sub treatments (M):
M_1 - White mulch
M_2 - Black mulch
M_3- Silver mulch
M_4 - Jute mulch
M_5 - No mulch

eters such as plant height (34.41 cm), number of branches (7.96), plant spread (35.20 cm), leaf area index (1.71) and chlorophyll content (42.96) were recorded under black shade net. The plant height (39.80 cm), number of branches (11.70), plant spread (40.88 cm), leaf area index (2.04), chlorophyll content (47.38) of chrysanthemum plants were significantly higher with white plastic mulch followed by silver mulch. The lowest plant height (35.88 cm), number of branches (10.17), plant spread (37.74 cm), leaf area index (1.66), chlorophyll content (41.00) were recorded under no mulch condition.

Improved vegetative growth as evidenced by plant height, number of branches, leaf area index, and chlorophyll content under the different colour low tunnel shade nets may be due to the favorable weather conditions, *i.e.,* lower and optimum temperature, and light intensity in white shade net when compared with black coloured shade net (Iglesias *et al.*, 2006). The results of the present study are in agreement with Hashem *et al.,* 2011 and Soud *et al.*, 2014 who found that vegetative growth of chrysanthemum plants under white shade net was higher than under other treatments. The influence on plant height by the white plastic mulch might be due to the fact that sun radiation enters through the white plastic mulch, but very little amount of radiation goes back to the environment. This might have improved the soil temperature underneath the white mulch resulting in high growth parameters. Similar trend was also reported by Tegen *et al.,* 2016 and Kishor *et al*., 2018.

Yield Parameters

There was a significant difference among the treatments in yield parameters (Table 2). Higher flower yield per plant (0.15 kg), average flower weight (6.56 g) and flower yield per ha (8.72 t ha^{-1}) were recorded in plants grown under white colour shade net and this was followed by green shade net. Lowest flower yield per plant (0.07 kg), average flower weight (5.10 g) and flower yield per ha (4.43 t ha^{-1}) was recorded in plants under black colour shade net. The flower yield per plant (0.13 kg), average flower weight (6.25 g) and flower yield per ha (8.81 t ha^{-1}) of chrysanthemum plants grown under white plastic mulch was significantly higher followed by silver plastic mulch. Lower yield parameters such as flower yield per plant (0.08 kg), average flower weight (5.30 g) and flower yield per ha (4.59 t ha^{-1}) were noticed under no mulch conditions.

Table 2. Flower yield under different colour low tunnel shade nets and mulches

Treatments	Average flower weight (g)	Flower yield per plant (kg)	Flower yield (t ha{¹)
Shade nets (S)			
S_1	6.00	0.14	7.95
S_2	6.56	0.15	8.72
S_3	5.10	0.07	4.43
S_4	5.86	0.07	7.18
SE m±	0.04	0.003	0.03
C.D. at 5%	0.72	0.01	0.16
Mulches (M)			
M_1	6.25	0.13	8.81
M_2	5.86	0.11	6.78
M_3	6.14	0.12	7.95
M_4	5.63	0.1	6.23
M_5	5.30	0.08	4.59
SE m±	0.09	0.003	0.1
C.D. at 5%	0.28	0.007	0.29
Interaction	NS	NS	NS

Main treatments (S):
S_1 - Green shade net
S_2 - White shade net
S_3 - Black shade net
S_4 - Control

Sub treatments (M):
M_1 - White mulch
M_2 - Black mulch
M_3 - Silver mulch
M_4 - Jute mulch
M_5 - No mulch

Significantly higher flower yield parameters were observed under the white colour shade net. The environment created by colored net increased average flower weight and the number of flower per plant due to the positive effect on increasing the plant biomass by increasing the availability of solar radiation and the efficiency of photosynthesis thus promoting the growth rate of individual flowers, decreasing the growth period from anthesis to harvest and increasing the production. The result obtained in the current study was in agreement with Soud *et al.*, 2014 Hashem *et al.,* 2011 and Tafoya *et al.,* 2018. Among the different mulches, white plastic mulch resulted in better growth parameters such as plant height, the number of branches, leaf area index and chlorophyll content. This could be due to efficient utilization of resources, high moisture retention for growth of plants and optimum soil temperature which led to higher flower yield. This is in confirmation with studies conducted by Rajablariani *et al.,* 2012.

Conclusion

The results of the experiment exhibited that the growth and yield parameters were higher in chrysanthemum grown under white shade net than other colour shade nets. Growth and yield of chrysanthemum were maximum where white colour plastic mulch was used, when compared to other mulches and no mulch. The light intensity under white and green shade net and open field condition was found to be better than under black shade net. The temperature was higher in open field condition than the black shade net, green shade net and white shade net. The relative humidity in white shade net was greater than the green, black shade net and lowest under open field conditions.

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