EFFECTS OF COLOR SHADE NETS ON GROWTH, YIELD AND QUALITY OF CAPSICUM

SUMMY AKTER SUMONA

.

DEPARTMENT OF HORTICULTURE
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

JUNE, 2020

EFFECTS OF COLOR SHADE NETS ON GROWTH, YIELD AND QUALITY OF CAPSICUM

BY

SUMMY AKTER SUMONA

Reg. No. 18-09092

A Thesis
Submitted to the Department of Horticulture
Sher-e-Bangla Agricultural University, Dhaka-1207
In partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JANUARY-JUNE, 2020

Approved by:

Prof. Dr. Md. Nazrul Islam
Department of Horticulture
Sher-e-Bangla Agricultural University
Dhaka - 1207
Supervisor

Prof. Dr. A. H. M. Solaiman
Department of Horticulture
Sher-e-Bangla Agricultural University
Dhaka - 1207
Co-Supervisor

Prof. Dr. Md. Jahedur Rahman
Chairman
Examination Committee

Alhamdulillah
All praise to Almighty Allah
"my creator, my strong pillar and my source of inspiration''

Dedicated to-

My Beloved parents
"My love for you people shall live forever''

DEPARTMENT OF HORTICULTURE
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

Ref..... Date: .....

CERTIFICATE

This is to certify that the thesis entitled **"Effects of color shade nets on growth, yield and quality of capsicum"** submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE,** embodies the result of a piece of *bona fide* research work carried out by **Summy Akter Sumona,** Registration No. **18-09092**, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that such help or sources of information as has been availed of during the course of this investigation have been duly acknowledged.

Dated: June, 2020
Place: Dhaka, Bangladesh

Prof. Dr. Md. Nazrul Islam
Department of Horticulture
Sher-e-Bangla Agricultural University
Dhaka -1207
Supervisor

ACKNOWLEDGEMENTS

All praises goes to the Almighty Allah, the Supreme Ruler of the universe, who enabled the author for successful completion of this research work.

The author would like to expresses her heartiest gratitude and thanks to his research Supervisor, ***Prof. Dr. Md. Nazrul Islam****, Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka 1207, for his scholastic guidance and constant encouragement during the entire period of the research work and in the preparation of the manuscript of the thesis. The author also cordially expresses her thankfulness and best esteems to respected Co-Supervisor* ***Prof. Dr. A. H. M. Solaiman,*** *Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka 1207, for his encouragement, prized advice, valuable suggestion, constructive criticisms, special help and co-operation during the occupancy of this research work, as well as preparing of this thesis and providing all the necessary facilities during entire period of this study.*

The author expresses her gratitude and indebtedness to all the honorable course teachers of the Dept. of Horticulture, Sher-e-Bangla Agricultural University, for their sympathetic help and co-operation in various stages towards completion of this research work.

Finally, the author is deeply grateful to her beloved parents, brothers, friends and other well-wishers specially S. M. Anamul Arefin, Suchona, Sharika Hydar, Rasel and Osman Goni for their constant inspiration and moral support which can never be forgotten.

The Author

EFFECTS OF COLOR SHADE NETS ON GROWTH, YIELD AND QUALITY OF CAPSICUM

BY

SUMMY AKTER SUMONA

ABSTRACT

An experiment was conducted in the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from October 2019 to April 2020, to find out the effects of color shade nets on growth, yield and quality of capsicum. The experiment consisted with two factors. Factor A: Three types of color shade nets such as C_N - White color shade net (control), G_N - Green color shade net (25%) and B_N - Black color shade net (40%). Factor B: Three varieties such as R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder and Y - BARI Mistimorich 2. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Results revealed that in terms of yield and yield contributing parameters, G_NR gave the highest yield plant^{-1} (318 g) and fruit yield (34.52 t/ha) where the lowest yield plant^{-1} (121 g) and fruit yield (13.13 t/ha) was recorded from the treatment B_NG. In terms of quality parameters, the highest (10.23%) total soluble solids (TSS) was obtained from C_NR and the lowest (3.80 %) total soluble solids (TSS) was obtained from B_NG. The highest vitamin C content (164.50 mg$\cdot$ 100g^{-1}) was obtained from C_NG where the lowest (146.63 mg$\cdot$100g^{-1}) was obtained from B_NY. The highest antioxidant activity (81.16%) and anthocyanin concentration (10.47 mg/100gFw) was obtained G_NR whereas the lowest antioxidant activity (71.75 %) and anthocyanin concentration (4.23 mg/100gFw) was obtained from B_NG. From economic point of view the highest BCR (4.25) was obtained from G_NR and lowest BCR (1.04) was obtained from B_NG. Green shade net (G_N) with F1 Hybrid Sweet Pepper (R) gave the best performance among all the treatment combinations.

LIST OF CONTENTS

LIST OF CONTENTS (CONT'D)

LIST OF CONTENTS (CONT'D)

LIST OF CONTENTS (CONT'D)

LIST OF CONTENTS (CONT'D)

LIST OF CONTENTS (CONT'D)

LIST OF CONTENTS (CONT'D)

LIST OF CONTENTS (CONT'D)

LIST OF TABLES

LIST OF TABLES (CONT'D)

LIST OF FIGURE

LIST OF FIGURE (CONT'D)

LIST OF PLATE

LIST OF APPENDICES

LIST OF APPENDICES (CONT'D)

LIST OF ABBRIVIATIONS

Abbreviations	Elaborations
%	Percentage
^{0}C	Degree Celsius
Agril.	Agricultural
ANOVA	Analysis of variance
B	Boron
BARI	Bangladesh Agricultural Research Institute
cm	Centimeter
CV%	Percentage of Coefficient of Variation
df	Degrees of Freedom
et al.	and others *(at elli)*
g	Gram
K	Potassium
kg	Kilogram
LSD	Least Significant Difference
MP	Muriate of Potash
NS	Non-significant
ppm	Parts per Million
RCBD	Randomized Complete Block Design
RH	Relative Humidity
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources Development Institute
t/ha	Tonne Per Hectare
TSP	Triple Super Phosphate

CHAPTER I
INTRODUCTION

Sweet pepper (*Capsicum annuum,* Solanaceae) is one of the most important vegetable crops grown extensively throughout the world especially in the temperate countries. The genus *Bell pepper* contains about 20 species and now five domesticated species *Capsicum annuum, C. frutescens, C. chinense, C. baccatum, C. pubescens* are only recognized. All these species of sweet pepper have many cultivated varieties suited to different agro-climatic conditions.

In Bangladesh it is commonly known as capsicum. Sweet pepper is considered a minor vegetable crop in Bangladesh (Hasanuzzaman, 1999). The popularity of sweet pepper is increasing day by day in Bangladesh especially among the urban people because of its high nutritive value and possible diversified use in making different palatable foods. It is chosen because of its higher nutritive value and generally it contains 1.29 mg protein, 11 mg calcium, 870 I.U. vitamin A, 17.5 mg ascorbic acid, 0.6 mg thiamin, 0.03 mg riboflavin and 0.55 mg niacin per 100 g of edible fruit (Joshi and Singh, 1975). It has different colors-range from green to yellow, red, orange, purple, and black. Other sweet peppers include the red, heart-shaped; the pale green, slender and curved bull's horn which range in color from yellow to red and sweet banana pepper which is yellow and banana shaped (Teshm Tadesse Michael *et al*., 1999).

Capsicum is the most important summer crop of temperate regions but now a days effort are being made to grow sweet pepper in Bangladesh (Paul, 2009). Some advanced farmers grow capsicum sporadically to meet the demand of the periphery of Dhaka city (Saha and Salam, 2004). The optimum temperature requirement for sweet pepper growth ranged from 16-25^0 C. High night temperature is more detrimental to fruit set than day temperature (Rylski and Spigelman, 1982). Sweet pepper is very sensitive to environmental factors (Bhatt *et al*., 1992). Owing to its sensitivity, its yield is affected significantly. Sweet pepper production has some constraints which include flower

dropping, poor fruit set, and susceptibility to viral diseases and it is a serious concern for the successful introduction of this crop. However, photo-selective shade nets may be effective to reduce dropping of sweet pepper and may increase fruit number, fruit size and fruit weight.

The application of photo-selective netting technology is gaining popularity around the world. This practice is already popular in Europe, especially in Israel (Fallik *et al*., 2009; Kong *et al*., 2013) and other Mediterranean countries (Diaz-Perez, 2014) as well as in South Africa (Mashabela *et al*., 2015; Selahle *et al*., 2015). Photo-selective shade-nets provide physical protection against hail, wind, bird and insect-transmitted virus diseases (Shahak, 2008). Reducing the transmitted solar radiation under shading reduces the canopy and air temperatures as well as the transpiration rate in the greenhouses. This consequently reduces the water consumption by about 50%, increases the water use efficiency and enhances the crop productivity up to 40% (Ahemd. *et al*., 2016). Regardless of the stress level, light quality changes could potentially alter the crop's physiological and biochemical processes, metabolite profiles and ultimately growth, development, yield and quality. Light quality and different wave lengths were reported to affect fruit colour and maturation (Alkalai-Tuvia *et al*., 2014). Ripening inhibition can be associated with less fruit susceptibility to fungal infection in the field (Goren *et al*., 2011), produce better crop yields (Ilic *et a*l., 2011) and lower the fruit susceptibility to decay during post-harvest storage (Shahak, 2014; Selahle *et al*., 2015).

Considering the above mentioned facts, the present investigation was undertaken with the following objectives-

i. To evaluate the effects of different color shade nets on plant growth and yield of capsicum.
ii. To investigate the effects of different color shade nets on quality of capsicum.

CHAPTER II
REVIEW OF LITERATURE

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. Research on light in horticultural systems is necessary for a sustainable and market-oriented greenhouse production in the future. This technology has the ability to extend the shelf life of produce, thereby lowering postharvest losses. Overall, photo-selective netting has proven to be a cost effective approach for manipulating crop microclimate properties in order to regulate not only yield, but also the retail eating quality as well as functional or bioactive properties of vegetables that are associated with human health and wellbeing.

Some of the research findings relevant to the growth and yield of capsicum as influenced by different color shade nets and verities have been reviewed here.

Ilic *et al.* (2017) conducted an experiment with sweet pepper (*Capsicum annuum* L.) under four different coloured shade-nets (pearl, red, blue and black) with 40% relative shading. The aim of the study was to determine how different environmental control technologies, coloured shade-nets as net house or plastic-house integrated with coloured shade-nets, could influence plant parameters, production and quality traits in pepper fruits. The highest concentration of total soluble solids (TSS) was detected in pepper fruits grown under the open field conditions (8.03%). Pepper fruits grown in plastic tunnels had significantly lower TSS content (6.58%). The highest concentration of vitamin C was detected in peppers grown in plastic tunnels integrated with red coloured nets (175.77 mg 100 g^{-1}). These results show that red and pearl photoselective nets create optimal growing conditions and increase the total fruit yield as well as the number of fruits with fewer physiological disorders and with thicker pericarp.

Ledone *et al*. (2017) conducted an experiment Sweet pepper (*Capsicum annuum* L.) cultivated under plastic tunnel by unheated technology. Sweet pepper plants can suffer from high temperature and radiation during the summer season. However, photoselective-shading nets can provide a new tool for radiation quality manipulation and support the plant development and fruit quality. The effect of shading of coloured nets depends on solar radiation conditions and on other environmental factors. A sweet pepper variety was grown in South-East Hungary under plastic tunnels using different coloured nets, such as white, yellow, green and red nets during summer 2013. Results of the trial have proved that green coloured net usually decreased the yield, while yellow and red nets can increase the yield and the fruit quality. Growers have to consider the shading intensity of the net, which should not be higher than 35-40%.

Ambrozy *et a*l. (2016) examined in 'Karpex' red colored sweet pepper hybrid (*Capsicum annuum L.*) using photo-selective shading nets were CN red from Israel, and yellow, red, green, and white from Hungary, all with 40% shade factor. We found a significantly higher yield under the yellow and red net compared with the unshaded control. The yield was more than 50% higher under the yellow net (33.6 t ha^{-1}), than in the control plot (15.5 t ha-1; F5, 12=10.761, $p<0.001$). All shading nets had a significantly positive effect against sunburn at the first harvest (F5, 12=12.403, $p<0.001$), except for the white shading net. In addition, no sunscald fruit were observed under CN red net and green net, compared to 4 $t.ha^{-1}$ losses due to sunburn in the control plot. No sunscald pepper fruit were detected at the second harvest. In contrast, the ratio of red and yellow pigments was higher at the first harvest. Hence, the earlier harvest is recommended in order to produce pepper fruits with attractive red color. Significantly higher yield was found under yellow and red net compared with the control. The lowest yield was found in the control (15.5 t ha^{-1}), it was more than 50% lower than under yellow net (33.6 t ha^{-1}). In conclusion, the use of net shading technology resulted in increased yield, reduced sunscald, and can be tailored to improve fruit color.

Selahle *et al*. (2015) investigated in this study Postharvest responses of red ('HTSP-3') and yellow ('Celaya') sweet pepper fruit yield, quality parameters and bioactive compounds (to three types of photo-selective nets and a standard black net). Red and

yellow peppers produced under the black net retained higher b-carotene(9.39 µg g FW^{-1}) than yellow (6.64 µg g FW^{-1}) ,pearl (5.28 µg g FW^{-1}), red (6.60 µg g FW^{-1}) and lower total phenolic contents (7.57 mg GAE 100 g FW^{-1})) compared to yellow (9.79 mg GAE 100 g FW^{-1}), pearl (11.12 mg GAE 100 g FW^{-1}), red (10.06 mg GAE 100 g FW^{-1}) and showed deep red and orange colour after storage. Both peppers produced under the pearl net retained a higher ascorbic content (22.88 mg 100 g FW^{-1}) than yellow (18.69 mg 100 g FW^{1}) , black (17.08 mg 100 g FW^{-1}) , red (20.27 mg 100 g FW^{-1}) and antioxidant scavenging activity (.389 mg GAE g^{-1} FW) than yellow (.165 mg GAE g^{-1} FW), black (.144 mg GAE g^{-1} FW) , red (.162 mg GAE g^{-1} FW) and also reduced weight loss after storage. Red and yellow peppers grown under pearl and yellow nets resulted in a higher percentage of marketable fruit, after storage. Red pepper grown under the yellow net showed a higher number of odour active aroma compounds in the fruit, while black nets significantly affected the synthesis of odour active aroma compounds during storage. Sensory analysis indicated a preference for red pepper fruits after storage from plants grown under pearl nets.

An experiment was executed by Mashabela *et al.* (2015) in this study, influence of 3 types of photo-selective nets (pearl, red and yellow) and a standard black net on marketable yield, fruit quality and bioactive compounds after postharvest storage was investigated. Percentage marketable fruits were higher in green sweet peppers produced under the pearl nets. Fruits produced under the pearl nets showed higher fruit mass (195.8 g), firmness (5.87 kg), chlorophyll content (290 µg/g FW) , ascorbic acid content (24.67 mg/100g FW), antioxidant scavenging activity (1.20 mg/ GAE 100g FW) after postharvest storage. Red/far red photon ratio under the pearl net could have improved the ascorbic acid content and the antioxidant scavenging activity in green peppers. Green sweet peppers grown under the pearl nets had higher hue values (128.46 h^{0}) and maintained green color longer. Our results showed the impact of modified light quality on the bioactive compounds of green sweet pepper during postharvest storage.

The antioxidant activity in tomato and pepper fruit increases during postharvest storage, and is due to coloured net cultivation. This activity is related to metabolic pathways

involved during ripening and the production of lipophilic antioxidants (carotenoids, lycopene and phenolic compounds). Light conditions during production, and genotype differences have been shown to affect the fruit antioxidant activity during postharvest storage. Significantly higher antioxidant scavenging activity was obtained during postharvest storage in tomatoes cvs 'AlfaV' and 'Irit' grown under black and pearl shade nets. Another cultivar 'SCX 248′ produced higher antioxidant activity when grown under red shade nets (Selahle et al., 2014).

Perez, D.C.J. (2014) conducted an experiment in 2009 and 2010 (with cvs. Camelot, Lafayette, Sirius, and Stiletto). Bell pepper plants were grown under shade levels of 0% (unshaded, as a control), 30%, 47%, 63%, and 80%. In 2009 and 2010 sweet pepper yields and fruit weight were lower in 2009 than in 2010 ($P < 0.01$). Total number of fruit was highest for 'Stiletto' (362,000 fruit/ha) and total numbers in remaining cultivars were similar (mean = 290,000 fruit/ ha). Marketable yield was highest in 'Camelot' (18 t. ha^{-1}) and 'Stiletto' (17.9 t. ha^{-1}) in 2009 and 'Camelot' (22.5 t. ha^{-1}) and 'Lafayette' (19.8 t. ha^{-1}) in 2010. Total fruit weight was similar among cultivars in 2009; it was highest in 'Lafayette' (42.4 t. ha^{-1}) and lowest in 'Sirius' (29.9 t. ha^{-1}) in 2010. Individual fruit weight was lowest in 'Stiletto' in both years. In both 2009 and 2010, shading resulted in improved yield and quality of ripe bell pepper fruit. Number of fruit with different marketable fruit grades varied in response to shade level.

Milenkovic *et al.* (2012) conducted an experiment with photoselective netting concept was tested in greenhouse pepper (*Capsicum annuum* 'Chameleon') production under high solar radiation 942 W•m-2 (value of photosynthetic photon flux density -PPFD is about 1600 μmol•m-2•s-1) in the south part of Serbia (Aleksinac). Four different coloured shade-nets (pearl, red, blue and black) with different relative shading (40% and 50% PAR) were mounted over the plastic-house and applied at the start of warm weather in the middle of June. Shading of pepper plants affected both fruit yield and quality. Total and marketable yield increased with 40% shading level and then decreased (with 50% shade). Shading of pepper (40%) may be an option to reduce heat stress conditions and

extend the spring-summer season toward September. Although light is not essential for the synthesis of vitamin C in plants, the amount and intensity of light during the growing season influence the amount of vitamin C formed. Significantly higher vitamin C content was observed in greenhouse pepper integrated with red shade netting technologies (188.4 $mg \bullet 100g^{-1}$) than in greenhouse pepper without colour nets (151.4 $mg \bullet 100g^{-1}$). The results of the present study should provide useful preliminary data for detecting differences among environment variation in quality and light-dispersive colour shade nets, as a new multi-benefit tool for crop protection.

In another experiment Lopez-Marin *et al.* (2012) conducted to avoid the problem of too high temperature and high radiation during late spring and summer period, growers reduce the incident radiation with several methods, like with the use of shading screens and whitening. To determine the effects of shade, simultaneous comparisons were carried out among greenhouses that were either not shaded (control treatment) or shaded with reflective aluminized shade cloth positioned below the roof, which attenuated 40 (T40) or 60% (T60) of direct sunlight. Leaf CO2 assimilation rate, relative (SPAD) and absolute chlorophyll content, transpiration rate, stomatal conductance, internal CO2 concentration and water use efficiency were measured. Plants cultivated under 40 and 60% of shading significantly decreased the net CO2 assimilation rate, stomatal conductance, and transpiration. Sweet pepper plants cultivated under 60% of shading had higher contents of chlorophyll *a*, *b*. Under 40% of shading, plants yielded 1.26 $kg \cdot m^2$ more than under control. However, the yields of T60 and control treatment were similar (8.9 $kg \cdot m^2$). The use of shading decreased the unmarketable yield.

