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Effect of coloured shade net on production of *Dracaena fragrans*

Abhay K. Gaurav[*], D.V.S. Raju, T. Janakiram[**], Bhupinder Singh[***], Ritu Jain and S. Gopala Krishnan[****]

Division of Floriculture and Landscaping, ICAR-Indian Agricultural Research Institute, New Delhi 110012

ABSTRACT

An experiment was conducted to study the effect of different coloured shade-nets on production and quality of *Dracaena fragrans*. Plants were grown under different coloured shade-nets, *viz.* red, green, black, and white with 50% shading intensity along with control (without shade net). Different weather parameters and plant growth parameters were measured at different crop growth stages. Coloured shade net exhibited special optical properties and also influenced the microclimate. Cut greens grown under coloured shade-nets gave better performance in terms of plant height, number of leaves, biomass, leaf area, photosynthetic rate, harvest index etc. compared to control. All the shade-nets reduced temperature, light intensity and improved relative humidity. Red and white shade-nets gave higher photosynthetically active radiation (PAR, µmol/m²/s) and transmittance than other coloured nets. Plants grown under red and white shade-nets exhibited better plant height, leaf number, leaf chlorophyll content, leaf area, fresh weight, dry weight, photosynthetic rate and transpiration. The harvest index was superior under red shade net. Red and white shade-nets were found superior in improving plant and weather parameters and hence they can be used in place of the commercially used green shade net for improved growth of dracaena.

Key words: *Dracaena fragrans*, shade-net, leaf area, transmittance, quality.

INTRODUCTION

Cut greens are an important component of the floricultural industry and are largely used for decoration as fillers in floral compositions. They provide freshness, colour and variety to arrangements and bouquets. Dracaena is one of the important cut greens and is used widely for its beautiful foliage. Nets are commonly used in agricultural crops for specific modification of sunlight, improving microenvironment, and providing physical protection. They not only decrease light quantity but also alters light quality to a varying extent and also change other environmental conditions (Smith *et al*., 11). Colour nets represent new agro-technological concept, which not only exhibit special optical properties that allow the control of light, but also have the advantage of influencing the microclimate to which the plant is exposed and offer physical protection against excessive radiation, insect pests and environmental changes (Shahak *et al*., 10).

The utilization of solar radiation by ornamental crops is based on selective filtration of light by different colour shade-nets with special optical properties that modify the quality of natural radiation. Use of these nets aim to optimize desirable physiological responses, resulting in substantial effect on shoot elongation, branching and flowering in ornamentals crops (Oren-Shamir *et al*., 9). The colour shade-nets approach is evaluated in ornamentals (Nissim-Levi, 8), vegetables (Fallik *et al*., 4) and fruit trees (Shahak *et al*., 10). Nettings, regardless of colour, reduce radiation reaching crops underneath which is directly proportional to the shade factor and modify micro-environment. Keeping these facts in view the present study was undertaken to observe the production and quality of dracaena under different colour shade-nets.

MATERIALS AND METHODS

A field experiment was conducted at the Research Farm of the Division of Floriculture and Landscaping, IARI, New Delhi during 2013-14 with *Dracaena fragrans*. The planting was done during September 2013 under four coloured shade-nets (white, red, black and green) with shading intensity of 50%. The micro-environment and production under these shade levels were compared with the outdoor environment (without shade net).

Weather parameters such as temperature and relative humidity were measured by pocket weather tracker. Light measurement was carried out periodically during different growth stages, to monitor the actual light conditions to which the plants were exposed. All the measurements were taken on clear days at mid-day. The light intensity was measured by digital light meter (Extech Instruments, 401025). Transmitted photosynthetically active radiation (PAR) as well as

