



Performance evaluation of *Nephrolepisexaltata* and *Asparagus densiflorus* under different coloured shade nets

Andrew L Myrthong¹ and P. K. Sudhadevi²

¹PG Scholar, Department of Pomology and Floriculture, COH, KAU, E-mail:hortidrew@gmail.com

²Professor and Head, AICFIP, COH, KAU, Thrissur, Kerala

ABSTRACT

*An evaluation of the performance of cut greens *Nephrolepisexaltata* and *Asparagus densiflorus* under five different coloured nets viz., red, yellow, green, blue and black of 50% shade level was carried out during 2015-2016. Light intensity and PAR were reduced inside the shade nets. Both light intensity and PAR were in the ascending order of black, yellow, green, blue and red. In both the plants, red and black coloured nets, positively influenced all the parameters under study viz., plant height, spread, leaf area, length and breadth of leaf and length and girth of petiole. Plants were dwarf and compact when grown under green and blue coloured nets. Total chlorophyll content was maximum under black and minimum under red coloured nets in both the plants.*

Keywords: Coloured nets, *Nephrolepisexaltata*, *Asparagus densiflorus*, Total chlorophyll content

I. INTRODUCTION

Cut foliage is an important part of the florist industry for use as fillers in bouquets, background and lining material in various flower arrangements etc. They bring about a sense of liveliness and activity when used for ornamental purposes. The demand for cut foliage is particularly high during festivals and annual events. Year round production is possible in cut foliage which offers an advantage over the season bound cut flowers. *Nephrolepisexaltata* (sword fern) and *Asparagus densiflorus* (foxtail fern) are two important ferns which are used widely for this purpose. Both of them belong to the tropical regions of the world and favoured for use as indoor plants also.

In protected cultivation, nets have been used for a multitude of reasons viz., protection from pests, diseases, extremes of climate and environmental hazards. A new agro technology has developed recently for the development of coloured shade nets. These nets have the ability to modify the spectrum of the incoming solar radiation, thereby transforming it into scattered light [12]. Due to scattering, the penetration of light in the plant's inner canopy is improved and the desired physiological responses are promoted. These responses include increased plant vigour, dwarfing, better development of root system and canopy, bushiness, leaf size and variegation [8]. The differential effects of coloured shade nets has been studied in ornamentals [7], [8] and [9], fruits [1], [3] and [11] and vegetables [4]. Since, cut greens are usually grown under protected condition, this study, for evaluating the differential effects of coloured shade nets on the performance of selected cut greens was undertaken.

II. MATERIALS AND METHODS

The study was conducted in the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, during 2015-2016 with *Nephrolepisexaltata* and *Asparagus densiflorus*. The plants were grown in pots under five different coloured shade nets (viz., red, yellow, green, blue and black) of 50 per cent shade level. Data on morphological parameters including plant height, spread, leaf area, number of leaves, internodal length, length and breadth of leaves and length and girth of petiole was taken at 3, 4, 9 and 12 MAP. Vase life of the plant was also studied. Total

chlorophyll analysis was done by acetone method. Weather parameters like light intensity and Photosynthetically Active Radiation (PAR) were also measured. Light intensity was recorded using a light meter (Model: LX-1102, Lutron Electronic Enterprise Co., Ltd., Taiwan) and expressed in lux. PAR was recorded using a quantum light meter (Model- 3415 F, Field scout, spectrum technology, Inc. USA) and expressed in $\mu\text{molm}^{-2}\text{S}^{-1}$. The trial was laid out in a Completely Randomized Design (CRD) and data were statistically analysed using Web Based Agricultural Statistics Software Package (WASP 2.0) developed by ICAR Research Complex for Goa, Ela, Old Goa.

III. RESULTS AND DISCUSSION

Based on the results obtained, it was found that both the light intensity as well as PAR were reduced inside the shade nets compared to the open condition. The highest light intensity was recorded under red coloured net while the lowest, was under the black net. PAR also was the highest under red and lowest under black nets. Both light intensity and PAR followed the increasing trend of black<yellow<green<blue<red (Table 1).