Ilic *et al.* (2012) investigated the photoselective netting concept was studied in a tomato 'Vedeta' cultivation in the south part of Serbia (Aleksinac) under high solar radiation, using four different colored shade-nets (pearl, red, blue and black) with different relative shading (40% and 50% PAR). Exposure to full sunlight was used as a control. Red and pearl nets with 40% shade significantly increased the total yield. Shading reduced the appearance of tomato cracking and eliminated sunscalds on tomato fruits and accordingly, increased the marketable tomato production by about 35% compared to non-

shading conditions. Changing the light intensity by color shade nets affected the biosynthesis of lycopene and β-carotene in tomatoes. Thus, significantly higher lycopene content was observed in greenhouse tomato integrated with red shade netting technologies (64.9 µg g^{-1}) than in field-grown tomatoes (48.1 µg g^{-1}). By contrast, shaded fruits have lower content of β-carotene. The photo-selective, light-dispersive shade nets appear as interesting tools that can be further implemented within protected cultivation practices.

Ilic *et al*. (2011) investigated the influence of different colored shade nets (photoselective) on the plant development, yield and quality of bell pepper (*Capsicum annuum* L.). Pepper was grown under four different colored shade-nets (pearl, red, blue and black) with different relative shading (40% and 50%). Exposure to full sunlight was used as a control. Used color-shade nets improved productivity by moderating climatic extremes. Depending on the year, the total fruit yields (t/ha) under the colored shade nets were higher by 113 to 131%, relative to the open field. In this investigation the potential use of pearl and red colored shade nets (40% by FAR) was demonstrated.

In an another experiment Goren *et al*. (2011) evaluated the influence of photoselective coloured shade nets on the quality of fresh harvested pepper fruits (*Capsicum annuum*) after prolonged storage and shelf life simulation. Pepper cultivar 'Romans' grown in a semi-arid region under 35% pearl and yellow shade nets significantly maintained better pepper fruit quality after 16 days at 7°C plus three days at 20°C during two consecutive years (2008 and 2009), compared to commercial black and red nets. No significant differences were observed in percentage of weight loss, firmness and total soluble solids in fruit harvested under the different coloured shade nets. However, TSS was similar in the two years. In 2008, fruits lost less weight under the red net (2.9%), while under the yellow net weight loss was higher (3.5%). In 2009, percentage of weight loss under the four shade nets was similar (between 3.4 to 3.6%). Immediately after harvest, fruits picked from the pearl net treatment were significantly lighter in their red colour index (2.33) than fruit picked from the commercial black or red shades (2.60 and 2.64, respectively). No significant differences were observed in fruit colour index between the

yellow and pearl treatments. After 16 days at 7°C plus three additional days at 20°C, all fruits turned almost dark red, however fruits picked under the red shade were significantly darker (3.86) than fruits picked under yellow and pearl shades (3.76 and 3.75, respectively)

Fallik *et al*. (2009) conducted an experiment with sweet pepper grown under various colored (photo-selective) shade nets (ChromatiNets™) were found to improve their fruit yield and fruit quality. In the study described here, we have found that pepper grown in an arid region under red and yellow shade nets, had a significant higher yield compared with black nets of the same shading factors, without reducing fruit size. In addition, the export-quality fruit yield was also significantly increased under the red and yellow shade nets. Our results from 2007 further showed that the photo-selective nets, especially the yellow shade net, maintained better the pepper fruit quality, as was evaluated by several quality parameters. Most prominently, it lowered the decay incidence at the end of storability and shelf-life simulation. The results suggest the advantage of growing pepper under light-dispersive photo-selective shade nets, rather than the traditional black nets, for improving productivity, quality and probably also, shelf-life. The latter requires further verification. The whole-season cumulative yield, under the red or yellow shade nets, was significantly increased by an average of 18–20% (Ton/ha) in cv. Romans and 11–40% in cv. Vergasa, relative to the black nets. Export-quality yield was also significantly increased under the red and yellow shade nets, by 17% to 44% in cv. Romans and cv. Vergasa, respectively. The average fruit weight under the photo-selective nets in both cultivars Romans (168 g for red net and 164 g for yellow net) Vergasa (169 g for red net and 171 g for yellow net) was larger, compared to the average fruit weight grown under the two black nets Romans (161 g for 35% and 30% black net) Vergasa (162 g for 35% black net and 151 g for 30% black net).

In another experiment Shahak (2008) conducted with sweet peppers were commercially grown so far at Besor area in Israel under black shade nets of 30-40% shading and compared the traditional black shade nets with red, yellow and pearl nets for their effect on productivity and quality. The results showed a significant increase in productivity

under the photo-selective shading. The number of fruit produced per plant througho9ut the growing season was 30-40% higher, and the yield 20-30% higher under these photoselective nets, in all tested cultivars, while fruit size was comparable with the black shade net control. The average fruit yield was higher in pearl and red net than the black net. Average fruit yield in pearl net for Caliber (123ton/ha), Anna (134.5ton/ha), Triple star (118.3ton/ha) and for red net Caliber (127.6 ton/ha), Anna (136.1 ton/ha), Triple (128.3 ton/ha) and for black net Caliber (99.6 ton/ha), Anna (116.2 ton/ha), Triple star (97 ton/ha).

CHAPTER III
MATERIALS AND METHODS

The field experiment was conducted during October 2019 to April 2020 to study the response of capsicum on different color shade nets. This chapter includes a brief description of the location of experimental site, soil and climate condition, materials used for the experiment, design of the experiment, intercultural operations, data collection procedure and procedure of data analysis that were used for conducting the experiment.

3.1 Description of experimental site

3.1.1 Experimental site:

The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka 1207. The location of the experimental site is situated in $23^{0}74^{/}$ N latitude and $90^{0}35^{/}$ E longitude (Anon., 1989). The experimental field belongs to the Agro–ecological zone of AEZ–28 under Modhupur Tract.

3.1.2 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, SRDI Farmgate, Dhaka. Details descriptions of the characteristics of soil are presented in Appendix I.

3.1.3 Climatic condition of the experimental site

The experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon or hot season from March to April and the monsoon period from May to October (Edris *et al*., 1979). Details of the meteorological data during the period of the experiment

were collected from the Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix II.

3.2 Details of experiment

3.2.1 Planting materials

The seeds of variety BARI Misti morich-2 was collected from Bangladesh Agricultural Research Institute (BARI), Joydepur, Gajipur and F_1 Hybrid Sweet pepper (Lalima), Peperone Yolo wonder were collected from Siddik Bazar, Gulistan, Dhaka.

3.2.2 Earthen pot preparation for seed germination

Earthen pot was prepared on 1 October 2019 for seed germination. The pot media comprised of soil, vermicompost and cocodust. After filling the pot, the surface of the media was leveled with stick. Three earthen pots were used for germination of seedling for three varieties of capsicum.

3.2.3 Seed sowing

The seeds were soaked in water for 24 hours and then wrapped with piece of thin cloth. The socked seed were then spread over polythene sheet for 2 hours to dry out the surface water. Seeds were sown on 10 October, 2019 in the earthen pot. Before sowing seeds were treated by Vitavex-200 @ 5g/1kg seeds to protect some seed borne diseases such as leaf spot, blight, anthracnose etc. Seeds of each variety were mixed with a little amount of pot media and broadcasted on pot for uniform distribution. Seeds were sown at depth of 2 cm and covered with a fine layer of soil followed by light watering by watering cane. These earthen pots were covered with polythene tunnel to avoid direct sunlight and stormy winds.

3.2.4 Raising of seedlings

Light watering and weeding were done several times as per needed. No chemical fertilizers were applied for raising of seedlings. Seedlings were not attacked by any kind of insect or disease. Seedlings of 2-3 leaf stage were transplanted to poly bags. Thirty days old seedlings (4-5 true leaf stage) were transplanted into grow bag under the different color shade nets on 10 November 2019 (plate 1).

3.2.5 Treatments:

The experiment comprised of two factors.

Factor A: Color shade nets

C_N - White color shade net (control)

G_N - Green color shade net (25% shading)

B_N - Black color shade net (40% shading)

Factor B: Variety

R - F1 Hybrid Sweet Pepper (Lalima)

G - Peperone Yolo Wonder

Y - BARI Mistimorich 2

Treatment combination: C_NR, C_NG, C_NY, G_NR, G_NG, G_NY, B_NR, B_NG, B_NY.

3.2.6 Design and layout of the experiment

The experiment was carried out in Randomized Complete Block (RCBD) design with three replications which comprise in 81 grow bag. A single plant was grown in a grow bag. The size of each grow bag was 25cm (10 inches) in diameter and 25cm (10 inches) in height. The layout of the experiment is presented in the below (plate 1)

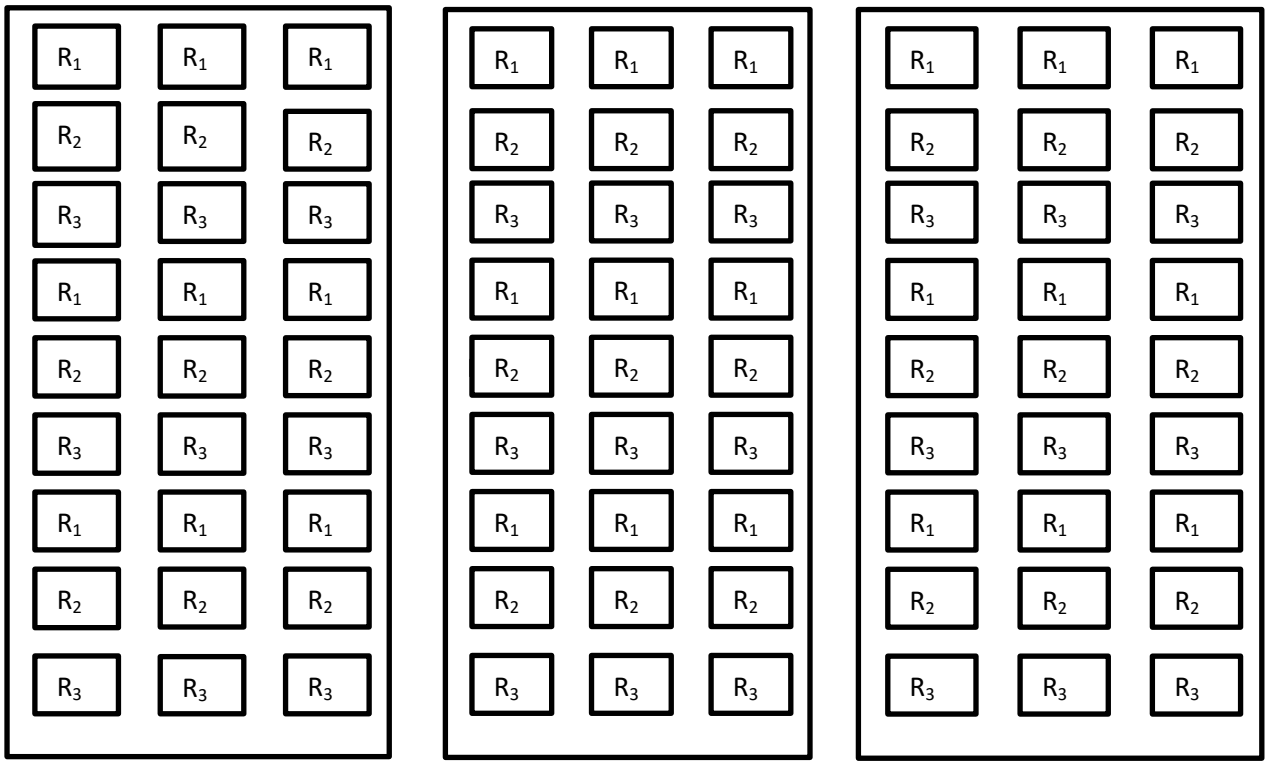


Plate 1. Layout of the experiment

3.2.7 Preparation of shade house

The sweet pepper (*Capsicum annuum* L.) was grown during 2019–2020 in a tunnels (1.8 m high, 3m length, 1.5m wide) covered with white net (control) and two photo-selective shade nets green (25% shading) and black (40% shading) were shown in plate 2. The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University (SAU) Sher-e-Bangla Nagar, Dhaka, Bangladesh ($23^0$74' N latitude and $90^0$35' E longitudes with an elevation of 8 meter). Grow bags with sweet pepper plants were transferred in shade houses and plants were put under each shade house.

Plate 2. Different color shade nets

3.2.8 Grow bag preparation:

Grow bag were filled up 7 days before planting was shown in plate 3. Pulverized soil: vermin compost: coco dust: mushroom compost (20:50:20:10) used as growing media. Weeds and stubbles were completely eliminated and the soil was treated with lime and fungicide to keep the media free from pathogen.

3.2.9 Fertilizer application

The fertilizers N, P, K, S and Zn in the form of urea, TSP, MOP, Gypsum and Zinc oxide, respectively were applied as BARI recommended dose (Foshol shomuho, Page-149).

3.3 Growing of the crops

3.3.1 Transplanting of seedlings

Healthy and uniform capsicum seedlings of 30 days old seedlings with 4-5 leaves were transplanting in grow bags on 10 November, 2019 (plate 3). The seedlings were uploaded carefully from the seed bed to avoid damage to the root system. To minimize the damage to the roots of seedlings, the seed beds were watered on hour before uprooting the seedlings. Transplanting was done in the afternoon. Sweet pepper seedlings were transplanted in the bag carefully, so that root and shoot crown were not injured during transplanting. The seedlings were watered immediately after transplanting.

3.3.2 Intercultural operations

After raising seedlings, various intercultural operations, such as gap filling, weeding, earthing up, irrigation pest and disease control etc. were accomplished for better growth and development of the capsicum seedlings.

3.3.3 Irrigation

Light watering was given by a watering cane at every morning and afternoon. Following transplanting and it was continued for a week for rapid and well establishment of the transplanted seedlings.

3.3.4 Gap filling

The transplanted seedlings were kept under careful observation. Very few seedlings were damaged after transplanting and such seedling were replaced by new seedlings from the same stock. Those seedlings were transplanted with a big mass of soil with roots to minimize transplanting stock. Replacement was done with healthy seedling having a boll of earth. The transplants were watering for 7 days for their proper establishment.

3.3.5 Weeding

The hand weeding was done 15, 30, 45 and 60 after transplanting to keep the grow bags free from weeds.

3.3.6 Pruning

Three weeks after transplanting, the crown flower and the flower on the first node of each stem were removed, allowing plants to develop an adequate vegetative frame before fruit set. Starting four weeks after transplanting, plants are trained with "V" trellis system. In the "V" trellis system, the lateral shoot (the smaller shoot of the pair that bifurcated on a node) were pruned when they reached 3-4cm long.

3.3.7 Staking

For supporting, stacking was done after 25 days to maintain upright growing of capsicum plant.

3.3.8 Control of pest and disease

Insect attack was serious problem at the time of establishment of the seedling. Mole cricket, field cricket and cut warm attacked the young transplanted seedlings. To control the pest and disease three types of controlling measure was applied. These are:

1. **Mechanical control**: Shade nets were applied in whole field to protect the crop from caterpillars, moths, flies etc. Yellow sticky trap was used to prevent the small insect such as, aphid, mites, thrips, leaf hopper, and white fly. Yellow sticky trap (plate 3).

2. **Chemical control:** Basudin was applied for controlling the soil born insects. Cut worms were controlled both mechanically and spraying by Dursban 20 EC @ 3%. Some of the plants were attacked by aphids and were controlled by spraying Diazinon 60 EC@560 ml/ha. Few plants were infected by Alternaria leaf spot disease caused by *Alternaria brasicae.* To prevent the spread of disease Copper oxychloride (50%) was sprayed in the field at the rate of 1.35 kg per 450 liters of water.

3. **Biological control:** Pheromone trap was used to capture the moths and fruit fly (plate3). Neembecidine was used to control the leaf curl disease of capsicum caused by aphid.

3.3.9 Harvesting

Harvesting of fruits was started at 80 DAT and continued up to final harvest based on the marketable sized of fruits. Hand picking was done in the morning and picked with an upward twist which leaves the fruit stalk attached.

(a)

(b)

(c)

(d)

(e)

(f)

Plate 3. Photograph showing 3(a) Raising of seedlings; 3(b) Polybagging of seedling; 3(c) Prepared grow bags; 3(d) Transplanting of seedlings; 3(e) Used Yellow sticky traps; 3(f) Used pheromone traps

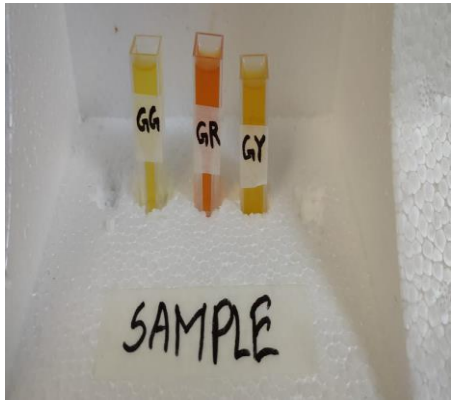
(a)

(b)

(c)

(d)

(e)



(f)

(g)

(h)

Plate 4. Photograph showing 4(a) Fruit weight determined using digital weight machine; 4(b) Color measurement; 4(c) Sample preparation for TSS measurement; 4(d) Filter with whatman filter paper; 4(e) Sample centrifuged for anthocyanin determination ; 4(f) Sample prepared for antioxidant determination; 4(g) Spectrophotometer used for antioxidant reading; 4(h) Refractometer used for TSS measurement.

3.4 Data collection

All plants were randomly selected for data collection. Data were collected in respect of the following parameters to assess environmental condition, plant growth, yield attributes and quality of capsicum fruit.

Parameters studied

A. Environmental conditions

- Temperature (^{0}C)
- Relative humidity (%)
- UV- irradiance (mW.cm^{-2})
- Solar radiation (W.m^{-2})
- Soil temperature (^{0}C)
- Soil moisture (%)

B. Vegetative characteristics

- Plant height (cm)
- Number of branches plant^{-1}
- Number of leaves plant^{-1}
- Leaf length plant^{-1}
- Leaf breadth plant^{-1}
- Canopy size plant^{-1} (cm)

C. Yield related parameters

- Days to 1st flowering
- Days to 50 % flowering
- No. of flowers plant^{-1}
- No. of fruits plant^{-1}
- Fruit length (cm)
- Fruit diameter (cm)
- Fruit weight (g)
- Yield plant^{-1} (g)
- Yield (t/ha)

D. Quality parameters

- Color measurement
- Determination of total soluble solids content (TSS)
- Vitamin C content (mg. 100 g^{-1} FW)
- Antioxidant determination (%)
- Determination of anthocyanin (mg·100 g^{-1} FW)

E. Economic analysis

- Total cost of production
- Gross return (Tk./ha)
- Net return (Tk./ ha)
- Benefit Cost Ratio (BCR)

3.4.1 Measurement of environmental condition

Temperature, humidity, light intensity, UV-light irradiation, soil temperature, soil moisture were measured daily during the experiment. All the reading was measured every day at 12:00 pm.

3.4.2 Plant height (cm)

Plant height was measured in centimeter (cm) through the measuring scale and data were taken at 25 days interval.

3.4.3 Number of branches plant^{-1}

Primary and secondary branches of plants were recorded at 25, 50, 75, and 100 DAT. Main shoots were considered as primary branches and lateral shoots were considered as secondary branches. Then mean was calculated.

3.4.4 Number of leaves plant^{-1}

Number of leaves plant^{-1} was recorded at 25 days interval on the tagged plant as per experimental treatments. Number of leaves plant^{-1} was not counted at 100 days after transplanting.

3.4.5 Leaf length plant^{-1} (cm)

Leaf length plant^{-1} was measured in centimeter (cm) through the measuring scale and data were taken at 25 days interval.

3.4.6 Leaf breadth plant^{-1} (cm)

Leaf breadth plant^{-1} was measured in centimeter (cm) through the measuring scale and data were taken at 25 days interval.

3.4.7 Canopy size plant^{-1} (cm)

Canopy size plant^{-1} was measured in centimeter (cm) through the measuring scale and data were taken at 25 days interval.

3.4.8 Days to 1st flowering

Difference between the dates of transplanting to the date of 1st flower emergence of different shade were counted and recorded.