*Corresponding author's E-mail: gabhaykumar@gmail.com
**ADG (Hort. Sci), KAB-II, New Delhi
***Nuclear Research Laboratory, IARI, New Delhi
****Division of Genetics, IARI, New Delhi

intercepted radiation by plant in each treatment was measured by the Line Quantum Sensor (LiCOR-3000), whereas transmittance inside the net was calculated as the ratio of the PAR radiation spectra inside net and outdoor. Canopy temperature was measured using infrared thermometer. Plant height (cm) was taken up-to the tip of 3rd leaf using standard scale and number of matured leaves was also counted during different growth stages. Leaf readings to determine chlorophyll content were taken with a chlorophyll meter (model SPAD-502) by averaging the 10-15 readings per plant. The photosynthesis/ CO_2 uptake rate (μmol $CO_2/m^2/s$), transpiration (μmol $H_2O/m^2/s$), stomatal conductance (μmol/m^2/s) and PS2 efficiency were taken by LiCor-6400 Leaf Gas Exchange instrument, *i.e.*, Infra-red gas analyzer (IRGA) (Long *et al.*, 7). Fresh leaf weight was taken, and then leaf area was measured using leaf area meter (Licor-3100). The specific leaf area (SLA) was computed using the fresh weight and leaf area. Harvest index (HI) was calculated as percentage of economic yield to the biological yield whereas vase-life was estimated by placing the stem along with leaves in test tube containing distilled water. The trial was laid out in randomized block design (RBD) and the data were analyzed accordingly.

RESULTS AND DISCUSSION

In the present investigation all the shade-nets reduced temperature, light intensity and improved humidity. Black shade net exhibited the lowest temperature, light intensity and highest RH levels. The light intensity was 44.77, 16.53, 34.15 and 40.55% of control for green, black, red and white nets, respectively (Fig. 1). Radiation is the major mode of energy exchange between plant and environment. Solar radiation provides the main energy input to plants, with much of this energy being converted to heat and driving other radiation exchanges and processes such as transpiration and photosynthesis, as well as being involved in determining tissue temperatures with consequences for rates of metabolic processes and the balance between them (Jones, 5). The main climatic parameter affected by shade net is solar radiation, which depends upon type of shade net and density. The coloured shade cloth is designed to modify light in either the ultra-violet, visible, or far-red spectral regions; the cloth also enhances the relative content of scattered vs. direct light and absorbs infra-red radiation (Shahak *et al.*, 10).

The temperature under different coloured shade-nets varied and was found to be higher under control as compared to shade net. Temperature reduction was the highest in black shade net followed by green, white and red, while during winter months, temperature inside the nets was higher compared to control (Fig. 2). Relative humidity was higher under coloured nets even though temperature was low. Relative humidity was highest under black shade net, which was followed by green, red and white as compared to control (Fig. 3). Reduction in radiations resulting from netting affects temperature and RH (Stamps, 13). Reduced air temperature was in agreement with the result of Campanha *et al*. (1). The present study was in agreement with earlier studies that the temperatures reduced by 2-3°C under black shade net and this in turn affects plant processes (Smith *et al.*, 11).

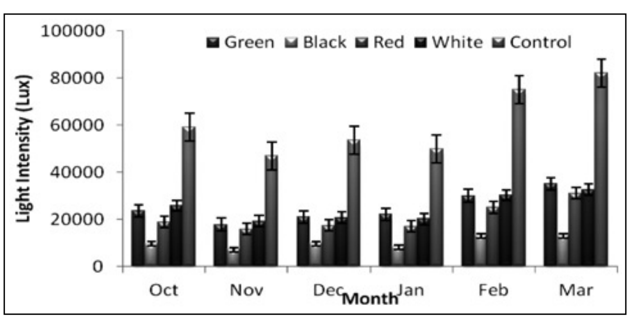

Fig. 1. Light intensity under different coloured nets during different months after planting.

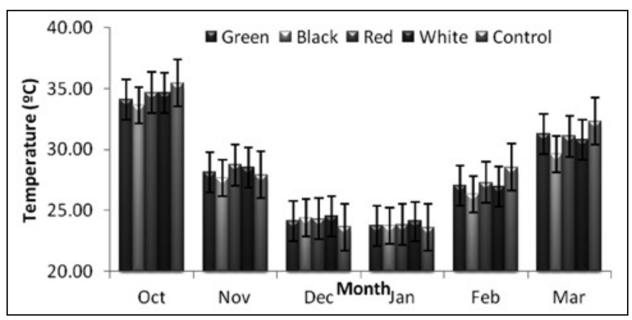

Fig. 2. Air temperature under different coloured nets during different months after planting.