The different net colours had a positive influence on *Nephrolepisexaltata*. All the parameters studied showed significant variation almost throughout the year. It was found that plants were tallest when grown under red, followed by black; medium under yellow and shortest under green and blue coloured nets. The spread and number of leaves were more in plants under red and black coloured nets. Leaf characteristics including area as well as length and breadth showed significant improvement under black and red nets compared to other colours. Leaf area was highest under black, leaf length was maximum under red and black and breadth was maximum under black coloured nets. The petiole length and girth was maximum under black and minimum under green and blue coloured nets (Table 2).

In *Asparagus densiflorus*, all the parameters studied except the number of leaves, showed less variation between the net colour. Significant results were obtained only for certain months. With respect to height, tallest plants were under red and shortest under green and blue nets. Plant spread was found to be insignificant except during the 9th MAP. The number of leaves produced significantly varied between the different coloured nets. Plants under red net followed by blue had highest number of leaves while lowest was in plants grown under black coloured net. Leaf area was significant only in the 3rd and 9th MAP. It was found to be higher under red, medium under black while the other three viz., yellow, green and blue were on par. Leaf length and breadth were not much affected by the colour of the nets as no significant results could be obtained except during 12th MAP for leaf length and 3rd MAP for leaf breadth. Petiole was the longest under black and red while it was equal for plants under yellow, green and blue nets. Petiole girth was the highest under black followed by red but during 12th MAP, plants under red, yellow and green recorded values which were on par with plants under black net. The plants under blue net had the minimum girth (Table 3).

An increase in plant height under red may be due to the reduced R:FR ratio or the deficiency of blue light [6]. The reduced growth of plants under blue net may be attributed to the blue light-phytochrome B-cryptochrome effect which reduces the transport of auxin [2]. The transport of auxin is generally reduced on that part of the plant which absorbs blue light in the phototropic gap filling response. Since the plants grown under blue colour shade net are likely to receive blue light from all directions, it is possible that the reduction in auxin transport minimizes the elongation of cells surrounding the stem just beneath the zone of cell division of the apical meristem, leading to reduced elongation of stem just as in the case of chrysanthemum and easter lilies [5] and [10].

The total chlorophyll as well as carotenoid concentration of both the plants were higher under black and lower under red coloured nets (Table 4). The results corroborates the findings of Stamp and Chandler [13] who found greater chlorophyll content in *Pittosporumtobira* 'Variegata' under

black and blue coloured nets. This is associated with the low levels of PAR and light intensity recorded under black net. Although the plants were not directly exposed to sun, they produced additional chlorophyll to capture the diffuse radiation in order to produce carbohydrates required for their growth and development [4].

IV. CONCLUSION

The study revealed that red and black net enhanced the elongation of stem and petioles respectively which is a desirable trait with regards to the cut flower industry, thus fetching a higher price in the market. The compactness of plants grown under blue net could be successfully employed in interior plants capping which is a need of the hour for green-building concepts in urban areas.

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Table 1. Weather data collected during the trial period

Weather parameter	MAP	Coloured shade nets					Open condition
		Red	Yellow	Green	Blue	Black	
Light intensity (lux)	3	41920.00	30916.00	32420.00	37664.00	13808.00	116340.00
	6	35127.27	23850.00	26563.64	30477.27	12018.18	105200.00
	9	37409.52	24676.19	27342.86	34409.52	14395.24	107485.71
	12	41408.70	30526.09	33365.22	37617.39	16373.91	112652.17
PAR ($\mu\text{molm}^{-2}\text{S}^{-1}$)	3	554.80	396.40	378.60	500.20	199.60	1040.60
	6	906.00	590.25	648.50	849.75	219.50	1433.75
	9	794.20	525.60	629.80	676.20	254.40	1402.00
	12	1200.25	791.50	798.50	982.50	477.50	1907.75