3.4.9 Days to 50% flowering

Difference between the dates of transplanting to the date of flowering of different shade was counted as days to 50% flowering. Days to 50% flowering was recorded when 50% flowers of different shade were at the flowering stage.

3.4.10 Number of flowers plant^{-1}

Number of flowers plant^{-1} was recorded in each shed at every replication during experimental period.

3.4.11 Number of fruits plant^{-1}

Number of fruits plant^{-1} was recorded in each shed at every replication during experimental period.

3.4.12 Fruit length (cm)

The length of fruits was estimated from the neck to the base of the fruits. Mean data were calculated in centimeter (cm).

3.4.13 Fruit diameter (cm)

Diameters of fruit were measured using slide calipers in millimeter (cm).

3.4.14 Fruit weight (g)

Fruit form in tagged plants of each treatment was weighted with the help of an electric precision balance in gram.

3.4.15 Yield plant^{-1} (g)

Fruit yield plant^{-1} was recorded in gram by a multiplying individual fruit weight and number of fruits/plant by a digital weight machine.

3.4.16 Yield (t/ha)

Yield of capsicum was calculated by converting the weight of plot yield into hectare and was expressed in ton.

3.4.17 Color measurement

Color was measured with a colorimeter (iWave, WF28, China) using the CIE Lab L*, a*, b* and c*color scale (plate 4). The L* value is the lightness parameter indicating degree of lightness of the sample; it varies from 0 = black (dark) to 100 = white (light). The value a* which is the chromatic redness parameter whose value means tending to red color when positive (+a*) and green color when negative (-a*). The b* is yellowness chromatic parameter corresponding to yellow color when it is positive (b*) and blue color

when it is negative (-b*). Chroma = $\sqrt{a^{*2} + b^{*2}}$ was calculated and higher numbers of chromaticity indicate a more vivid color, whereas lower numbers correspond to dull colors. Color measurement was done just after harvesting of capsicum fruits.

3.4.18 Determination of Total soluble solids (TSS)

TSS was measured by Refractometer (Hanna Instruments, HI96801, Romania) at room temperature (plate 4). Firstly selected fruit was blended and juice extract was collected to determine TSS and expressed as percent wise.

3.4.19 Vitamin C content (mg. 100 g^{-1} FW)

Ascorbic acid was quantitatively determined according to 2, 6 dichlorophenolindophenol-dye method as described by Jones and Hughes (1983) with slight modifications. The ascorbic acid in 10 g of fresh sample was extracted by grinding with a small amount of acid-washed quartz sand and 3% meta-phosphoric acid (v/v). The extract volume was made up to 100 ml, mixed and centrifuged at 3000 g for 15 min at room temperature. Ten milli litres were titrated against standard 2, 6-dichlorophenolindophenol dye, which was already standardized against standard ascorbic acid. Results were expressed on mg.100 g^{-1} FW.

3.4.20 Antioxidant activity (%)

Methanol extracts of freeze-dried fruits were prepared for the determination of antioxidant activity. Weighed pepper fruit samples (5 g) were placed in a glass beaker and homogenized with 50 mL of methanol at 24◦C overnight. The homogenate was filtered and then centrifuged at 6000 rpm for 15 min. Free radical scavenging activity of the samples was determined using the 2,2,-diphenyl-2-picrylhydrazyl (DPPH) method (Turkmen, *et al*., 2005). An aliquot of 2 ml of 0.15 mM DPPH radical in methanol was added to a test tube with 1 ml of the sample extract. The reaction mixture was vortex mixed for 30 s and left to stand at room temperature in the dark for 20 min. The absorbance was measured at 517nm, using a visible spectrophotometer (Hanna Instruments, Iris HI801, Romania) which was shown plate 4. The antioxidant activity was

calculated using the following equation: Antioxidant activity (%) = 1 - A Sample (517 nm)/A Control (517 nm) ×100.

3.4.21 Determination of anthocyanin (mg·100 g^{-1} FW)

The pigment (anthocyanin, at 500 and 900nm) of the fruit was investigated with a visible spectrophotometer (Hanna Instruments, Iris HI801, Romania). Three equivalent aged fruits from each tunnel were collected early in the morning. Each sample was extracted with 15 ml of metahanol: HCl (99:1) and placed in a vial. Then the procedure was followed according to Tsormpatsidis *et al*. (2008) and then the results were expressed as mg $100g^{-1}$ fresh weight (FW). The absorbance measurement was done within 20-50 min of preparation (plate 4).

The anthocyanin pigment concentration expressed as cyaniding-3-glucoside equivalent, as follows:

Anthocyanin pigment (cyaniding-3-glucoside equivalents, mg·100 g^{-1} FW)

$$= \frac{A \times MW \times DF \times 1000}{\varepsilon \times 1}$$

Where, A = (A500nm- A900nm) pH 1.0 – (A500nm – A900nm) pH 4.5; MW (molecular weight) = 449.2 g.mol-1for cyaniding-3-glucoside; DF = dilution factor; 1 = path length in cm; e = 26, 900 molar extinction coefficient, in L × mol 1× cm-1, for cyaniding-3-glucoside and 1000 = factor for conversion from g to mg.

3.4.22 Economic analysis

The cost of production was calculated to find out the most economic combination of variety and different color shade nets. All input cost like the cost for land lease and interests on running capital were computing in the calculation. The interests were calculated at the rate of 13% in simple rate. The market price of capsicum was considered for estimating the return. Analyses were done according to the procedure of Alam *et al*. (1989).

The benefit cost ratio (BCR) was calculated as follows: The benefit cost ratio (BCR) was calculated by the following formula.

$$\text{Benefit Cost Ratio} = \frac{\text{Gross Return (Tk/ha)}}{\text{Total Cost of Production}}$$

3.4.23 Statistical analysis

Collected data were tabulated and analyzed in accordance with the objectives of the study using statistix 10 computer package programme and difference between treatments was assessed by Least Significant Difference (LSD) test at 5% level of significance.

CHAPTER IV
RESULTS AND DISCUSSION

The experiment was carried out to find out the effect of different color shade nets and varieties on the growth, yield and quality of capsicum. Data on growth, yield and quality were recorded. A summary of the analysis of variance (ANOVA) of the data on different characters have been presented in Appendix IV-XII. The results have been presented and discussed and the interpretations are given under the following headings:

4.1 Environmental condition

Monthly meteorological data from December 2019 to March 2020 was shown (Table 1, 2 and appendix III, IV) for temperature, relative humidity, solar radiation and UV-irradiance. Temperature, relative humidity, solar radiation and UV-irradiance varied significantly under different treatments.

Throughout the duration of the investigation, the maximum temperature (12:00 pm, midday) did not exceed 30.19 °C which was found in treatment during the month March. Throughout the duration of the investigation, the minimum (16.77^0C) temperature was found in the treatment B_N during the month January. Shading technology on a number of locations in Israel confirmed a general decrease of maximum daily temperature (Tmax) by 1–5°C, followed by an increase in maximum daily relative air humidity by approximately 3–10%. Shahak (2008) reported that the maximum daily temperature under shade-nets (30%) was up to 3°C lower than the control, similar to what Iglesias and Alegre (2006) have stated, and that larger differences are recorded during bright and sunny days.

The relative humidity (RH %) was highest (81.12%) in the treatment B_N during the month January. The relative humidity was lowest 56.73% in the treatment C_N during the month March.

Solar radiation was highest in treatment combination C_NR i.e. 948.33 ($W.m^{-2}$) during the month March. However, lowest solar radiation was found in treatment B_NY and the result was 411.17 ($W.m^{-2}$)**.** In addition to solar radiation (Shahak, 2008; 2014), shade-nets may modify environmental variables such as temperatures, wind speed, or relative humidity inside the canopy (Arthurs *et al*., 2013).

On the other hand, UV radiation significantly decreased continuously as the shading nets decreased. UV radiation was highest (585.00 $mW.cm^{-2}$) found in the treatment C_NG during the month March and the lowest (16.00 $mW.cm^{-2}$) was found in the treatment B_NG during the month January.

The maximum soil temperature (25.79^0C) was found in treatment C_NY whereas minimum (16.85^0C) soil temperature was found in treatment B_NG (Table 2 and appendix V). The highest (33.45%) soil moisture was found in treatment B_NG which was statistically similar to treatment combination B_NR (32.78%) and B_NY (32.55%). The minimum (14.00%) soil moisture was found in treatment C_NR.

Table 1. Mean values of recorded (at 12:00 pm) temperature (^{0}C) and RH (%) during the period of experiment

Treatment combinations	Temperature (^{0}c)				Relative humidity (%)			
	Dec	**Jan**	**Feb**	**Mar**	**Dec**	**Jan**	**Feb**	**Mar**
C_N	23.59 a	18.26 a	24.88 a	30.19 a	73.63 c	78.07 c	62.40 c	56.73 c
G_N	22.48 b	17.79 b	23.04 b	27.16 b	75.14 b	79.13 b	64.12 b	58.69 b
B_N	19.40 c	16.77 c	21.24 c	25.34 c	77.63 a	81.12 a	66.42 a	60.56 a
CV%	3.88	1.71	3.51	2.73	0.86	0.74	1.07	1.14
$LSD_{(0.05)}$	0.83	0.29	0.79	0.74	0.63	0.57	0.67	0.66

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

[C_N - White net (control), G_N - Green net, B_N - Black net]

Table 2. Mean values of recorded (at 12:00 pm) UV-reading (mW.cm^{-2}), solar radiation (W.m^{-2}), soil temperature (^{0}C) and soil moisture (%) during the period of experiment

Treatment combinations	UV-irradiance (mW.cm^{-2})				Solar radiation (W.m^{-2})				Soil temperature (^{0}C)	Soil moisture (%)
	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar		
C_NR	327.00 c	250.00 c	489.33 c	538.67 c	828.00 a	789.17 a	867.50 a	948.33 a	24.14 ab	14.00 e
C_NG	352.67 a	284.67 a	517.67 a	585.00 a	824.33 b	787.08 b	863.17 b	945.17 b	21.58 bc	17.78 d
C_NY	331.00 b	272.67 b	505.00 b	567.33 b	821.50 c	783.17 c	861.33 c	942.50 c	25.79 a	21.22 c
G_NR	120.33 f	85.33 e	125.00 f	169.00 f	591.17 d	514.33 d	615.50 c	633.00 d	19.14 cde	22.77 c
G_NG	130.00 d	108.67 d	157.67 d	212.67 d	587.17 e	511.83 e	613.17 d	629.50 e	18.43 de	27.67 b
G_NY	126.00 e	87.00 e	135.33 e	187.00 e	584.50 f	510.17e	611.67 d	626.33 f	19.87 cd	28.33 b
B_NR	29.67 i	16.00 h	38.33 i	66.33 i	434.50 g	417.50 f	457.17 e	480.00 g	17.48 de	32.78 a
B_NG	35.67 g	25.00 f	54.67 g	74.33 g	432.17 h	413.83 g	454.83 f	478.50 g	16.85 e	33.45 a
B_NY	33.00 h	21.00 g	47.67 h	70.33 h	428.83 i	411.17 h	450.83 g	471.50 h	18.00 de	32.55 a
CV%	0.88	1.34	1.50	0.82	0.18	0.17	0.18	0.19	7.60	6.47
$LSD_{(0.05)}$	2.52	2.96	5.98	3.91	1.96	1.70	2.04	2.27	2.65	2.87

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability. [C_N - White net (control), G_N - Green net, B_N - Black net, R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.2 Plant height

4.2.1 Effect of color shade net on plant height

Significant variation on plant height at different growth stages was recorded influenced by different color of shade nets (Fig. 1). Results revealed that the highest plant height (32.36, 48.83, 64.78 and 73.89 cm at 25, 50, 75, and 100 DAT, respectively) was recorded from the treatment G_N (Green net). The lowest plant height (22.83, 36.72, 49.06 and 52.50 cm 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment B_N (Black net). According to Appling (2012), red and yellow nets have been found to specifically stimulate the plant height compared to black net. In another experiment, the increase in plant height of shaded plants was a result of both internode elongation and node number (Rylski *et al*.1986).

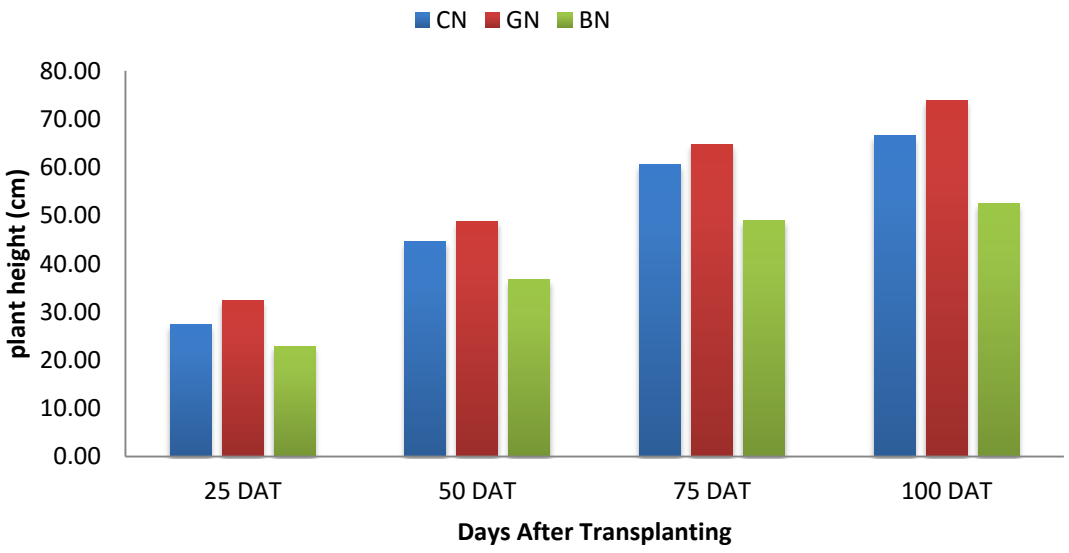


Figure 1. Plant height of capsicum as influenced by different color shade nets at different days after transplanting.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.2.2 Effect of varieties on plant height

Significant variation was recorded on plant height at different growth stages influenced by different varieties (Fig. 2). Results showed that the highest plant height (29.50, 45.28, 59.67 and 65.50 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment R (Lalima) which was significantly different from all other treatments at all growth stages where the lowest plant height (25.67, 41.78, 56.44 and 63.11 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment G (Peperone Yolo Wonder). Different varieties produced different plant height on the basis of their varietal characters and crop variety is one of the important factors. Hasanuzzaman *et al*. (2007) reported that Genotype CP0039 produced the longest plant of 24.23 cm.

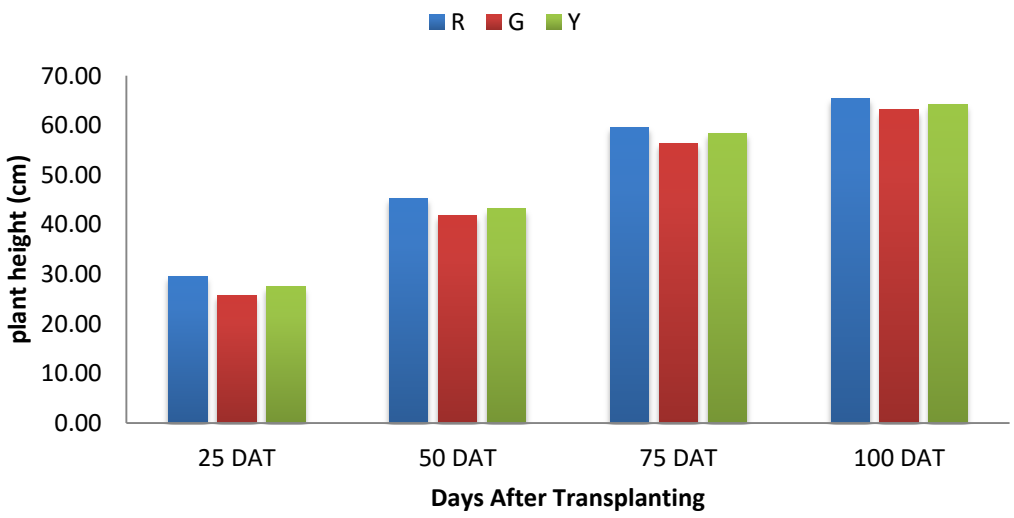


Figure 2. Plant height of capsicum as influenced by different varieties at different days after transplanting.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.2.3 Combined effect of shade nets and varieties on plant height

Plant height was significantly varied due to combined effect of shade nets and varieties at different growth stages (Table 3 and appendix VI). Results indicated that the highest plant height (34.67, 51.50, 66.00 and 75.17 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment combination of G_NR .The lowest plant height (20.50, 35.33, 47.83 and 51.17 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment combination of B_NG which was statistically identical with the treatment combination of B_NY at 50 and 75 DAT.

Table 3. Effect of different color shade nets in combination with varieties on plant height of capsicum

Treatment combinations	Plant height (cm) at different days after transplanting (DAT)			
	25 DAT	**50 DAT**	**75 DAT**	**100 DAT**
C_NR	29.33 d	45.83 c	62.50 cd	67.50 c
C_NG	26.00 e	43.50 e	58.00 e	65.50 d
C_NY	26.92 e	44.67 d	61.50 d	66.50 cd
G_NR	34.67 a	51.50 a	66.00 a	75.17 a
G_NG	30.50 c	46.50 c	63.50 c	72.67 b
G_NY	31.92 b	48.50 b	64.83 b	73.83 b
B_NR	24.50 f	38.50 f	50.50 f	53.83 e
B_NG	20.50 g	35.33 g	47.83 g	51.17 g
B_NY	23.50 f	36.33 g	48.83 g	52.50 f
CV%	2.35	1.45	1.11	1.19
$LSD_{(0.05)}$	1.12	1.09	1.11	1.32

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.3 Number of branches plant^{-1}

4.3.1 Effect of shade net on number of branches plant^{-1}

Number of branches plant^{-1} was significantly influenced by different color shade nets at different growth stages (Fig. 3).The highest number of branches plant^{-1} (4.67, 5.67,6.78 and 8.11 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment G_N (Green net) . The lowest number of branches plant^{-1} (1, 2.11, 3.33 and 4.56 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment B_N (Black net). Nissim-Levi et al. (2008) reported that the number of branches per plant increased under the different shading net compared to black shade.

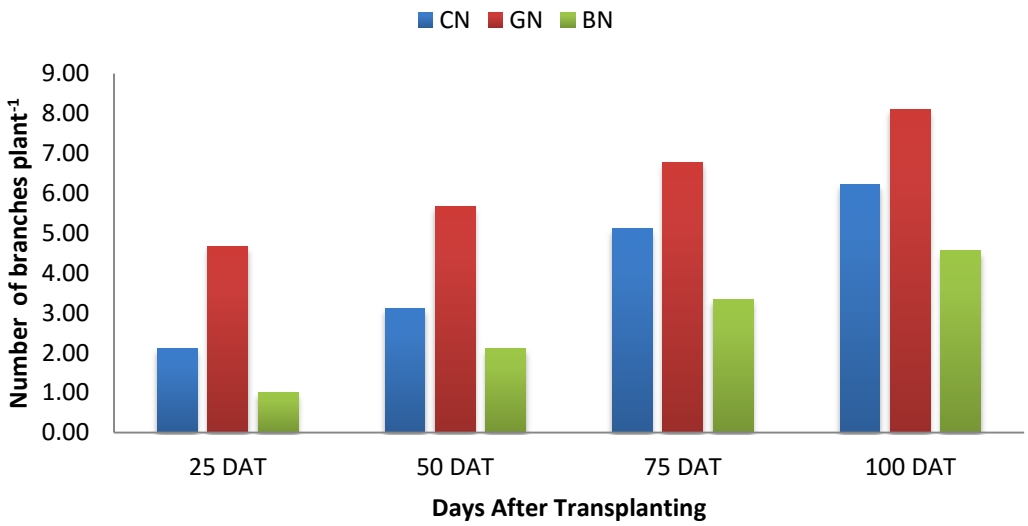


Figure 3. Number of branches plant^{-1} of capsicum as influenced by different color shade nets at different days after transplanting.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.3.2 Effect of varieties on number of branches plant^{-1}

Remarkable variation was found on number of branches plant^{-1} at different growth stages influenced by different varieties (Fig. 4). It was found that the maximum number of branches plant^{-1} (3.22, 4.22, 6.00 and 7.11 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment R (Lalima). The minimum number of branches plant^{-1} (2.00, 3.00, 4.22 and 5.44 at 25, 50, 75 and 100 DAT, respectively) was recorded from the G (Peperone Yolo Wonder).