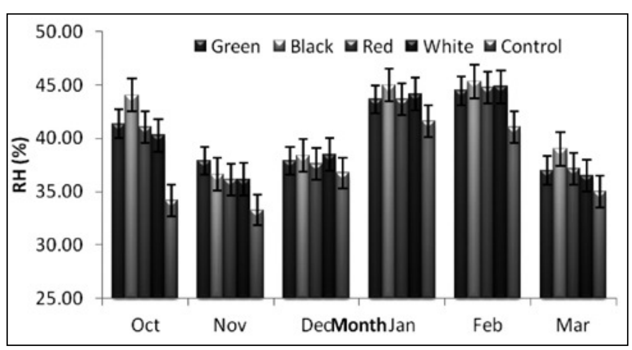

Fig. 3. Relative humidity under different coloured nets during different months after planting.

PAR and transmittance levels were significantly lower under different colour shade nets. White (519.80-648.20 μmol/m^2/s) and Red (459.20-577.00 μmol/m^2/s) shade-nets exhibited higher PAR and transmittance than other colour nets, while, it was minimum under black net (Fig. 4 & 5). The proportion of diffused to direct PAR was significantly higher under green shade net compared to black (Oren-Shamir *et al*., 9).

Canopy temperature under coloured shade-nets was lower as compared to control. Black shade-nets had lowest light, temperature, PAR and transmittance; as a result the plants grown under this had the lowest canopy temperature, fresh and dry weight. Black net (5.40-6.93°C) showed maximum reduction followed by green, white and red. Smith *et al*. (11) also observed that under shade-nets, canopy temperature were lower than those of control. In this study, all the nets improved leaf chlorophyll content. The SPAD reading was found to be significantly higher under coloured net when compared to control. It was found to be higher by 31.22% under white net and by 29.65% under red net compared to control (Table 2).

Chloroplasts were more numerous and larger in plants grown under shading, whilst the accumulation of chloroplastic starch grains was greater in plants grown under red shading or in full sunlight (Costa *et al.*, 2). Because of the above factor photosynthetic rates were higher in white shade net. The photosynthetic activity of the leaves was significantly higher by 41.92% and stomatal conductance under white net over control. The efficiency of photosystem 2 is directly related with CO_2 absorbance. It was maximum under white net as well as control. Transpiration rate was observed highest under white-net followed by red, control, black and green-nets. Overall all the gaseous exchange was found to be higher under white shade net.

Plants grown under different coloured nets had varying growth due to their spectral effect that influences the plant growth. Plants were found to be significantly taller by 24.80% over control with higher number of leaves under red net (Fig. 6 & 7). The present study was in agreement to Kawabata *et al.*

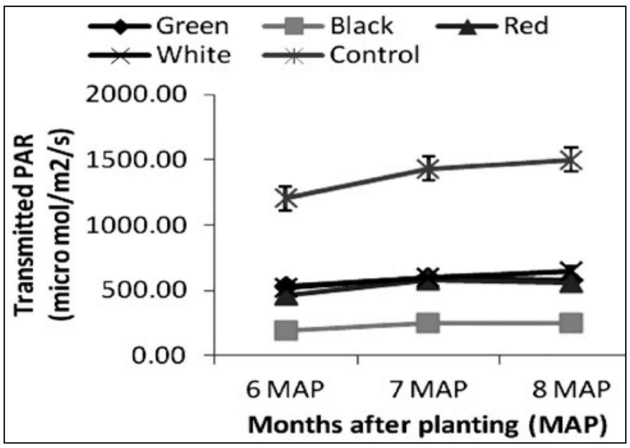

Fig. 4. Transmitted PAR under different coloured nets during different months after planting.