Table 2. Effect of coloured nets on the growth of *Nephrolepisexaltata*

S.No.	Plant parameters	MAP	Coloured shade nets				
			Red	Yellow	Green	Blue	Black
1	Height (cm)	3	47.79 ^a	46.42 ^{ab}	43.98 ^{abc}	41.89 ^c	42.20 ^{bc}
		6	64.41 ^a	57.79 ^b	51.73 ^c	52.04 ^c	58.08 ^b
		9	65.19 ^a	60.90 ^b	53.23 ^c	55.95 ^c	65.90 ^a
		12	67.15 ^a	57.58 ^b	52.87 ^c	52.86 ^c	65.12 ^a
2	Spread (cm ²)	3	1492.03 ^a	1181.16 ^b	1227.13 ^b	1046.16 ^b	1129.50 ^b
		6	3876.33 ^{ab}	3407.50 ^{bc}	2670.58 ^c	2951.50 ^c	4428.08 ^a
		9	3518.91 ^a	3637.95 ^a	2057.71 ^c	2556.08 ^b	3519.25 ^a
		12	4297.96 ^a	3068.51 ^b	2626.52 ^b	3021.48 ^b	4499.10 ^a
3	Leaf area (cm ²)	3	173.5	137.5	158	141.87	173.75
		6	210.00 ^{ab}	208.50 ^b	151.12 ^c	155.37 ^c	247.25 ^a
		9	219.57 ^{ab}	204.00 ^{bc}	184.37 ^c	176.25 ^c	252.12 ^a
		12	212.00 ^b	209.50 ^b	151.00 ^c	157.25 ^c	251.00 ^a
4	Number of leaves	3	43.16 ^a	35.58 ^{bc}	40.25 ^{ab}	35.33 ^c	43.41 ^a
		6	44.75 ^{ab}	36.08 ^c	41.08 ^{abc}	40.50 ^{bc}	48.00 ^a
		9	55.00 ^a	48.25 ^b	47.66 ^b	54.08 ^{ab}	58.00 ^a
		12	46.58	46.00	44.16	47.83	48.33
5	Leaf length (cm)	3	36.27	35.10	34.06	38.45	38.59
		6	49.20 ^a	47.91 ^a	41.98 ^b	43.45 ^b	48.06 ^a
		9	55.22 ^a	49.04 ^b	45.10 ^c	48.06 ^{bc}	54.15 ^a
		12	52.60 ^a	44.58 ^b	43.44 ^{bc}	40.95 ^c	53.12 ^a
6	Leaf breadth (cm)	3	4.25 ^b	3.85 ^c	3.95 ^c	4.15 ^b	4.70 ^a
		6	4.73 ^a	4.37 ^{ab}	3.90 ^b	3.75 ^b	5.04 ^a
		9	4.50 ^b	4.46 ^{bc}	4.18 ^{cd}	4.08 ^d	5.65 ^a
		12	4.54 ^b	4.52 ^b	4.38 ^b	3.79 ^c	5.00 ^a
7	Petiole length (cm)	3	6.72 ^{bc}	7.58 ^{ab}	6.30 ^c	6.67 ^{bc}	8.00 ^a
		6	10.91 ^a	10.83 ^a	9.08 ^b	8.16 ^b	11.50 ^a
		9	12.83 ^a	11.75 ^a	9.58 ^b	9.29 ^b	13.34 ^a
		12	14.02 ^{ab}	12.57 ^b	12.45 ^b	12.99 ^b	14.86 ^a
8	Petiole girth (cm)	3	0.30 ^b	0.25 ^{bc}	0.23 ^c	0.24 ^c	0.35 ^a
		6	0.35 ^b	0.31 ^b	0.38 ^b	0.31 ^b	0.49 ^a
		9	0.45	0.40	0.36	0.42	0.45
		12	0.46 ^a	0.46 ^a	0.36 ^b	0.46 ^a	0.49 ^a