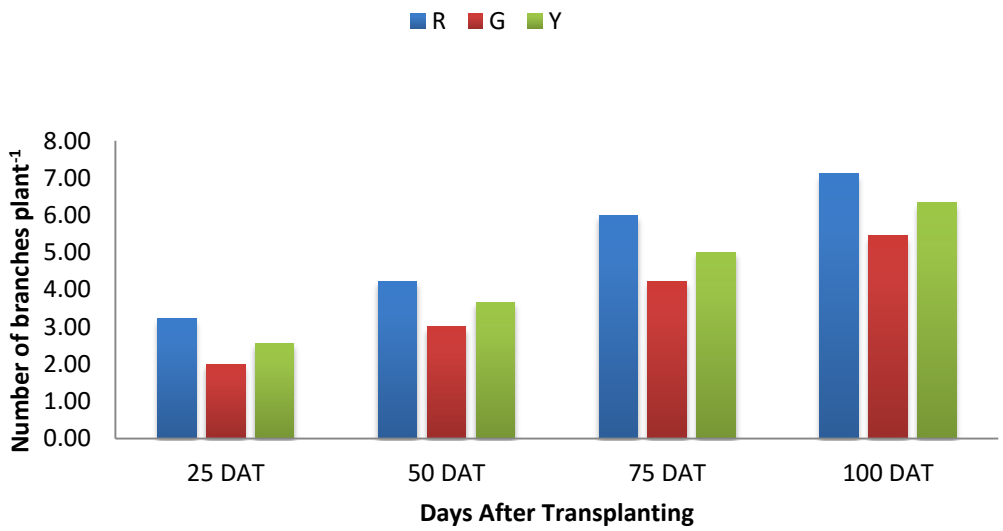


Figure 4: Number of branches plant^{-1} of capsicum as influenced by different varieties at different days after transplanting.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.3.3 Combined effect of shade nets and varieties on number of branches plant^{-1}

Significant variation was recorded on number of branches plant^{-1} at different growth stages influenced by combined effect of shade nets and varieties (Table 4 and appendix VI). The maximum number of branches plant^{-1} (5.67, 6.67, 8.00 and 9.33 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of G_NR. The minimum number of branches plant^{-1} (0.67, 1.67, 2.67 and 3.67 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of B_NG which was statistically identical with the treatment combination of B_NY at 25 and 75 DAT.

Table 4. Effect of different color shade nets in combination with varieties on number of branches plant^{-1} of capsicum

Treatment combinations	Number of branches plant^{-1} at different days after transplanting (DAT)			
	25 DAT	**50 DAT**	**75 DAT**	**100 DAT**
C_NR	2.67 d	3.67 d	6.00 bc	6.67 c
C_NG	1.67 ef	2.67 ef	4.33 ef	5.67 de
C_NY	2.00 e	3.00 e	5.00 de	6.33 cd
G_NR	5.67 a	6.67 a	8.00 a	9.33 a
G_NG	3.66 c	4.67 c	5.67 cd	7.00 c
G_NY	4.67 b	5.66 b	6.67 b	8.00 b
B_NR	1.33 fg	2.33 f	4.00 fg	5.33 ef
B_NG	0.67 h	1.67 g	2.67 h	3.67 g
B_NY	1.00 gh	2.33 f	3.33 gh	4.67 f
CV%	11.74	8.38	9.76	6.92
$LSD_{(0.05)}$	0.53	0.53	0.86	0.75

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.4 Number of leaves plant^{-1}

4.4.1 Effect of color shade net on number of leaves plant^{-1}

Remarkable variation was recorded on number of leaves plant-$^{-1}$ at different growth stages influenced by different color shade nets (Fig. 5). It was found that the maximum number of leaves plant^{-1} (20.67, 32.67, 47.44 and 50.01 at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment G_N (Green net) .The minimum number of leaves plant^{-1} (10.11, 15.44, 29.89 and 32.78 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment B_N (Black net).

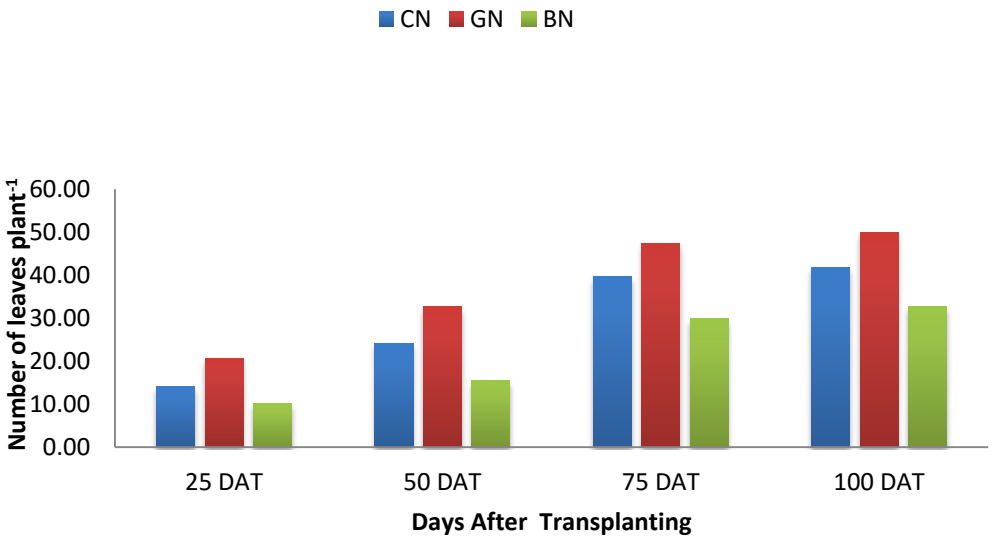


Figure 5. Number of leaves plant^{-1} of capsicum as influenced by different color shade nets at different days after transplanting.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.4.2 Effect of varieties on number of leaves plant^{-1}

Number of leaves plant^{-1} of capsicum showed statistically significant differences on different varieties at 25, 50, 75 and 100 DAT (Figure 6). At 25, 50, 75 and 100 DAT the maximum number of leaves plant^{-1} (16.78, 26.89, 42.33 and 44.89 respectively) was recorded from R (Lalima) while the minimum number of leaves plant^{-1} (13, 21.33, 35.89 and 38.46 at same days of observation respectively) was obtained from G (Peperone Yolo Wonder).

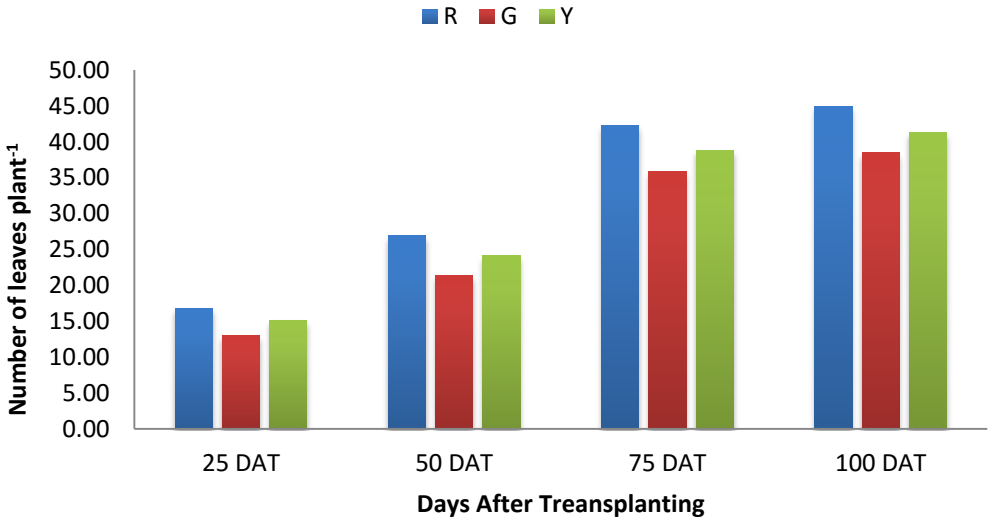


Figure 6. Number of leaves plant^{-1} of capsicum as influenced by different varieties at different days after transplanting.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.4.3 Combined effect of shade nets and varieties on number of leaves plant^{-1}

Significant variation was recorded on number of leaves plant^{-1} at different growth stages influenced by combined effect of shade nets and varieties (Table 5 and appendix VII). The maximum number of leaves plant^{-1} (24.00, 37.00, 52.00 and 54.83 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of G_NR. The minimum number of leaves plant^{-1} (9.33, 14.00, 27.00 and 30.50 at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of B_NG which was statistically identical with the treatment combination of B_NY at 25 and 50 DAT.

Table 5. Effect of different color shade nets in combination with varieties on number of leaves plant^{-1} capsicum

Treatment combinations	Number of leaves plant^{-1} at different days after transplanting (DAT)			
	25 DAT	**50 DAT**	**75 DAT**	**100 DAT**
C_NR	15.33 d	26.67 d	42.00 cd	44.67 c
C_NG	12.67 e	21.00 f	36.67 e	38.51 e
C_NY	14.33 d	25.00 e	40.33 d	42.50 d
G_NR	24.00 a	37.00 a	52.00 a	54.83 a
G_NG	17.00 c	29.00 c	44.00 c	46.35 c
G_NY	21.00 b	32.00 b	46.33 b	48.83 b
B_NR	11.00 f	17.00 g	33.00 f	35.16 f
B_NG	9.33 g	14.00 h	27.00 h	30.50 h
B_NY	10.00 fg	15.33 h	29.67 g	32.67 g
CV%	5.61	3.69	3.14	2.37
$LSD_{(0.05)}$	1.45	1.54	2.12	1.71

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.5 Leaf length

4.5.1 Effect of color shade net on leaf length

Remarkable variation was recorded on leaf length at different growth stages influenced by different color shade nets (Fig. 7). It was found that the maximum leaf length (14.83 18.94, 21.33, 22.12 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment G_N (Green net) .The minimum leaf length (10.50, 11.83, 14.72, 15.78 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment B_N (Black net). Rylski *et al*. (1986) reported that leaf length were higher under the shaded plants than those in full light.

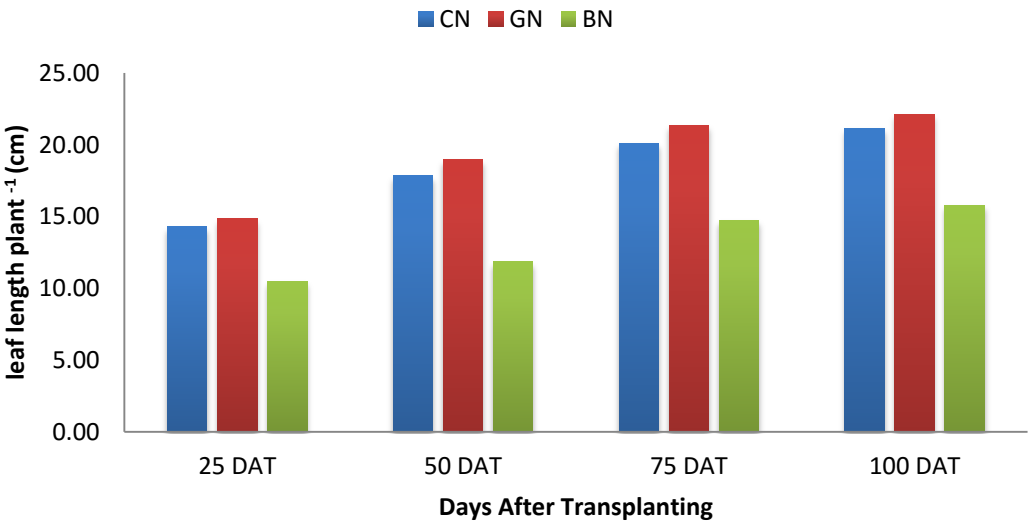


Figure 7. Leaf length of capsicum as influenced by different color shade nets at different days after transplanting.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.5.2 Effect of varieties on leaf length

Remarkable variation was recorded on leaf length at different growth stages influenced by different varieties (Fig. 8). It was found that the maximum leaf length (14.06, 17.56, 20.00 and 21.00 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment R (Lalima). The minimum leaf length (12.33, 15.39, 17.83 and 18.67 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the G (Peperone Yolo Wonder).

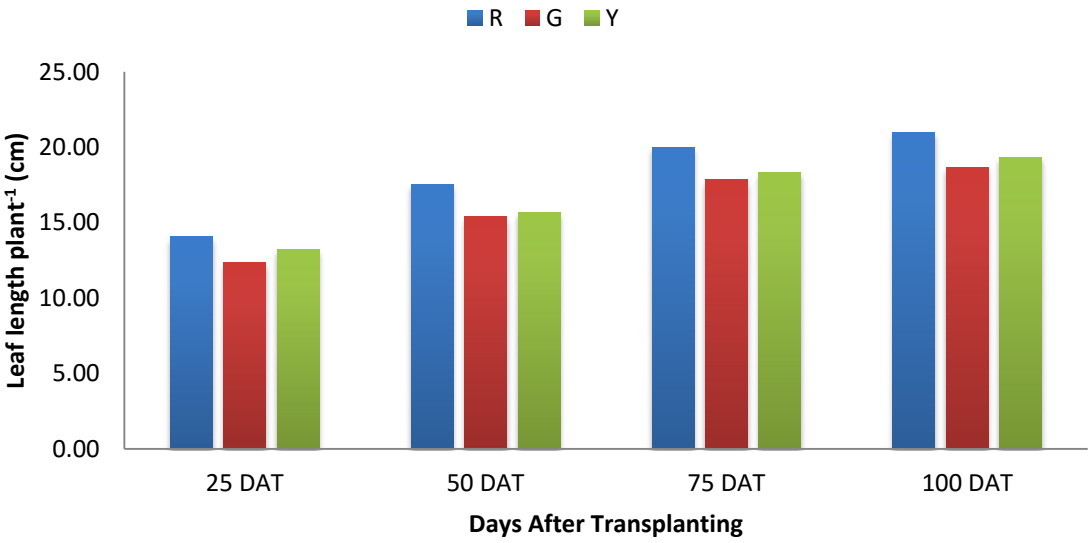


Figure 8. Leaf length of capsicum as influenced by different varieties at different days after transplanting.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.5.3 Combined effect of shade nets and varieties on leaf length

Significant variation was recorded on leaf length at different growth stages influenced by combined effect of shade nets and varieties (Table 6 and appendix VIII). The maximum leaf length (15.67, 20.00, 22.33 and 23.33 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of G_NR which was statistically identical with the treatment combination of G_NY at 25, 50, 75 and 100 DAT. The minimum leaf length (9.33, 10.67, 13.33 and 14.33 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of B_NG which was statistically identical with the treatment combination of B_NY at 25, 50, 75 and 100 DAT.

Table 6. Effect of different color shade nets in combination with varieties on leaf length of capsicum

Treatment combinations	Leaf length (cm) at different days after transplanting (DAT)			
	25 DAT	**50 DAT**	**75 DAT**	**100 DAT**
C_NR	14.33 ab	19.50 a	22.00 a	23.00 a
C_NG	14.67 ab	18.00 ab	20.17 ab	21.00 ab
C_NY	13.83 ab	16.00 bc	18.17 bc	19.33 bc
G_NR	15.67 a	20.00 a	22.33 a	23.33 a
G_NG	13.00 abc	17.50 ab	20.00 ab	20.67 ab
G_NY	15.83 a	19.33 a	21.67 a	22.36 ab
B_NR	12.17 bcd	13.17 cd	15.66 cd	16.67 cd
B_NG	9.33 d	10.67 d	13.33 d	14.33 d
B_NY	10.00 cd	11.67 d	15.16 cd	16.33 cd
CV%	14.2	11.35	10.51	10.07
$LSD_{(0.05)}$	3.24	3.18	3.41	3.43

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.6 Leaf breadth

4.6.1 Effect of color shade net on leaf breadth

Remarkable variation was recorded on leaf breath at different growth stages influenced by different color shade nets (Fig. 9). It was found that the maximum leaf breadth (6.44, 8.39, 11.19, and 12.19 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment G_N (Green net) .The minimum leaf breadth (3.89, 4.86, 5.78 and 6.89 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment B_N (Black net). Rylski *et al*. (1986) reported that leaf breadth were higher under the shaded plants than those in full light.

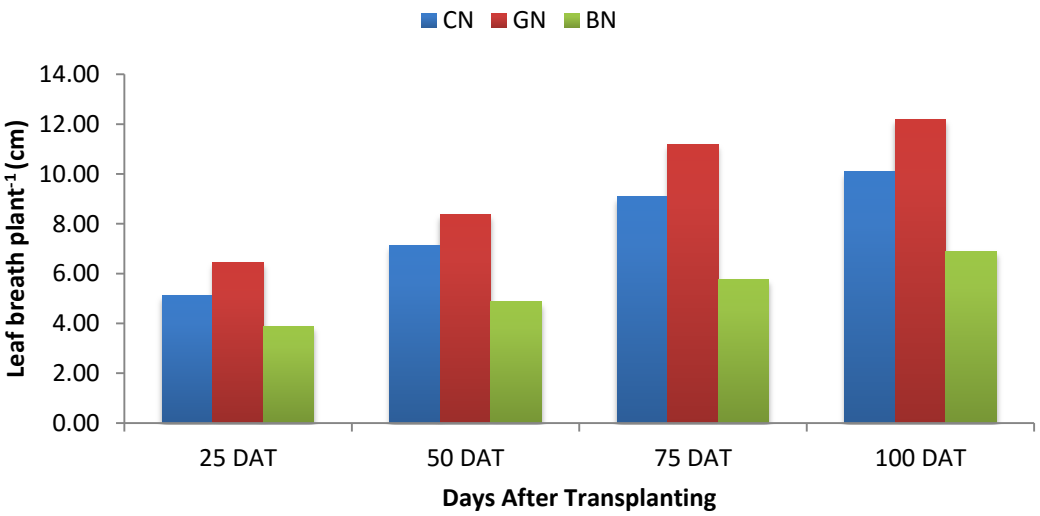


Figure 9. Leaf breadth of capsicum as influenced by different color shade nets at different days after transplanting.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.6.2 Effect of varieties on leaf breadth

Remarkable variation was recorded on leaf breadth at different growth stages influenced by different varieties (Fig. 10). It was found that the maximum leaf breadth (5.58, 7.25, 9.42 and 10.53 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment R (Lalima). The minimum leaf breadth (4.67, 6.32, 7.89 and 8.89 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the G (Peperone Yolo Wonder).