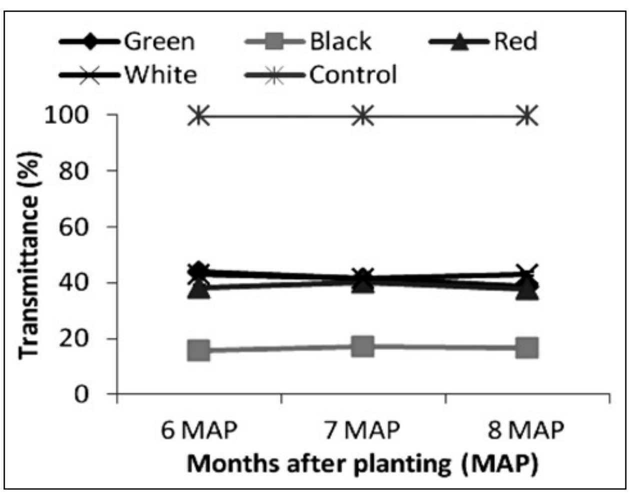

Fig. 5. Transmittance under different coloured nets during different months after planting.

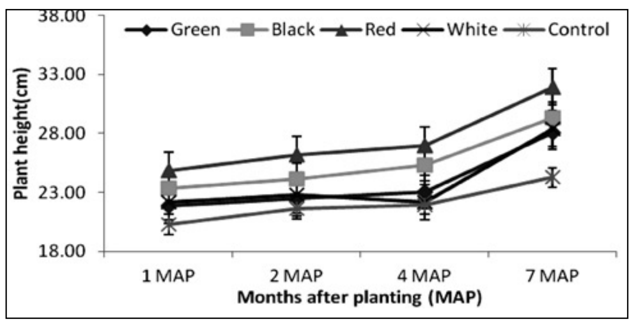

Fig. 6. Influence of coloured shade-nets on plant height at different months after planting.

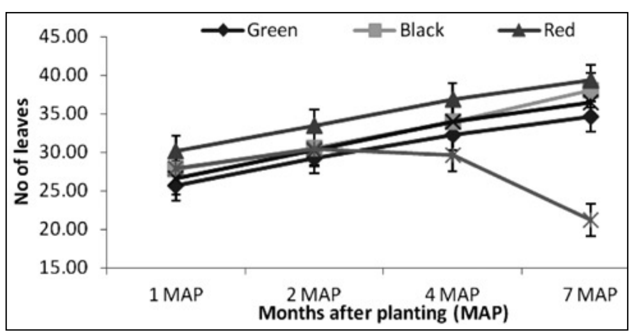

Fig. 7. Influence of coloured shade-nets on number of leaves at different months after planting.

Table 1. The influence of different coloured shade-nets on plant height, number of leaves, chlorophyll content (SPAD), canopy temperature, leaf area, leaf weight, Specific Leaf Area (SLA), gas exchange characteristics and vase-life of dracaena.

Treatment	Plant height (cm)	Leaf No.	SPAD reading	Canopy temp. (°C)	Leaf area (cm^2)	Fresh leaf wt. (g)	SLA (cm^2/g)
Green	23.86 ± 1.21	30.46 ± 1.88	34.87 ± 0.52	26.62 ± 0.10	508.60 ± 25.33	22.47 ± 2.14	22.73 ± 0.82
Black	25.54 ± 0.56	32.60 ± 4.01	37.77 ± 0.39	25.36 ± 0.08	455.45 ± 17.92	20.63 ± 1.62	22.40 ± 1.43
Red	27.51 ± 0.99	34.98 ± 4.68	39.56 ± 0.37	27.53 ± 0.06	543.18 ± 27.20	23.63 ± 2.93	22.70 ± 1.41
White	23.90 ± 1.55	31.86 ± 3.24	40.04 ± 0.94	27.18 ± 0.06	457.23 ± 39.49	20.98 ± 2.89	21.16 ± 0.92
Control	22.04 ± 0.74	27.29 ± 2.23	30.51 ± 0.09	30.81 ± 0.15	317.13 ± 33.15	15.46 ± 1.39	21.25 ± 1.01
$CD_{(0.05)}$	3.216	4.99	1.51	0.27	97.11	NS	1.33

contd...