Table 3. Effect of coloured nets on the performance of *Asparagus densiflorus*

S.No.	Plant parameters	MAP	Coloured shade nets				
			Red	Yellow	Green	Blue	Black
1	Height (cm)	3	27.78 ^a	24.24 ^b	23.26 ^{bc}	23.26 ^{bc}	27.16 ^a
		6	31.41	31.12	31.07	31.07	30.41
		9	36.91	35.00	35.41	35.41	36.00
		12	39.39 ^a	37.77 ^{ab}	35.41 ^{bc}	35.41 ^{bc}	38.25 ^{ab}
2	Spread (cm ²)	3	560.53	602.75	640.70	544.81	657.08
		6	1179.66	1051.58	1032.58	872.91	1050.25
		9	1193.91 ^{ab}	1080.45 ^{ab}	1013.50 ^{bc}	887.25 ^c	1212.04 ^a
		12	1573.10	1453.73	1531.02	1414.62	1534.25
3	Leaf area (cm ²)	3	145.20 ^a	109.35 ^b	122.25 ^{ab}	112.25 ^b	133.87 ^{ab}
		6	164.00	137.25	127.50	134.37	145.37
		9	189.00 ^a	145.50 ^b	134.95 ^b	150.62 ^b	161.12 ^{ab}

S.No.	Plant parameters	MAP	12	142.25	140.25	187.75	189.00
			Coloured shade nets				
			Red	Yellow	Green	Blue	Black
4	Number of leaves	3	27.75 ^{ab}	22.16 ^c	23.83 ^{bc}	29.83 ^a	23.66 ^{bc}
		6	42.41 ^a	31.83 ^b	39.83 ^{ab}	39.41 ^{ab}	22.33 ^c
		9	47.75 ^a	43.66 ^a	42.58 ^a	48.25 ^a	25.25 ^b
		12	45.33 ^a	38.41 ^{ab}	32.50 ^b	42.25 ^a	32.50 ^b
5	Leaf length (cm)	3	22.12	21.27	22.55	21.35	23.85
		6	24.66	24.66	22.90	25.95	25.16
		9	30.16	31.08	29.41	32.16	32.36
		12	33.25 ^a	29.32 ^{ab}	26.34 ^b	30.75 ^a	32.10 ^a
6	Leaf breadth (cm)	3	6.72 ^{ab}	5.95 ^{bc}	5.44 ^c	5.86 ^{bc}	7.22 ^a
		6	6.83	6.95	6.17	6.41	6.60
		9	7.62	7.16	7.66	6.91	7.91
		12	7.32	6.56	7.36	7.82	7.20
7	Petiole length (cm)	3	1.38	2.19	2.34	2.00	2.45
		6	6.50 ^a	4.08 ^b	5.08 ^b	4.08 ^b	6.34 ^a
		9	6.40 ^a	4.41 ^b	4.25 ^b	5.08 ^b	6.50 ^a
		12	7.59	8.35	9.20	8.50	9.84
8	Petiole girth (cm)	3	0.41 ^a	0.34 ^{abc}	0.34 ^{bc}	0.27 ^c	0.41 ^a
		6	0.47	0.43	0.39	0.42	0.47
		9	0.46 ^b	0.45 ^b	0.52 ^{ab}	0.34 ^c	0.55 ^a
		12	0.59 ^a	0.58 ^a	0.55 ^a	0.42 ^b	0.57 ^a

Table 4. Total chlorophyll concentration of plants under different coloured shade nets

Treatments	Total chlorophyll concentration		Carotenoid concentration	
	<i>Nephrolepisexaltata</i>	<i>Asparagus densiflorus</i>	<i>Nephrolepisexaltata</i>	<i>Asparagus densiflorus</i>
Red	0.92 ^c	1.13 ^b	0.28 ^c	0.31 ^c
Yellow	1.29 ^b	1.33 ^a	0.36 ^b	0.40 ^b
Green	1.29 ^b	1.26 ^{ab}	0.34 ^{bc}	0.44 ^{ab}
Blue	1.08 ^{bc}	1.32 ^a	0.32 ^{bc}	0.39 ^b
Black	1.57 ^a	1.37 ^a	0.46 ^a	0.48 ^a