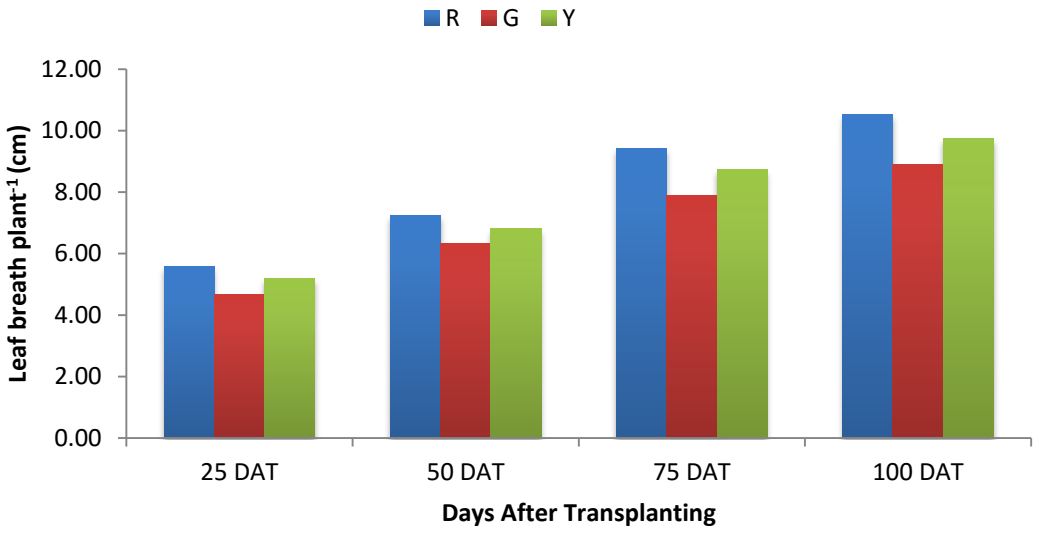


Figure 10. Leaf breadth of capsicum as influenced by different varieties at different days after transplanting.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.6.3 Combined effect of shade nets and varieties on leaf breadth

Significant variation was recorded on leaf breath at different growth stages influenced by combined effect of shade nets and varieties (Table 7 and appendix VIII). The maximum leaf breadth (6.83, 8.83, 12.08 and 13.08 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of G_NR. The minimum leaf breadth (3.25, 4.17, 5.17 and 6.17 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of B_NG.

Table 7. Effect of different color shade nets in combination with varieties on leaf breadth of capsicum

Treatment combinations	Leaf breadth (cm) at different days after transplanting (DAT)			
	25 DAT	**50 DAT**	**75 DAT**	**100 DAT**
C_NR	5.58 cd	7.58 c	9.833 c	10.83 c
C_NG	4.67 ef	6.70 d	8.250 e	9.25 e
C_NY	5.08 de	7.08 d	9.167 d	10.17 d
G_N R	6.83 a	8.83 a	12.083 a	13.08 a
G_NG	6.08 bc	8.08b	10.250 c	11.25c
G_NY	6.42 ab	8.25 b	11.250 b	12.25 b
B_NR	4.33 fg	5.33 e	6.333 f	7.67 f
B_NG	3.25 h	4.17 f	5.167 h	6.17 h
B_NY	4.08 g	5.08e	5.833 g	6.83 g
CV%	5.86	3.63	3.05	2.68
$LSD_{(0.05)}$	0.52	0.43	0.46	0.45

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R - F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.7 Canopy size plant^{-1}

4.7.1 Effect of color shade net on canopy size plant^{-1}

Remarkable variation was recorded on canopy size plant^{-1} (cm) at different growth stages influenced by different color shade nets (Fig. 11). It was found that the maximum canopy size plant^{-1} (28.50, 34.00, 48.50 and 51.11 cm at 25, 50, 75 and 100 DAT respectively) was recorded from the treatment G_N (Green net) .The minimum canopy size plant^{-1} (19.83, 23.22, 31.83 and 34.94 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment B_N (Black net).

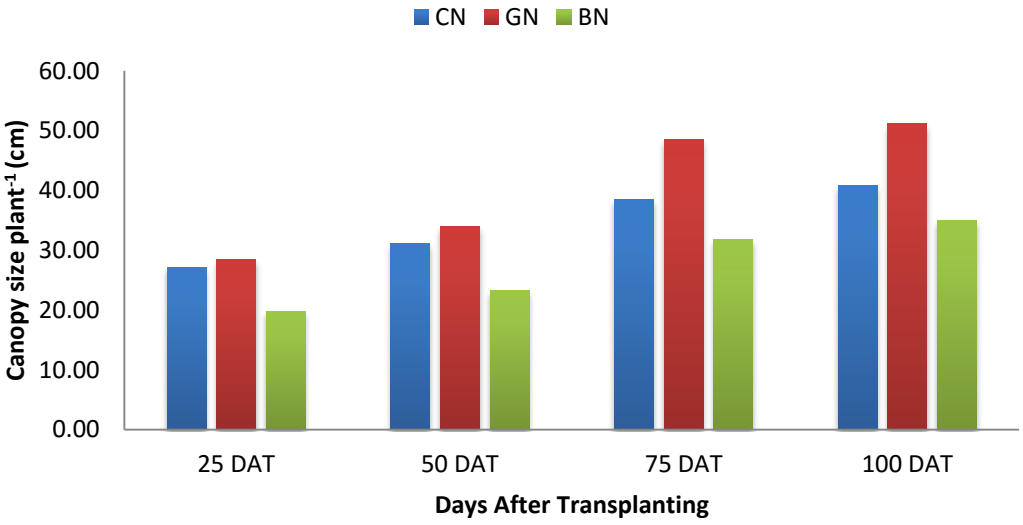


Figure 11. Canopy size plant^{-1} of capsicum as influenced by different color shade nets at different days after transplanting.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.7.2 Effect of varieties on canopy size plant^{-1}

Remarkable variation was recorded on canopy size plant^{-1} at different growth stages influenced by different fruit varieties (Fig. 12). It was found that the maximum canopy size plant^{-1} (27.33, 32.22, 42.83 and 45.67 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment R (Lalima). The minimum canopy size plant^{-1} (23.22, 26.78, 35.06 and 37.77 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the G (Peperone Yolo Wonder).

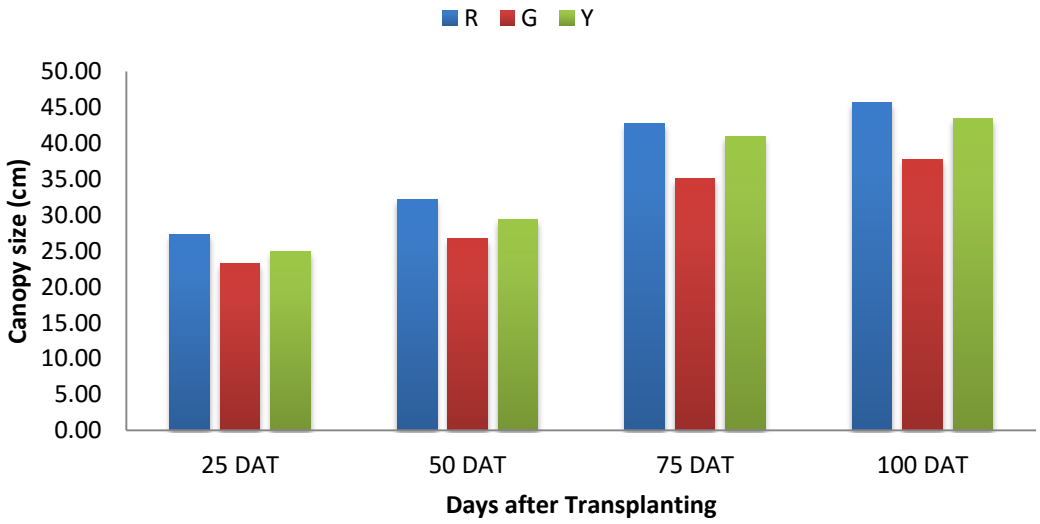


Figure 12. Canopy size plant^{-1} of capsicum as influenced by different varieties at different days after transplanting.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.7.3 Combined effect of shade nets and varieties on canopy size plant[1]

Significant variation was recorded on canopy size plant^{-1}(cm) at different growth stages influenced by combined effect of shade nets and varieties (Table 8 and appendix VII). The maximum canopy size plant^{-1} (30.83, 38.00, 52.33 and 54.83 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of G_NR which was statistically identical with the treatment combination of C_NR at 25 DAT and G_NY at 25, 75 and 100 DAT. The minimum canopy size plant^{-1} (17.83, 21.33, 28.33 and 31.78 cm at 25, 50, 75 and 100 DAT, respectively) was recorded from the treatment combination of B_NG which was statistically identical with the treatment combination of B_NY at 25 , 50, 75 and 100 DAT and B_NR at 75 and 100 DAT.

Table 8. Effect of different color shade nets in combination with varieties on canopy size plant^{-1} of capsicum

Treatment combinations	Canopy size plant^{-1} (cm) at different days after transplanting (DAT)			
	25 DAT	**50 DAT**	**75 DAT**	**100 DAT**
C_NR	28.83 ab	33.00 bc	40.67 cd	43.94 cd
C_NG	25.83 c	28.83 de	35.50 de	38.22 de
C_NY	26.67 bc	31.67 bcd	42.00 c	43.61 cd
G_NR	30.83 a	38.00 a	52.33 a	54.83 a
G_NG	26.00 c	30.16 cd	44.00 bc	46.53 bc
G_NY	28.67 ab	33.83 b	49.17 ab	51.97 ab
B_NR	22.33 d	25.67 ef	32.83 ef	35.00 e
B_NG	17.83 e	21.33 g	28.33 f	31.78 e
B_NY	19.33 e	22.67 fg	31.67 ef	34.83 e
CV%	5.79	7.11	8.96	9.12
LSD(0.05)	2.52	3.62	6.14	6.68

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.8 Days to 1st flowering

4.8.1 Effect of color shade net on days to 1st flowering

The recorded data on days to 1st flowering was significantly influence by different color shade nets (Table 9 and appendix IX) The highest days to 1st flowering (83.56) was recorded from the treatment B_N (Black net) .The lowest days to 1st flowering (46.22) was recorded from the treatment G_N (Green net).

4.8.2 Effect of varieties on days to 1st flowering

Days to 1st flowering was significantly varied due to different varieties at different growth stages (Table 10 and appendix IX). It was found that the highest days to 1st flowering (64.22) was recorded from treatment G (Peperone Yolo Wonder) where the lowest days to 1st flowering (59.89) were recorded from the treatment R (Lalima).

4.8.3 Combined effect of shade nets and varieties on days to 1st flowering

Days to 1st flowering was significantly influenced by different color shade nets and fruit varieties. Maximum days (86.67) required for capsicum flowering was found in B_NG which was closely followed by B_NY (83) and B_NR (81). The minimum days (44.67) was found in G_NR which was statistically identical to G_NY (Table 11 and appendix IX)

4.9 Days to 50% flowering

4.9.1 Effect of color shade net on days to 50% flowering

The recorded data on days to 50% flowering was significantly influence by different color shade nets (Table 9 and appendix IX). The maximum days to 50% flowering (118) was recorded from the treatment B_N (Black net) .The minimum days to 50% flowering (82.11) was recorded from the treatment G_N (Green net).

4.9.2 Effect of varieties on days to 50% flowering

Days to 50% flowering was significantly varied due to different varieties at different growth stages (Table 10 and appendix IX). It was found that the maximum days to 50% flowering (99.11) was recorded from treatment G (Peperone Yolo Wonder) where the minimum days to 50% flowering was (95.44) recorded from the treatment R (Lalima).

4.9.3 Combined effect of shade nets and varieties on days to 50% flowering

Significant variation was recorded due to the combined effect of different shade nets and varieties in terms of days to 50% flowering (Table 11 and appendix IX). The maximum days from transplanting to 50% flowering (120.33) was obtained from B_NG which was closely followed by B_NY (117.67) and B_NR (116). The minimum days (80.67) was found from G_NR which was statistically identical to G_NY (82).

4.10 Number of flowers plant^{-1}

4.10.1 Effect of different color shade net on number of flowers plant^{-1}

Significant variation was recorded due to the effect of different color shade nets of capsicum on number of flowers plant^{-1} (Table 9 and appendix IX). The higher number of flowers plant^{-1} (15.33) was recorded from G_N (Green net), while the lower number of flowers plant^{-1} (9.67) was obtained from B_N (Black net). Nissim-Levi *et al*. (2008) reported that the number of flowers plant^{-1} increased under the different shading net compared to black shade.

4.10.2 Effect of varieties on number of flowers plant^{-1}

Number of flowers plant^{-1} was significantly varied due to different varieties at different growth stages (Table 10 and appendix IX). It was found that the maximum number of flowers plant^{-1} (13.78) was recorded from treatment R (Lalima) where the minimum number of flowers plant^{-1} was (11) recorded from the treatment G (Peperone Yolo Wonder).

4.10.3 Combined effect of shade nets and varieties on number of flowers plant^{-1}

Number of flowers plant^{-1} of capsicum showed significant differences due to the combined effect of different color shade nets and varieties (Table 11 and appendix IX). The highest number of flowers plant^{-1} (17.00) was recorded from G_NR which was statistically similar (15.00) to G_NY whereas the lowest number (8.00) was attained from B_NG which was statistically identical to B_NY (10) and B_NR (11).Shade netting that increases light scattering but does not affect the light spectrum has been shown to increase number of flowers plant^{-1} (Nissim-Levi *et al*.2008).

Table 9. Effect of different color shade nets on days to 1st flowering, 50% flowering and number of flowers plant^{-1}

Treatments	Days to 1st flowering	Days to 50% flowering	No. of flowers plant^{-1}
C_N	56.00 b	91.44 b	12.33 b
G_N	46.22 c	82.11 c	15.33 a
B_N	83.56 a	118.00 a	9.67 c
CV%	2.12	1.2	7.15
LSD(0.05)	1.31	1.17	0.89

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

[C_N - White net (control), G_N - Green net, B_N - Black net]

Table 10. Effect of varieties on days to 1st flowering, 50% flowering and number of flowers plant^{-1}

Treatments	Days to 1st flowering	Days to 50% flowering	No. of flowers plant^{-1}
R	59.89 c	95.44 c	13.78 a
G	64.22 a	99.11 a	11.00 c
Y	61.67 b	97.00 b	12.56 b
CV%	2.12	1.2	7.15
$LSD_{(0.05)}$	1.31	1.17	0.89

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

Table 11. Combined effect of different color shade nets and varieties on days to 1st flowering, 50% flowering and number of flowers plant^{-1}

Treatment combinations	Days to 1st flowering	Days to 50% flowering	No. of flowers plant^{-1}
C_NR	54.00 d	89.67 d	13.33 c
C_NG	58.00 c	93.33 c	11.00 d
C_NY	56.00 cd	91.33 cd	12.67 c
G_NR	44.67 f	80.67 f	17.00 a
G_NG	48.00 e	83.67 e	14.00 bc
G_NY	46.00 ef	82.00 ef	15.00 b
B_NR	81.00 b	116.00 b	11.00 d
B_NG	86.67 a	120.33 a	8.00 e
B_NY	83.00 b	117.67 b	10.00 d
CV%	2.12	1.2	7.15
$LSD_{(0.05)}$	2.27	2.03	1.54

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.11 Number of fruits plant^{-1}

4.11.1 Effect of color shade net on number of fruits plant^{-1}

Fruit number showed significant variation among different color shade nets (Table 12 and appendix IX). Maximum number of fruits plant^{-1} (5.51) was recorded from the G_N (Green net). Minimum number of fruits plant^{-1} (3.22) was found in B_N (Black net). Shahak *et al*. (2008) reported that the number of fruits plant^{-1} produced per plant throughout the growing season was 30-40% higher under photo-selective nets, in all tested cultivars, while fruit size was comparable with the black shade net control.

4.11.2 Effect of varieties on number of fruits plant^{-1}

Different varieties of capsicum showed significant variation on number of fruits plant^{-1} (Table 13 and appendix IX). The higher number of fruits plant^{-1} (4.86) was obtained from R (Lalima), while the lower number (3.95) was obtained from G (Peperone Yolo Wonder). Different varieties responded differently for number of fruits to input supply, method of cultivation and the prevailing environment during the growing season.

4.11.3 Combined effect of shade nets and varieties on number of fruits plant^{-1}

Significant variation was recorded due to the combined effect of different color shade nets and varieties in terms of number of fruits plant^{-1} (Table 14 and appendix IX). The highest number of fruits plant^{-1} (6.17) was recorded from G_NR which was closely followed by treatment combination G_NY (5.15). The lowest number (2.67) was recorded from B_NG which was closely followed by treatment combination B_NY (3.33).

4.12 Fruit length

4.12.1 Effect of color shade nets on fruit length

Fruit length (cm) was significantly varied due to different color shade nets (Table 12 and appendix IX).The highest fruit length (8.55 cm) was recorded from the treatment G_N (Green net). The lowest fruit length (5.70 cm) was recorded from the treatment B_N (Black net)

4.12.2 Effect of varieties on fruit length

The recorded data on fruit length (cm) was significantly influence by different varieties (Table 13 and appendix IX). The highest fruit length (7.64 cm) was recorded from the treatment R (Lalima).The lowest fruit length (6.30 cm) was recorded from the treatment G (Peperone Yolo Wonder).

4.12.3 Combined effect of shade nets and varieties on fruit length

The recorded data on fruit length (cm) was significantly influence by combined effect of different color shade nets and varieties (Table 14 and appendix IX). Results revealed that the highest fruit length (9.88 cm) was from recorded the treatment combination of G_NR .The lowest fruit length (5.47 cm) was recorded from the treatment combination of B_NG which was statistically similar with B_NY (5.73) and B_NR (5.90).

4.13 Fruit diameter

4.13.1 Effect of color shade nets on fruit diameter

Fruit diameter (cm) was significantly varied due to different color shade nets (Table 12 and appendix IX). The highest fruit diameter (6.92 cm) was recorded from the treatment G_N (Green net) whereas the lowest fruit diameter (4.67 cm) was recorded from the control treatment B_N (black net).

4.13.2 Effect of varieties on fruit diameter

Significant influence was noted on fruit diameter (cm) affected by different varieties (Table 13 and appendix IX). The highest fruit diameter (6.00 cm) was recorded from the treatment R (Lalima). The lowest fruit diameter (5.37 cm) was recorded from the treatment G (Peperone Yolo Wonder).

4.13.3 Combined effect of shade nets and varieties on fruit diameter

Considerable influence was found on fruit diameter (cm) persuaded by combined effect of different color shade nets and varieties (Table 14 and appendix IX). The highest fruit diameter (7.40 cm) was recorded from the treatment combination of G_NR whereas the lower fruit diameter (4.43 cm) was recorded from the treatment combination of B_NG which was followed by the treatment combination of B_NY (4.67).

4.14 Fruit weight (g)

4.14.1 Effect of color shade nets on fruit weight (g)

Significant influence was noted on individual fruit weight (g) affected by different color shade nets (Table 12 and appendix IX). Maximum fruit weight (50.39 g) was obtained from the treatment G_N (Green net) on the other hand minimum fruit weight (46.34 g) was recorded from the treatment B_N (Black net). Light environment created by plastic nets and influence of these on plant physiology affected the average fruit weight. In another crop cucumber Tafoya et al. (2018) reported that the aluminized, pearl, blue and red nets, the average weight of cucumber fruits increased by between 6.9 and 8.7%, due to the positive effect on the increase of plant biomass (fruits and vegetative parts) by increasing solar radiation compared to black net.

4.14.2 Effect of varieties on fruit weight (g)

Individual fruit weight (g) was significantly varied due to different varieties at different growth stages (Table 13 and appendix IX). Maximum fruit weight (49.08 g) was recorded

from the treatment R (Lalima) on the other hand minimum fruit weight (47.29 g) was recorded from the treatment G (Peperone Yolo Wonder).

4.14.3 Combined effect of shade nets and varieties on fruit weight (g)

The recorded data on individual fruit weight (g) was significantly influence by combined effect of different color shade nets and varieties (Table 14 and appendix IX). The maximum fruit weight (51.50 g) was recorded from the treatment combination of G_NR. The minimum fruit weight (45.37 g) was recorded from the treatment combination of B_NG. Fallik *et al*. (2013) who found increased fruit weight both two cultivars of sweet pepper (Romans and Vergasa) under the photo-selective nets compared to the fruit weight grown under the two black nets.