Treatment	Dry leaf wt. (g)	Gas exchange characteristics				Vase-life (days)
		Photosynthesis rate (μmol $CO_2/m^2/s$)	Stomatal conductance (μmol $H_2O/m^2/s$)	Efficiency of photo system 2	Transpiration rate (μmol $H_2O/m^2/s$)	
Green	4.55 ± 0.50	2.36 ± 0.19	0.005 ± 0.000	0.169 ± 0.010	0.30 ± 0.03	11.50 ± 1.50
Black	3.32 ± 0.18	2.99 ± 0.76	0.005 ± 0.000	0.064 ± 0.015	0.32 ± 0.00	16.00 ± 0.00
Red	4.71 ± 0.68	3.99 ± 0.58	0.010 ± 0.002	0.193 ± 0.005	0.54 ± 0.09	11.50 ± 1.50
White	4.39 ± 0.92	7.59 ± 0.33	0.021 ± 0.001	0.198 ± 0.002	1.08 ± 0.03	19.00 ± 1.00
Control	3.16 ± 0.50	5.35 ± 0.22	0.008 ± 0.001	0.199 ± 0.007	0.38 ± 0.04	10.00 ± 0.00
$CD_{(0.05)}$	1.18	1.09	0.003	0.031	0.16	3.38

Note: Data (mean ± SE) at P<0.05

(6), who had also reported that red shade produced higher number of leaves in dracaena.

Leaf area is an useful parameter of growth as it interprets the capacity of a crop for producing dry matter in term of the utilization of intercepted radiation and amount of photosynthesis synthesized. Leaf area was calculated and results show that leaf area was lowest in control, followed by black, white, green and it was highest under red. The percentage increase in leaf area was nearly 71.28% under red as compared to control (Table 1).

The differences in fresh weight of leaves were insignificant, while the specific leaf area (SLA) value was significant when compared to control but not between green, black and red nets. It was highest under green followed by red and black shade net indicating thinner leaves in shade net compare to outdoor environment. Stomatal density and leaf thickness increased in plants maintained in full sunlight owing to the expansion of the abaxial epidermis and the spongy parenchyma. Dry leaf weight for dracaena was found to be significantly higher under red net and lowest under control. In accordance with study carried by Crowley (3) in the present investigation fresh and dry weight of leaves were highest under red shade net. Plants grown under red and white shade nets exhibited highest HI. Red and white shade-nets gave higher PAR and transmittance than other coloured nets. As a result plants grown under red and white shade nets exhibited better plant height, leaf number, leaf chlorophyll content, leaf area, fresh weight and dry weight, photosynthetic rate and transpiration and thus HI.

Table 2. The influence of different coloured shade-nets on the harvest index.

Treatment	Harvest index (%)
Green	66.06
Black	66.76
Red	70.52
White	68.58
Control	60.00

Vase-life determines the commercial value of cut greens and higher value is always preferred in trade. Vase-life was found higher under white shade net. It was higher by 90% when compared to control (Fig. 8). In the present study, vase-life was found to be superior under white and black coloured nets, which was in contradiction to earlier reports (Stamps and

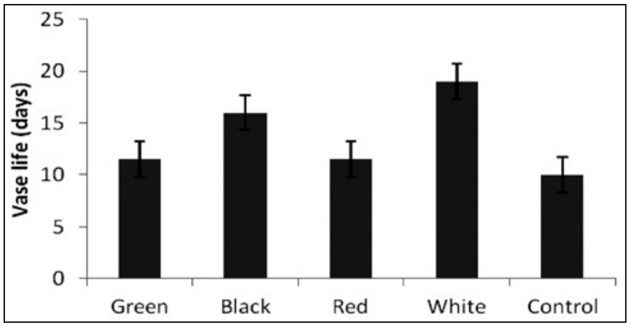

Fig. 8. Influence of coloured shade-nets on vase-life of dracaena cut foliage.

Chandler, 12). This may be due to better protection of the leaves by these nets from high light intensity and thereby improved quality of cut foliage.

Red and white coloured shade-nets were found to be superior in improving most of the plant parameters compared to green net, black net and control. Red shade net has been found to be effective for improving plant height, number of leaves, leaf area and Harvest Index (Table 2), while other important characteristics were superior under white. Hence, it can be recommended to use red and white nets for commercial production of dracaena in place of commonly used green net.

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