4.15 Yield plant^{-1}

4.15.1 Effect of color shade nets on yield plant^{-1}

Yield plant^{-1} of capsicum varied significantly on different color shade nets (Table 12 and appendix IX). The highest yield plant^{-1} (278.11 g) was found from G_N (Green net) while the lowest yield plant^{-1} (149.62 g) was recorded from B_N (Black net).

4.15.2 Effect of varieties on yield plant^{-1}

Different varieties of capsicum showed significant variation on yield plant^{-1} (Table 13 and appendix IX). The higher yield plant^{-1} (240.48 g) was found from R (Lalima), while the lower yield plant^{-1} (188.54 g) was recorded from G (Peperone Yolo Wonder). Yield varied for different varieties might be due to genetically and environmental influences as well as management practices.

4.15.3 Combined effect of shade nets and varieties on yield plant^{-1}

Interaction effect of different color shade nets and varieties varied significantly due to the in terms of yield plant^{-1} (Table 14 and appendix IX). The highest yield plant^{-1} (317.58 g) was attained from G_NR, while the lowest yield plant^{-1} (120.77 g) was found from B_NG.

4.16 Yield (t/ha)

4.16.1 Effect of color shade nets on yield (t/ha)

Yield (t/ha) recorded significant variation for different color shade nets of capsicum (Table 12 and appendix IX). The highest yield (30.23 t/ha) was attained from G_N (Green net) while the lowest yield (16.26 t/ha) was recorded from B_N (Black net). Fallik *et al*. (2009) reported that pepper grown in an arid region under red and yellow shade nets, had a significant higher yield compared with black nets of the same shading factors, without reducing fruit size. In another experiment, Shahak (2008) reported that production of three cultivars of bell pepper was increased by 16% to 32% under pearl and red compared with black netting. The colored nets increased the yield of cucumber, which was significantly higher with the pearl (71%), red (48%), aluminized and blue (46%) nets, compared with the yield obtained with the black net (52 ton/ha**)**, which was lower in 17% than that obtained with the gray net (Medany *et al*. 2008)

4.16.2 Effect of varieties on yield (t/ha)

Significant variation was recorded for yield (t/ha) of capsicum for different varieties (Table 13 and appendix IX). The highest yield (26.14 t/ha) was recorded from R (Lalima) which was closely followed (22.62 t/ha) by Y (BARI Mistimorich 2), while the lowest yield (20.49 t/ha) was observed from G (Peperone Yolo Wonder).

4.16.3 Combined effect of shade nets and varieties on yield (t/ha)

Interaction effect of different color shade nets and varieties showed significant variation in terms of yield t/ha (Table 14 and appendix IX). The highest yield (34.52 t/ha) was found from G_NR, while the lowest yield (13.13 t/ha) was observed from B_NG. Shahak *et al.* (2009) reported that in 2005 and 2006 the red net out-performed the Yellow and Pearl. It increased total fruit yield (ton/ha per season) by about 30% in 2005 (in 'Caliber' and 'Triple-star'), and 15% and 33% in 2006 ('Vergasa and 'Anna', respectively) relative to the black shade net.

Table 12. Effect of different color shade nets on numbers of fruits plant^{-1}, fruit length, fruit diameter, fruit weight, yield plant^{-1} and yield of capsicum

Treatments	Fruit plant^{-1}	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Yield plant^{-1} (g)	Yield (t/ha)
C_N	4.36 b	6.64 b	5.40 b	47.97 b	209.37 b	22.76 b
G_N	5.51 a	8.55 a	6.92 a	50.39 a	278.11 a	30.23 a
B_N	3.22 c	5.70 c	4.67 c	46.34 c	149.62 c	16.26 c
CV%	7.83	4.8	1.44	0.91	7.93	7.93
$LSD_{(0.05)}$	0.34	0.33	0.08	0.44	16.83	1.83

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

[C_N - White net (control), G_N - Green net, B_N - Black net]

Table 13. Effect of varieties on numbers of fruits plant^{-1}, fruit length, fruit diameter, fruit weight, yield plant^{-1} and yield of capsicum

Treatments	Fruit plant^{-1}	Fruit length(cm)	Fruit diameter (cm)	Fruit weight (g)	Yield plant^{-1} (g)	Yield (t/ha)
R	4.86 a	7.64 a	6.00 a	49.08 a	240.48 a	26.14 a
G	3.95 c	6.30 c	5.37 c	47.29 c	188.54 c	20.49 c
Y	4.28 b	6.95 b	5.62 b	48.33 b	208.08 b	22.62 b
CV%	7.83	4.8	1.44	0.91	7.93	7.93
$LSD_{(0.05)}$	0.34	0.33	0.08	0.74	16.83	1.83

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

Table 14. Combined effect of different color shade nets and varieties on number of fruits plant^{-1}, fruit length, fruit diameter, fruit weight, yield plant^{-1} and yield of capsicum

Treatment combinations	Fruit plant^{-1}	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Yield plant^{-1} (g)	Yield (t/ha)
C_NR	4.75 bc	7.13 cd	5.70 d	48.58 cd	230.85 cd	25.09 cd
C_NG	4.08 d	6.20 ef	5.10 f	47.33 ef	193.25 ef	21.01 ef
C_NY	4.25 cd	6.60 de	5.40 e	48.00 de	203.99 de	22.17 de
G_NR	6.17 a	9.88 a	7.40 a	51.50 a	317.58 a	34.52 a
G_NG	5.12 b	7.23 c	6.57 c	49.17 c	251.59 bc	27.35 bc
G_NY	5.15 b	8.53 b	6.80 b	50.50 b	265.17 b	28.82 b
B_NR	3.67 de	5.90 fg	4.90 g	47.17 fg	173.00 fg	18.80 fg
B_NG	2.67 f	5.47 g	4.43 i	45.37 h	120.77 h	13.13 h
B_NY	3.33 e	5.73 fg	4.67 h	46.50 g	155.08 g	16.86 g
CV%	7.83	4.8	1.44	0.91	7.93	7.93
$LSD_{(0.05)}$	0.59	0.56	0.14	0.76	29.15	3.17

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N -White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.17 Color measurement

4.17.1 Combined effect of shade nets and varieties on color measurements

Remarkable variation was noted on fruit color of capsicum influenced by combined effect of different color shade nets and fruit varieties (Table 15 and appendix X).The higher L* value indicates the lighter color which was found the treatment combination G_NY (63.28) closely followed by treatment combination C_NY (61.35) and B_NY (52.86) and lower L* value found in treatment combination B_NR (34.57) closely followed by treatment combination C_NR (35.83) and G_NG (37.37). The redness value a* was highest in treatment combination G_NR (37.10) closely followed by treatment combination C_NR (35.17) and B_NR (33.06) whereas lowest a* value found in treatment combination B_NG (7.42) which was statistically similar the treatment combination C_NG (7.92). The higher b* value indicates yellow color found in treatment combination G_NY (69.01) and lower value found treatment combination B_NR (18.63). The higher Chroma value was found in treatment combination G_NY (71.16) and lower value found in treatment combination B_NY (24.80).According to Selahle *et al.* (2015) 'HTSP-3' and 'Celaya' peppers produced under black nets had significantly lower L values, after postharvest storage indicating darker red and deep yellow colored fruits respectively.

Table 15. Combined effect of different color shade nets and varieties on chromatic characteristics of the capsicum fruit

Treatment combinations	L^*	a^*	b^*	Chroma
C_NR	35.83 g	35.17 b	21.03 g	40.98 e
C_NG	38.83 e	7.92 gh	25.15 e	26.37 h
C_NY	61.35 b	15.57 e	57.55 b	59.62 b
G_NR	37.37 f	37.10 a	21.50 g	42.88 d
G_NG	41.06 d	8.51 g	26.80 d	28.12 g
G_NY	63.28 a	17.36 d	69.01 a	71.16 a
B_NR	34.57 h	33.06 c	18.63 h	37.96 f
B_NG	37.62 f	7.42 h	23.66 f	24.80 i
B_NY	52.86 c	10.55 f	54.73 c	55.76 c
CV%	1.37	3.12	1.06	1.05
$LSD_{(0.05)}$	1.06	1.05	0.65	0.78

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

4.18 Total soluble solids (TSS)

4.18.1 Effect of color shade nets on total soluble solids (TSS)

Significant variation was remarked on TSS (%) as influenced by different color shade nets (Fig. 13). The highest TSS percentage (9.08%) was recorded from the treatment C_N (control) which was significantly different from all other treatments followed by G_N (Green net). The lowest TSS percentage (5.01%) was recorded from the treatment B_N (Black net). Ilic *et al*. (2017) reported that the highest concentration of TSS (8.03%) was detected in pepper fruits grown under open field conditions. Pepper fruits from plastic tunnels had significantly lower TSS content (6.58%). The TSS was reported to increase with fruit ripening as a result of greater degradation of the polysaccharides and accumulation of sugars (Molinari and others 1999). In another experiment according to Mashabela *et al.* (2015) after postharvest storage fruits produced under the yellow nets showed higher TSS compared to black net.

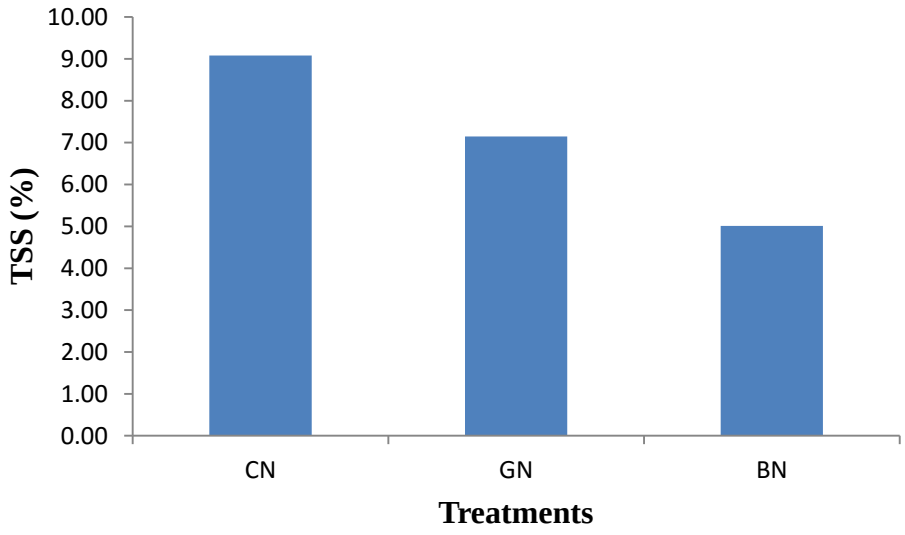


Figure 13. Total soluble solids (TSS) of capsicum as influenced by different color shade nets.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.18.2 Effect of varieties on total soluble solids (TSS)

The recorded data on TSS (%) was significantly influence by different varieties (Fig. 14). The highest TSS percentage (7.98%) was recorded from the treatment R (Lalima) which was significantly different from all other treatments followed by Y (BARI Mistimorich 2). The lowest TSS percentage (6.22%) was recorded from the treatment G (Peperone Yolo Wonder).

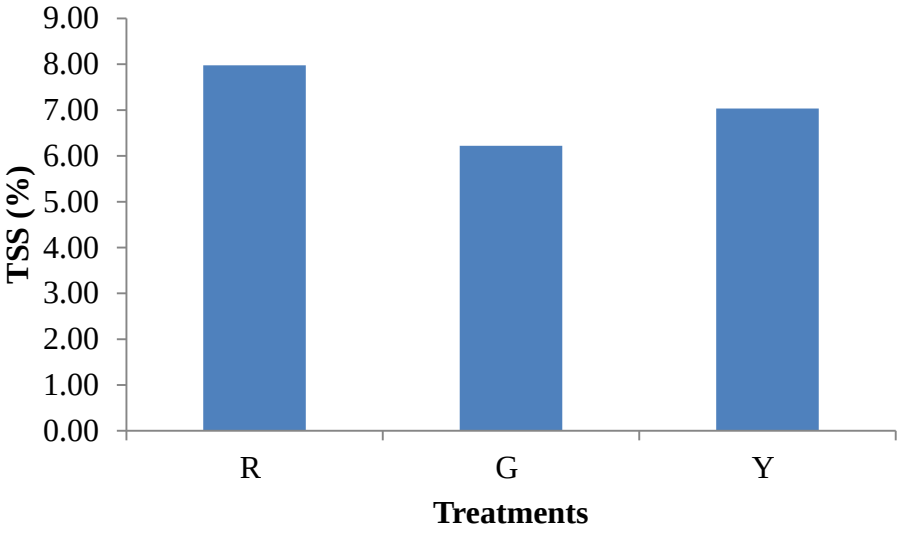


Figure 14. Total soluble solids (TSS) of capsicum as influenced by different varieties.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.18.3 Combined effect of shade nets and varieties on total soluble solids (TSS)

The recorded data on TSS (%) was significantly influence by combined effect of different colour shade nets and varieties (Table 16 and appendix X). The highest fruit TSS (10.23%) was recorded from the treatment combination of C_NR. The lowest fruit TSS (3.80%) was recorded from the treatment combination of B_NG.

4.19 Vitamin C content

4.19.1 Effect of color shade nets on vitamin C content

Significant variation was remarked on Vitamin C content as influenced by different color shade nets (Fig. 15). The highest Vitamin C content (163.22 mg. 100 g^{-1} FW) was recorded from the treatment C_N (control) which was significantly different from all other treatments followed by G_N (Green net). The lowest Vitamin C content (148.32 mg.100 g^{-1} FW) was recorded from the treatment B_N (Black net). Vitamin C in pepper fruits as a response to growing conditions, particularly variations in solar radiation and temperature. Light exposure has been reported to favor the accumulation of vitamin C in tomato fruit (Dumas et al. 2003).

Milenkovic *et al*.(2012) was reported that significant differences in vitamin C contents were recorded in peppers grown in plastic houses, at about 151.37 mg·100g^{-1} compared to control of open field conditions at about 171.27 mg·100g^{-1}.

In another experiment ,Earlier, Hamner *et al.* (1945) reported that the tomato fruit produced under shade had low vitamin C content, at about 15.5 mg·100g^{-1} fresh weight, when compared to the fruit produced under sunshine conditions, at about 25.8 mg·100g^{-1} fresh weight.

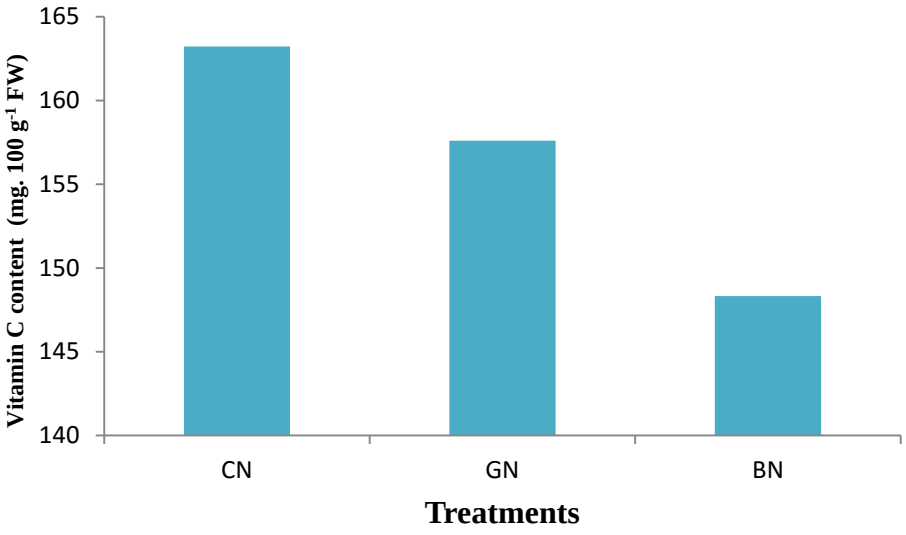


Figure 15. Vitamin C content of capsicum as influenced by different color shade nets.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.19.2 Effect of varieties on vitamin C content

The recorded data on Vitamin C content was significantly influence by different varieties (Fig. 16). The highest Vitamin C content (157.77 mg. 100 g^{-1} FW) was recorded from the treatment G (Peperone Yolo Wonder) which was significantly different from all other treatments followed by R (Lalima). The lowest Vitamin C content (154.88 mg. 100 g^{-1} FW) was recorded from the treatment Y (BARI Mistimorich 2).

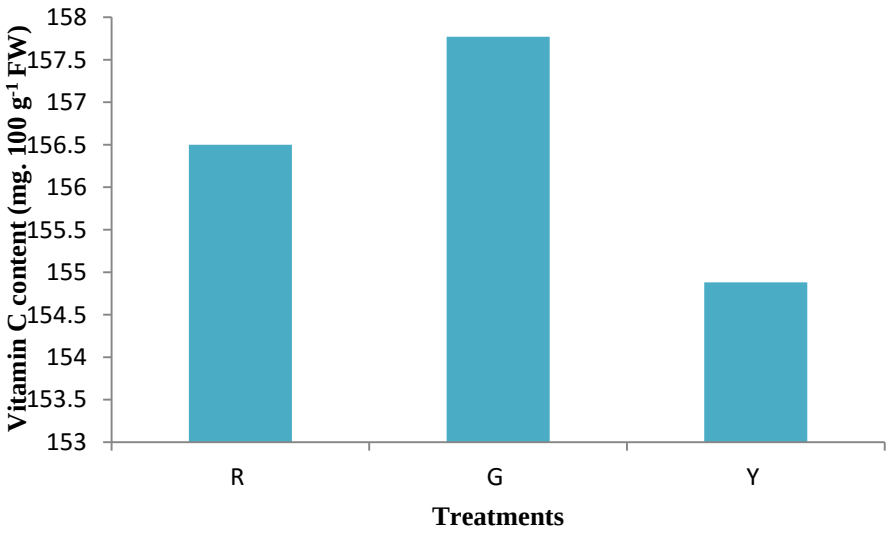


Figure 16. Vitamin C content of capsicum as influenced by different varieties.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.19.3 Combined effect of shade nets and varieties on vitamin C content

The recorded data on vitamin C was significantly influence by combined effect of different color shade nets and varieties (Table 16 and appendix X). The highest vitamin C (164.50 mg. 100 g^{-1} FW) was recorded in the treatment combination of C_NG whereas lowest vitamin C (146.63 mg. 100 g^{-1} FW) was recorded in the treatment combination of B_NY.

4.20 Antioxidant activity

4.20.1 Effect of color shade nets on antioxidant activity

The antioxidant activity in tomato and pepper fruit increases during postharvest storage, and is due to color net cultivation. This activity is related to metabolic pathways involved during ripening and the production of lipophilic antioxidants (carotenoids, lycopene and phenolic compounds). Light conditions during production, and genotype differences have been shown to affect the fruit antioxidant activity during postharvest storage. Significant variation was remarked on antioxidant activity (%) as influenced by different color shade nets (Fig. 17). The highest antioxidant activities (78.80%) were recorded from the treatment G_N (Green net) which was significantly different from all other treatments followed by C_N (control). The lowest antioxidant activities (72.61%) were recorded from the treatment B_N (Black net). According to Selahle *et al*. (2015) different result shown that pearl nets were reported to increase antioxidant activity during storage.

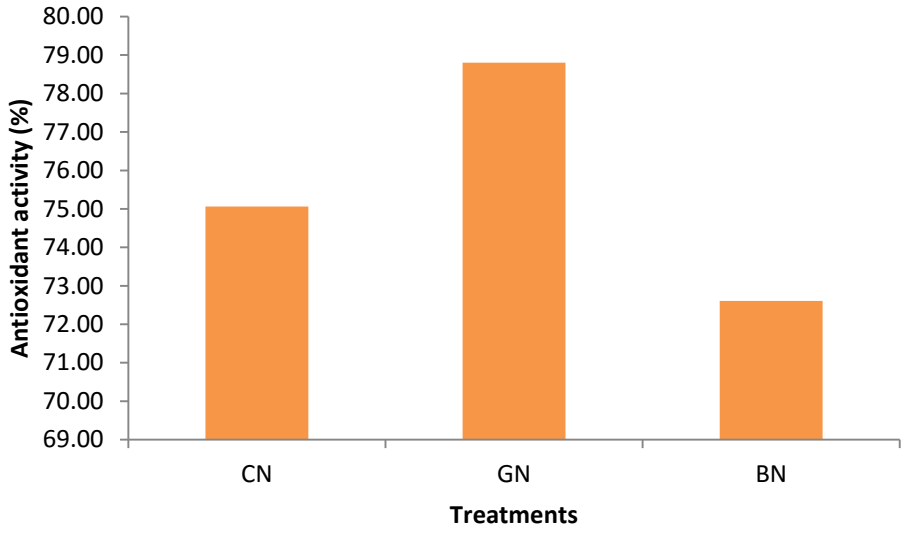


Figure 17. Antioxidant activity of capsicum as influenced by different color shade nets.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.20.2 Effect of varieties on antioxidant activity

The recorded data on antioxidant activities was significantly influence by different varieties (Fig. 18). The highest antioxidant activity (76.81%) was recorded from the treatment R (Lalima) which was significantly different from all other treatments followed by Y (BARI Mistimorich 2). The lowest antioxidant activity (74.29%) was recorded from the treatment G (Peperone Yolo Wonder). According to Selahle *et al.* (2014), significantly higher antioxidant activity was obtained during postharvest storage in tomatoes cultivars 'SCX 248' when grown under red shade nets.

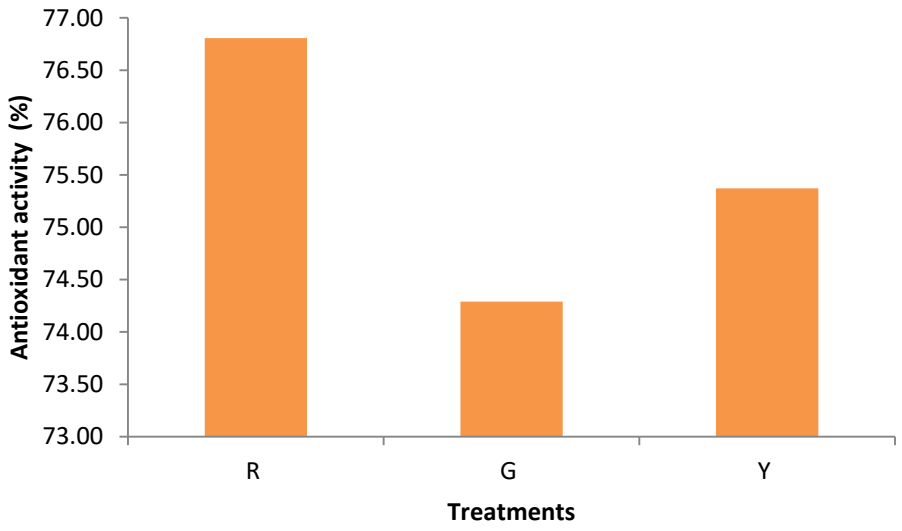


Figure 18. Antioxidant activity of capsicum as influenced by different varieties.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.20.3 Combined effect of shade nets and varieties on antioxidant activity

Different color shade nets and varieties of capsicum showed significant variation on antioxidant activity (Table 16 and appendix X). The higher antioxidant activity (81.16%) was recorded in the treatment combination of G_NR whereas lower antioxidant activity (71.75%) was recorded in the treatment combination of B_NG.

4.21 Anthocyanin determination

4.21.1 Effect of color shade nets on anthocyanin determination

The pigment (total anthocyanin) was investigated for sweet pepper fruits at the wavelength of 500 and 900 nm. Significant variation was remarked on anthocyanin concentration (mg/100gFw) as influenced by different color shade nets (Fig. 19). Highest values (7.71%) was calculated from the treatment G_N (Green net) and lowest (6.07%) from the treatment B_N (Black net).

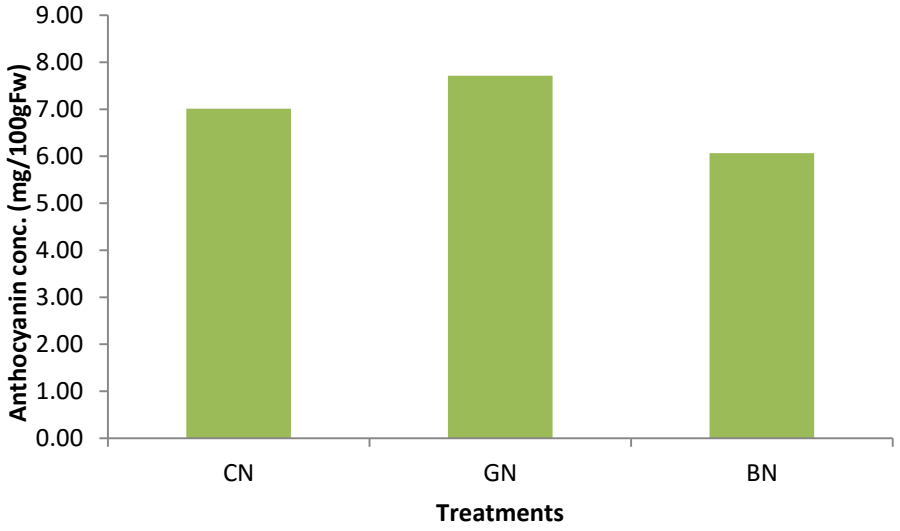


Figure 19. Anthocyanin concentration of capsicum as influenced by different color shade nets.

[C_N - White net (control), G_N - Green net, B_N - Black net]

4.21.2 Effect of varieties on anthocyanin determination

The recorded data on anthocyanin was significantly influence by different varieties (Fig. 20). The highest anthocyanin (9.29%) was recorded from the treatment R (Lalima) which was significantly different from all other treatments followed by Y (BARI Mistimorich 2). The lowest anthocyanin (4.87%) was recorded from the treatment G (Peperone Yolo Wonder). In an experiment, (Zhang *et al*., 2014) reported that dark color chilli pepper results more anthocyanin accumulation.

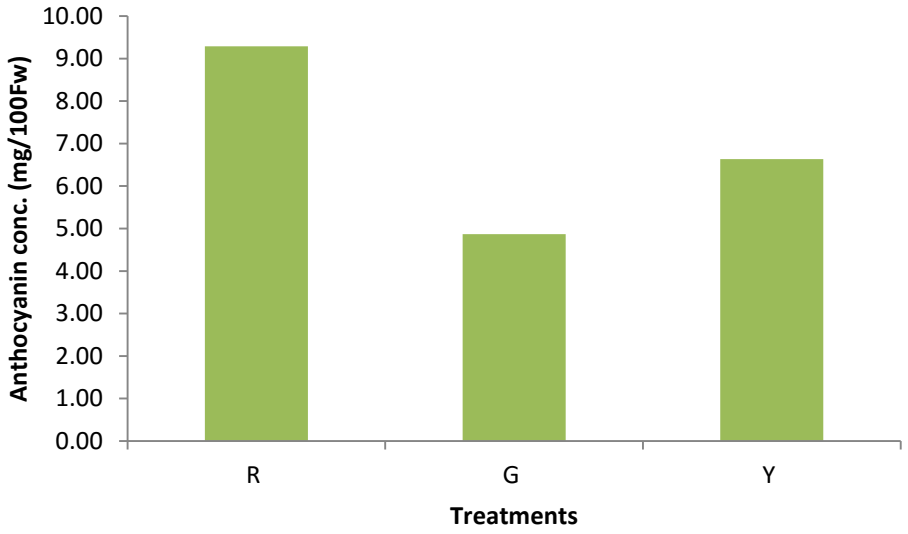


Figure 20. Anthocyanin concentration of capsicum as influenced by different varieties.

[R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder, Y - BARI Mistimorich 2]

4.21.3 Combined effect of shade nets and varieties on anthocyanin determination

Different color shade nets and varieties of capsicum showed significant variation on anthocyanin (Table 16 and appendix X). The higher anthocyanin concentration (10.47%) was recorded in the treatment combination of G_NR whereas lower anthocyanin concentration (4.23%) was recorded in the treatment combination of B_NG.

Table 16. Combined effect of different color shade nets and varieties on total soluble solids, vitamin C and antioxidant activity and anthocyanin concentration of capsicum

Treatment combinations	Total soluble solids	Vitamin C (mg. 100 g^{-1} FW)	Total antioxidant activity (%)	Anthocyanin concentration (mg/100gFw)
C_NR	10.23 a	163.17 b	75.82 cd	9.17 b
C_NG	8.23 c	164.50 a	74.37 de	4.97 f
C_NY	8.77 b	162.00 b	75.00 d	6.90 d
G_NR	7.60 d	157.50 d	81.16 a	10.47 a
G_NG	6.63 e	159.30 c	76.75 c	5.40 ef
G_NY	7.20 d	156.00 e	78.48 b	7.27 d
B_NR	6.10 f	148.83 f	73.43 ef	8.23 c
B_NG	3.80 h	149.50 f	71.75 g	4.23 g
B_NY	5.13 g	146.63 g	72.63 fg	5.73 e
CV%	4.13	0.44	1.12	4.65
$LSD_{(0.05)}$	0.50	1.20	1.47	0.56

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)

G_N - Green net

B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)

G - Peperone Yolo Wonder

Y - BARI Mistimorich 2

4.22 Economic analysis

Input costs for land preparation, fertilizer, irrigation and manpower required for all the operations from seed sowing to harvesting of capsicum were recorded for unit plot and converted into cost Tk/ha (Appendix XI). Price of capsicum was considered as per market rate. The economic analysis presented under the following headings-

4.22.1 Gross return (Tk/ha)

The combination of different shade nets and varieties showed different values in terms of gross return under the trial (Table 17 and appendix XI). The highest gross return (Tk. 6904000) was obtained from the treatment combination G_NR and the second highest gross return (Tk. 5187600) was found in G_NY. The lowest gross return (Tk. 1575600) was obtained from B_NG.

4.22.2 Net return (Tk/ha)

In case of net return, different treatment combination showed different levels of net return under the present trial (Table 17 and appendix XI). The highest net return (Tk. 5282200) was found from the treatment combination G_NR and the second highest net return (Tk. 3636200) was obtained from the combination C_NR. The lowest (Tk. 73800) net return was obtained B_NG.

4.22.3 Benefit cost ratio (BCR)

The combination of different color shade nets and varieties for benefit cost ratio was different in all treatment combinations (Table 17 and appendix XI). The highest benefit cost ratio (4.25) was recorded in G_NR. The lowest benefit cost ratio (1.04) was obtained from B_NG. From the economic point of view, it is apparent that G_NR treatment combination was the most profitable one than rest the of the treatment combinations under the study.

Table 17. Cost and return of capsicum cultivation as influenced by different color shade nets and varieties

Treatment combinations	Cost of production (Tk./ha)	Yield of capsicum (ton/ha)	Gross return (Tk/ha)	Net return (Tk/ha)	Benefit cost Ratio (BCR)
C_N R	1381800	25.09	5018000	3636200	3.63
C_NG	1381800	21.01	2521200	1139400	1.82
C_NY	1381800	22.17	3990600	2608800	2.88
G_NR	1621800	34.52	6904000	5282200	4.25
G_NG	1621800	27.35	3282000	1660200	2.02
G_NY	1621800	28.82	5187600	3565800	3.19
B_NR	1501800	18.8	3760000	2258200	2.50
B_NG	1501800	13.13	1575600	73800	1.04
B_NY	1501800	16.86	3034800	1533000	2.02

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Here,

C_N - White net (control)
G_N - Green net
B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)
G - Peperone Yolo Wonder
Y - BARI Mistimorich 2

CHAPTER V
SUMMARY AND CONCLUSION

Summary

The entitled with "Effects of color shade nets on growth, yield and quality of capsicum" was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2019 to April 2020. The experiment consisted with two factors. Factor A: Three types of color shade nets such as C_N - White color shade net (control), G_N - Green color shade net (25%) and B_N - Black color shade net (40%). Factor B: Three varieties such as R - F1 Hybrid Sweet Pepper (Lalima), G - Peperone Yolo Wonder and Y - BARI Mistimorich 2 .The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The results thus obtained are summarized below:

Temperature (12:00 pm, midday) did not exceed 30.19 °C which was found in C_N. Throughout the duration of the investigation, the minimum (16.77^0C) temperature was found in B_N. The highest relative humidity (RH %) was (81.12%) found in B_N. The lowest relative humidity was 56.73% found in C_N. Solar radiation was highest in C_NR i.e. 948.33 ($W.m^{-2}$). However, lowest solar radiation was found in B_NY and the result was 411.17 ($W.m^{-2}$). The highest UV radiation was (585.00 $mW.cm^{-2}$) found in C_NG and the lowest (16.00 $mW.cm^{-2}$) was found in B_NG. The maximum (25.79^0C) soil temperature was recorded in C_NY whereas minimum (16.85^0 C) soil temperature was recorded in B_NG. The highest (33.45%) soil moisture was recorded in B_NG and the minimum (14.00%) soil moisture was recorded in C_NR.

In case of different color shade nets, The maximum plant height (32.36, 48.83, 64.78 and 73.89 cm), number of branches $plant^{-1}$ (4.67, 5.67, 6.78 and 8.11), number of leaves $plant^{-1}$ (20.67, 32.67, 47.44 and 50.01), leaf length (14.83 18.94, 21.33, 22.12 cm), leaf breadth (6.44, 8.39, 11.19, and 12.19 cm), canopy size $plant^{-1}$ (28.50, 34.00, 48.50 and 51.11 cm) at (25, 50, 75, and 100 DAT, respectively) was recorded from G_N (Green net). The minimum plant height (22.83, 36.72, 49.06 and 52.50 cm), number of branches $plant^{-1}$ (1, 2.11, 3.33 and 4.56), number of leaves $plant^{-1}$ (10.11, 15.44, 29.89 and 32.78), leaf

length (10.50, 11.83, 14.72, 15.78 cm), leaf breadth (6.44, 8.39, 11.19, and 12.19 cm), canopy size plant^{-1} (19.83, 23.22, 31.83 and 34.94 cm) at (25, 50, 75 and 100 DAT, respectively) was recorded from B_N (Black net). The highest days to 1st flowering (83.56) and 50% flowering (118) was recorded from B_N (Black net) and the lowest days to 1st flowering (46.22) and 50% flowering (82.11) was recorded from G_N (Green net). The highest number of flowers plant^{-1} (15.33), fruits plant^{-1} (5.51), fruit length plant^{-1} (8.55 cm), fruit diameter (6.92 cm), fruit weight (50.39 g), yield plant^{-1} (278.11 g), yield (30.23 t/ha), antioxidant activity (78.80%) and anthocyanin concentration (7.71%) was recorded from G_N (Green net) while the lowest number flowers plant^{-1} (9.67), fruits plant^{-1} (3.22), fruit length plant^{-1} (5.70 cm), fruit diameter (4.67 cm), fruit weight (46.34 g), yield plant^{-1} (278.11 g), yield (16.26 t/ha), antioxidant activity (72.61%) and anthocyanin concentration (6.07%) was obtained from B_N (Black net). The highest TSS percentage (9.08%) and Vitamin C content (163.22 mg. 100 g^{-1} FW) was recorded from C_N (control) and the lowest TSS percentage (5.01%) and Vitamin C content (148.32 mg. 100 g^{-1} FW) was recorded from B_N (Black net).

In case of varieties, The highest plant height (29.50, 45.28, 59.67 and 65.50 cm), number of branches plant^{-1} (3.22, 4.22, 6.00 and 7.11), number of leaves plant^{-1} (16.78, 26.89, 42.33 and 44.89), leaf length (14.06, 17.56, 20.00 and 21.00 cm), leaf breadth (5.58, 7.25, 9.42 and 10.53 cm) and canopy size plant^{-1} (27.33, 32.22, 42.83 and 45.67 cm) at (25, 50, 75 and 100 DAT respectively) was recorded from R (Lalima) and where the lowest plant height (25.67, 41.78, 56.44 and 63.11 cm), number of branches plant^{-1} (2.00, 3.00, 4.22 and 5.44), number of leaves plant^{-1} (13, 21.33, 35.89 and 38.46), leaf length plant^{-1} (12.33, 15.39, 17.83 and 18.67 cm), leaf breadth plant^{-1} (4.67, 6.32, 7.89 and 8.89 cm) and canopy size plant^{-1} (23.22, 26.78, 35.06 and 37.77 cm) at 25, 50, 75 and 100 DAT respectively) was recorded from G (Peperone Yolo Wonder). The maximum number of flowers of plant^{-1} (13.78), number of fruits plant^{-1} (4.86), fruit length (7.64 cm), fruit diameter (6.00 cm), fruit weight (49.08 g), yield plant^{-1} (240.48 g), yield (26.14 t/ha), TSS percentage (7.98%), antioxidant activity (76.81%) and anthocyanin (9.29%) was recorded from R (Lalima) where the minimum number of flowers plant^{-1} was (11), number of fruits (3.95), fruit length (6.30 cm), fruit diameter (5.37 cm), fruit weight

(47.29 g), yield plant^{-1} (188.54 g), yield (20.49 ton/ha), TSS percentage (6.22%), antioxidant activity (74.29%) and anthocyanin (4.87%) was recorded from G (Peperone Yolo Wonder). The highest Vitamin C content (157.77 mg. 100 g^{-1} FW) was recorded from G (Peperone Yolo Wonder) and the lowest Vitamin C content (154.88 mg. 100 g^{-1} FW) was recorded from Y (BARI Mistimorich 2).

Different growth, yield and quality of capsicum were significantly influenced by different color shade nets and varieties. Result showed that the highest plant height (34.67, 51.50, 66.00 and 75.17 cm), number of branches plant^{-1} (5.67, 6.67, 8.00 and 9.33), number of leaves plant^{-1} (24.00, 37.00, 52.00 and 54.83), leaf length (15.67, 20.00, 22.33 and 23.33 cm), leaf breadth (6.83, 8.83, 12.08 and 13.08 cm) and canopy size plant^{-1} (30.83, 38.00, 52.33 and 54.83 cm) at (25, 50, 75 and 100 DAT respectively) was recorded from G_NR. The lowest plant height (20.50, 35.33, 47.83 and 51.17 cm), number of branches plant^{-1} (0.67, 1.67, 2.67 and 3.67), number of leaves plant^{-1} (9.33, 14.00, 27.00 and 30.50), leaf length (9.33, 10.67, 13.33 and 14.33 cm), leaf breadth (3.25, 4.17, 5.17 and 6.17 cm) and canopy size plant^{-1} (17.83, 21.33, 28.33 and 31.78 cm) at 25, 50, 75 and 100 DAT respectively) was recorded from B_NG. The maximum days to 1st flowering (86.67) and 50% flowering (120.33) was recorded from B_NG where the minimum days to 1st flowering (44.67) and 50% flowering (80.67) was recorded from G_NR. The highest number of flowers plant^{-1} (17.00), number of fruits plant^{-1} (6.17), fruit length (9.88 cm), fruit diameter (7.40 cm), fruit weight (51.50 g), yield plant^{-1} (317.58 g), yield (34.52 t/ha), antioxidant activity (81.16%) and anthocyanin concentration (10.47%) was recorded from G_NR. The highest fruit TSS (10.23%) was recorded from C_NR. The lowest fruit TSS (3.80%) was recorded from B_NG. The highest vitamin C (164.50 mg. 100 g^{-1} FW) was recorded from C_NG whereas lowest vitamin C (146.63 mg. 100 g^{-1} FW) was recorded from B_NY. The highest gross return (Tk. 6904000) was obtained from G_NR and the lowest gross return (Tk. 1575600) was obtained from B_NG. The highest net return (Tk. 5282200) was found from G_NR and the lowest (Tk. 73800) net return was obtained from B_NG.

Conclusion

Based on the result of the present study, the conclusion may be drawn as among different color shade nets G_N (Green net) gave the best performance in case of growth, yield and quality parameters contributing character. Capsicum F1 Hybrid variety R (Lalima) gave the highest growth, yield and quality than other varieties. Treatment combinations, G_NR gave the highest growth, yield and quality parameters and also gross return of capsicum. Treatment combinations G_NR can be considered as the best among all the treatment combinations. Therefore, it may be concluded that green shade net and F1 Hybrid variety (Lalima) can be commercially utilized for better yield.

REFERENCES

Ambrozy, Z.S., Daood, H., Nagy, Z.S. And Ledo, H.D. (2016). Effect of net shading technology and harvest times on yield and fruit quality of sweet pepper. Applied ecology and environmental research. **14**(1): 99-109.

Ahemd, H. A., Al-Faraj, A. A. and Abdel-Ghany, A. M. (2016). Shading greenhouses to improve the microclimate, energy and water saving in hot regions: a review. Sci. Hort., **201**: 36–45.

Alkalai-Tuvia, S., Goren, A., Perzelan, Y., Weinberg, T. and Fallik, E. (2014). The influence of colored shade nets on pepper quality after harvest-a possible mode-of-action. Agriculture and Forestry. **60**: 7–18.

Arthurs, S. P., Stamps, R. H. and Giglia, F. F. (2013). Environmental modification inside photo-selective shade houses. Hort. Sci. **48**: 975–979.

Appling, S. M. (2012). Colored Shade Affects the Growth of Basil, Cilantro and Parsley. M. S. c. Thesis. Polytechnic Institute and State University, Blacksburg, Virginia.

Bhatt, R. M., Rao, K. S. and Anand, N. (1992). Response of bell pepper to irradiance photosynthesis, reproductive attributes and yield. *Indian J. Hort*., **56**(1):62-66.

Diaz-Perez, J. C. (2014). Bell pepper (*Capsicum annuum* L.) crop as affected by shade level: fruit yield, quality, and postharvest attributes, and incidence of *phytophthora* blight (caused by *Phytophtora capsici* Leon.). Hort. Sci., **49**: 891–900.

Fallik, E., Alkalai-Tuvia, S., Parselan, Y., Aharon, Z., Elmann, A., Offir, Y., Matan, E., Yehezkel, H., Ratner, K., Zur, N. and Shahak, Y. (2009). Can colored shade nets maintain sweet pepper quality during storage and marketing? Acta Hortic., **830**: 37-44.

Farris, N. P. (1988). Perfect Peppers, Horticulture. U.S.A. Horticultural Limited Partnership. Pp. 60-62.

Goren, A., Alkalia-Tuvia, S., Perzelan, Y., Aharon, Z. and Fallik, E. (2011). Photo-selective shade nets reduce postharvest decay development in pepper fruits. Adv. Hort. Sci**., 25**(1): 26-31.

Hasanuzzaman, S. M., Hossain, S. M. M., Ali, M. O., Hossain, M. A. and Hannan, A. (2007). Performance of Different Bell Pepper (*Capsicum annuum* L.) Genotypes in Response to Synthetic Hormones. *Int. J. Sustain. Crop Prod*., **2**(5): 78-84.

Hasanuzzaman, S. M. (1999). Effect of hormone on yield of bell pepper (Capsicum annum L). MS thesis, BAU, Mymensingh.

Hamner, K. C., Bernstein, L. and Maynard, L. A. (1945): Effects of light intensity, day length, temperature, and other environment factors on the ascorbic acid content of tomatoes. *J. of Nutrition*. **29**: 85–97.

Ilic, Z. S., Milenkovic, L., Sunic, L., Barac, S., Mastilovic, J., Kevresan, Z. and Fallik, E. (2017). Effect of shading by coloured nets on yield and fruit quality of sweet pepper Zemdirbyste, Agric., **104**(1):53-62.

Ilic, S. Z., Milenkovic, L., Stanojevic, L., Cvetkovic, D. and Fallik, E. (2012). Effects of the modification of light intensity by color shade nets on yield and quality of tomato fruits. Scientia Hort., **139**: 90–95.

Ilic, Z., Milenkovic, L., Durovka, M. and Kapoulas, N. (2011). The effect of color shade nets on the greenhouse climate and pepper yield. 46th Croatian and 6th International Symposium on Agriculture. Opatija, Croatia. Symposium Proceedings. pp. 529-533.

Iglesias, I. and Alegre, S. (2006). The effect of anti-hail nets on fruit protection, radiation, temperature, quality and profitability of ‘Mondial Gala’ apples. *J. of App. Hort.,* **8** (2): 91–100

Joshi, M. C. and Singh, D. P. (1975). Chemical Composition in bell pepper. *Indian Hort*., **20**: 19-21.

Jones, E. and Hughes, R. E. (1983). Foliar ascorbic acid in some angiosperms. Phytochemistry, **22**: 2493–2499.

Kong, Y., Avraham, L., Perzelan, Y., Alkalai-Tuvia, S., Ratner, K., Shahak, Y. and Fallik, E. (2013). Pearl netting affects postharvest quality fruit in 'Vergasa' sweet pepper via light environment manipulation. Sci. Hort., **150**: 290–298.

Ledone, D. H., Pek, Z., Helyes, L. and Szuvandzsiev, P. (2017). Influence of colour net shading on quantity and quality of sweet pepper yield.

Lopez-Marin, J., Galvez, A. and Gonzalez, A. (2012). Effect of shade on yield, quality and photosynthesis-related parameters of sweet pepper plants. Acta Hort., **956**: 545-552.

Mashabela, N. M., Selahle, M. K., Soundy, P., Crosby, M. K. and Sivakumar, D. (2015). Bioactive compounds and fruit quality of green Sweet Pepper Grown under Different Colored shade netting during postharvest storage. *J. Food Sci*., **80**(11): 2612-2618.

Milenkovic, L., Ilic, Z. S., Durovka, M., Kapoulas, N., Mirecki, N. and Fallik, E. (2012). Yield and pepper quality as affected by light intensity using colour shade nets. Agriculture and Foresty. **58**(1):19-33.

Medany, M. A., Hassanei, M. K. and Farag, A. (2008). Effect of black and white net as alternative covers to sweet pepper production under greenhouse in Egypt. Acta Hort., **807**: 121-126.

Nissim-Levi, A., Farkash, L., Hamburger, D., Ovadia, R., Forrer, I., Kagan, S. and Oren - Shamir, M. (2008). Light-scattering shade net increases branching and flowering in ornamental pot plants. *J. Hort. Sci.*

Perez, D. C. J. (2014). Bell pepper (*Capsicum annum* L.) crop as affected by shade level: fruit yield, quality, and postharvest attributes, and incidence of Phytophthora Blight (caused by *Phytophthora capsici* Leon). Hort. Sci., **49**(7): 891-900.

Paul, T. K. (2009). Technology of sweet pepper production in Bangladesh. PhD Theis. Dept. of Horticulture, BSMRAU, Salna, Gazipur. p. 225.

Rylski, I. and Spigelman, M. (1986). Effect of shading on plant development, yield and fruit quality of sweet pepper grown under conditions of high temperature and radiation. Scientia Hort., **29**: 31–35.

Ryiski, I. and Spigelman, M. (1982). Effects of different diurnal temperature combination on fruit set of sweet pepper. Scintia Hort. **17**: 359-366.

Selahle, K. M., Sivakumar, D., Jifon, J. and Soundy, P. (2015). Postharvest responses of red and yellow sweet peppers grown under photoselective nets. Food chem. **173**: 951-956.

Saha, S. R. and Salam, M. A. (2004). Modern techniques of sweet pepper cultivation. A booklet published by plant physiology section, HRC, BARI, Gazipur.

Shahak, Y. (2014). Photo-selective netting: an overview of the concept, research and development and practical implementation in agriculture. Acta Hort., **1015**: 155–162.

Shahak, Y., Ratner, K., Zur, N., Offir, Y., Matan, E., Yehezkel, H., Messika, Y., Posalski, I. and Ben-Yakir, D. (2009). Photo-selective netting: an emerging approach in protected agriculture. Acta Hortic. **807**: 79-84.

Shahak, Y. (2008). Photoselective netting for improved performance of horticultural crops. A review of ornamental and vegetable studies carried out in Israel. Acta Hort., **770**: 161–168.

Shahak, Y., Ga E., Offir, Y. and Ben-Yakir, D. (2008). Photo-selective shade netting integrated with greenhouse technologies for improved performance of vegetable and ornamental crops. Acta Hort., **797**: 75–80.

Teshm Tadesse Michael, A., Thomas, J.R. and Heilmn, M.D. (1999). Nutrient conductivity effects on sweet pepper plants grown using a nutrient technique. *New Zealand J. crop & Hort. Sci*. **5**(1): 45-49.

Zhang, Y., Butelli, E., and Martin, C. (2014a). Engineering anthocyanin biosynthesis in plants. Curr. Opin. Plant Biol. **19**: 81-90.

APPENDICES

Appendix I: Characteristics of Horticulture Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Horticulture farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
% Sand	27
% Silt	43
% Clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10

Source: Soil Resource Development Institute (SRDI)

Appendices II: Monthly record of air temperature, rainfall, relative humidity, Sunshine of the experimental site during the period from October 2019 to April 2020

Month (2019-2020)	*Air temperature (°c)		*Relative Humidity (%)	*Rain Fall (mm) (total)	*Sunshine (hours)
	Maximum	Minimum			
October, 2019	32	26	72	175	6
November, 2019	30	19	66	35	8
December, 2019	26	14	63	15	9
January, 2020	25	13	54	7	9
February, 2020	28	16	49	25	8
March, 2020	32	20	45	155	7
April, 2020	34	24	55	340	6

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka –1207.

Appendix III: Analysis of variance of the data on temperature (^{0}C) and relative humidity (%)

Source of Variation	Degrees of freedom (df)	Mean Square							
		Temperature(^{0}C)				Humidity (%)			
		Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar
Replication	2	1.11	0.36	0.75	0.17	0.07	0.06	0.13	0.10
Factor A	2	42.42**	5.22**	29.70**	53.92**	36.71**	21.64**	36.65**	32.88**
Factor B	2	0.23^{NS}	0.01^{NS}	0.27^{NS}	4.56**	3.66**	2.60**	4.41**	4.06**
A X B	4	0.14^{NS}	0.10^{NS}	1.55*	0.19^{NS}	0.13^{NS}	0.06^{NS}	0.08^{NS}	0.18*
Error	16	0.92	0.10	0.48	0.16	0.08	0.13	0.08	0.06

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability; NS: Non significant

Appendix IV: Analysis of variance of the data on UV-radiation (mW.cm^{-2}) and solar radiation (W.m^{-2})

Source of Variation	Degrees of freedom (df)	Mean Square							
		UV-irradiance (mW.cm^{-2})				Solar radiation (W.m^{-2})			
		Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar
Replication	2	18.00	5.00	3.00	39.00	16.00	30.00	42 .00	17.00
Factor A	2	218669**	146752**	525717**	596326**	3771848**	2684726**	3947507**	5691673**
Factor B	2	447**	1128**	1499**	2402**	12690**	26241**	6565**	24355**
A X B	4	112**	186**	72**	366**	1853**	4398**	5859**	2489**
Error	16	2.00	3.00	12.00	5.00	33.00	10.00	17.00	44.00

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability; NS: Non significant

Appendix V: Analysis of variance of the data on soil temperature (^{0}C) and soil moisture (%)

Source of Variation	Degrees of freedom (df)	Mean Square	
		Soil temperature (^{0}C)	Soil moisture (%)
Replication	2	1.49	7.13
Factor A	2	98.72**	526.66**
Factor B	2	11.59*	42.52**
A X B	4	2.20^{NS}	12.46**
Error	16	2.34	2.75

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability;
NS: Non significant

Appendix VI: Analysis of variance of the data on plant height and number of branches plant^{-1} at different DAT of capsicum as influenced by different color shade nets and fruit varieties

Source of Variation	Degrees of freedom (df)	Mean Square							
		Plant height (cm)				Number of branches plant^{-1}			
		25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
Replication	2	0.11	1.18	0.19	0.23	1.59	1.92	3.70	3.81
Factor A	2	204.35**	340.73**	598.36**	1062.12**	31.81**	30.26**	26.70**	28.48**
Factor B	2	33.12**	27.95**	23.69**	12.84**	3.37**	3.37**	7.14**	6.26**
A X B	4	1.12^{NS}	1.49*	1.60*	0.09^{NS}	0.37**	0.42**	0.20^{NS}	0.37^{NS}
Error	16	0.42	0.39	0.41	0.59	0.09	0.09	0.24	0.19

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability; NS: Non significant

Appendix VII: Analysis of variance of the data on number of leaves plant^{-1} and canopy size plant^{-1} at different DAT of capsicum as influenced by different color shade nets and fruit varieties

Source of Variation	Degrees of freedom (df)	Mean Square							
		Number of leaves plant^{-1}				canopy size plant^{-1} (cm)			
		25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
Replication	2	0.70	6.33	0.33	0.72	4.73	15.51	14.19	26.37
Factor A	2	255.59**	667.44**	696.44**	668.55**	195.00**	280.95**	633.33**	602.27**
Factor B	2	32.26**	69.44**	93.78**	93.47**	38.48**	66.73**	148.11**	149.59**
A X B	4	6.15**	5.89**	3.22^{NS}	4.58**	1.02^{NS}	3.86^{NS}	8.57^{NS}	6.06^{NS}
Error	16	0.70	0.79	1.50	0.97	2.12	4.38	12.60	14.88
**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability; NS: Non significant									

Appendix VIII: Analysis of variance of the data on leaf length and leaf breadth at different DAT of capsicum as influenced by different color shade nets and fruit varieties

Source of Variation	Degrees of freedom (df)	Mean Square							
		Leaf length (cm)				Leaf breadth (cm)			
		25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
Replication	2	0.45	1.29	5.33	7.028	0.06	0.04	0.002	0.02
Factor A	2	50.04**	131.70**	111.36**	104.54**	14.70**	28.74**	67.08**	64.21**
Factor B	2	6.67^{NS}	12.51*	11.58^{NS}	12.97^{NS}	1.90**	1.96**	5.28**	6.04**
A X B	4	4.00^{NS}	3.26^{NS}	4.15^{NS}	3.69^{NS}	0.06^{NS}	0.11^{NS}	0.08^{NS}	0.03^{NS}
Error	16	3.52	3.38	3.87	3.92	0.09	0.06	0.07	0.07

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability ; NS: Non significant

Appendix IX: Analysis of variance of the data on days to 1st flowering, days to 50% flowering, flower/ plant, fruit plant^{-1}, fruit length, fruit diameter, individual fruit weight, yield plant^{-1} and yield of capsicum as influenced by different color shade nets and fruit varieties

Source of Variation	Degrees of freedom (df)	Mean Square								
		Days to 1st flowering	Days to 50% flowering	No. of flower plant^{-1}	Fruit plant^{-1} (g)	Fruit length(cm)	Fruit diameter (cm)	Fruit weight(g)	Yield plant^{-1} (g)	Yield (t/ha)
Replication	2	4.93	3.37	1.33	0.12	0.04	0.03	0.30	213.80	2.51
Factor A	2	3373.04**	3120.48**	72.33**	11.79**	18.97**	11.91**	37.27**	37211.70**	439.54**
Factor B	2	42.70**	30.48**	17.44**	1.89**	4.03**	0.91**	7.31**	6194.60**	73.13**
A X B	4	1.26^{NS}	0.37^{NS}	0.44^{NS}	0.11^{NS}	1.02**	0.04**	0.23^{NS}	343.90^{NS}	4.07^{NS}
Error	16	1.72	1.37	0.79	0.12	0.11	0.01	0.19	283.80	3.35

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability; NS: Non significant

Appendix X: Analysis of variance of the data on days to color measurement TSS, vitamin C, antioxidant activity and anthocyanin determination of capsicum as influenced by different color shade nets and fruit varieties

Source of Variation	Degrees of freedom (df)	Mean Square							
		L*	a*	b*	Chroma	Total soluble solids (%)	Vitamin C (mg/100 gram of fruit)	Antioxidant activity (%)	Anthocyanin (mg/100gFw)
Replication	2	0.02	0.47	0.11	0.45	0.09	1.48	0.05	0.06
Factor A	2	72.21**	36.60**	106.82**	143.53**	37.24**	509.54**	87.57**	6.14**
Factor B	2	1427.32**	1808.63**	4301.18**	2916.89**	6.95**	18.87**	14.34**	44.62**
A X B	4	17.66**	6.98**	39.64	37.92**	0.45*	0.38^{NS}	2.11*	0.31*
Error	16	0.37	0.36	0.14	0.21	0.08	0.48	0.72	0.10
**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability NS: Non significant;									

Appendix XI: Per hectare production cost of capsicum

A. Input cost

Treatment combination	Labour cost (Tk.)	Seed cost(Tk.)	Irrigation cost (Tk.)	Pesticide cost(Tk.)	Weeding cost(Tk.)	Other Material cost(Tk.)	Fertilizer cost(Tk.)	Shade net cost(Tk.)	Sub input cost (TK.) (A)
C_N R	100000	35000	150000	5000	4000	520000	25000	150,000	989000
C_N G	100000	35000	150000	5000	4000	520000	25000	150,000	989000
C_N Y	100000	35000	150000	5000	4000	520000	25000	150,000	989000
G_N R	100000	35000	150000	5000	4000	520000	25000	350,000	1189000
G_N G	100000	35000	150000	5000	4000	520000	25000	350,000	1189000
G_N Y	100000	35000	150000	5000	4000	520000	25000	350,000	1189000
B_N R	100000	35000	150000	5000	4000	520000	25000	250,000	1089000
B_N G	100000	35000	150000	5000	4000	520000	25000	250,000	1089000
B_N Y	100000	35000	150000	5000	4000	520000	25000	250,000	1089000

Here,

C_N - White net (control)

G_N - Green net

B_N - Black net

R- F1 Hybrid Sweet Pepper (Lalima)

G - Peperone Yolo Wonder

Y - BARI Mistimorich 2

B. Overhead cost (Tk. /ha)

Treatment combination	**Cost of lease of land for 6 months (13% of value of land Tk. 30,00000/year**	**Miscellaneous cost (Tk. 5% of the input cost**	**Interest on running capital for 6 months (Tk. 13% of cost/year**	**Sub total (Tk.) (B)**	**Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]**
C_NR	195000	49450	148350	392800	1381800
C_NG	195000	49450	148350	392800	1381800
C_NY	195000	49450	148350	392800	1381800
G_NR	195000	59450	178350	432800	1621800
G_NG	195000	59450	178350	432800	1621800
G_NY	195000	59450	178350	432800	1621800
B_NR	195000	54450	163350	412800	1501800
B_NG	195000	54450	163350	412800	1501800
B_NY	195000	54450	163350	412800	1501800

Here,

C_N - White net (control) R- F1 Hybrid Sweet Pepper (Lalima)

G_N - Green net G - Peperone Yolo Wonder

B_N - Black net Y - BARI Mistimorich 2

CHAPTER I

INTRODUCTION

CHAPTER II
REVIEW OF LITERATURE

CHAPTER III
MATERIALS AND METHODS

CHAPTER IV
RESULTS AND DISCUSSION

CHAPTER V
SUMMARY AND CONCLUSION