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Short Communication

Manipulation of shade and plant density for enhanced production of cut-foliage in *Ruscus hypophyllum* L.

Ranjit Singh*, Parminder Singh and Jaswinder Kaur
Department of Floriculture and Landscaping PAU, Ludhiana - 141 004
*Email: ranjit_flori@pau.edu

ABSTRACT

Cut foliage are deep green with long lasting and evergreen properties which are commonly preferred by the floral industry as accents in floral arrangements. *Ruscus hypophyllum* L. is one of the commercially produced cut foliage material for making good line, filler and mass material in making floral arrangements. It requires shade for growth. Experiments were conducted with the objectives to find out optimum shade levels and planting density. The rhizomes were planted in factonal randomized block design under three shade levels (0, 50% and 75%) and three plant spacing (30x30 cm, 30x40 cm, 30x50cm) with planting density of 18, 15, and 12 plants per m^2, respectively. It was observed that different shade levels and plant spacings exhibited significant effect on plant height, stem diameter, number of leaves, leaf size and number of stems harvested per plant. The plants were recorded tallest under 75 % shade levels and 30x30 cm plant spacing (61.30cm and 54.48 cm, respectively). The number of leaves produced per plant were maximum (69.99) under 75% shade, however, number of leaves per plant were maximum under 30x30cm spacing. Among various shade levels, 75% shade level resulted in maximum number of cut stems (16.28) that was at par with 50% shade level (16.08). However, the cut stems harvested per plant were recorded maximum (16.67) under 30x30cm spacing. From the results obtained, it was concluded that *Ruscus hypophyllum* grown under 75% shade level with 30x30 cm spacing and planting density of 18 plants per m^2, produced maximum yield of cut stems with longer stem length.

KEYWORDS: Shade level, cut foliage, planting density, *Ruscus hypophyllum*

Cut foliages are important component of the floricultural industry, largely used as fillers in bouquet making and flower arrangements. In general, plants that are deep green with long lasting evergreen properties are commonly used by the floral industry as accents in floral arrangements (Schlosser and Blatner, 1997). The foliage from a wide range of plants is used in florist industry. Some important plants include *unitalies, Asparagus, Ruscus hypophyllum, Dracaena, Codiaeum variegatum, Aspidistra elatior, Hedera helix, Cyperus*, some wild grasses *etc.* Apart from these, foliage and branches from some woody plants such as species of Eucalyptus, Bottlebrush, Euonymus, *Murraya paniculata, Cycas revoluta*, *Cycas circinalis, Livistona*, palms etc. are also used (Bhattacharjee, 1999). There is a tremendous increase in economic importance of cut foliage production in the ornamental industry. In India with changing life styles and increased urban affluence, floriculture has assumed a definite commercial status in recent times, particularly during the past 2-3 decades. Availability of natural resources like diverse agro-climatic conditions permit production of a wide range of temperate and tropical flowers and cut greens, almost all through the year in some parts of the country. Though India is leading supplier of dry flowers, dry and fresh foliage to Europe, the market share of all these three products put together is only 5.4%. In cut foliage, it is observed that the value of Indian exports was USD 7.28 millions. The trade of foliage indicates that India has emerged as the top most suppliers among the developing countries and has been successful in developing a sustainable market in the EU (Ladha and Gunjal, 2011). So keeping the importance and potential of cut foliage in international scenario, study was planned to evaluate the effects of modified shade levels combined with planting density on production of cut foliage of *Ruscus hypophyllum* L.

The experiments were conducted at the research farm of the Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana during 2014-2015. Three shade levels open, 50% and 75% were created with the help of green agro shade nets nand arched GI pipes. The shade nets were fixed on the arched GI pipes with the help of plastic ropes. The structure was erected in North - South direction. Beds of two meter square area were prepared under these nets and sprouted rhizomes of *Ruscus hypophyllum* were planted at three different plant densities i.e., S1 (18 plants per square meter, spacing 30x30 cm), S2 (15 plants per square meter, spacing 30x40 cm), and S3 (12 plants per square meter, spacing 30x50 cm) in these beds. The experiment was conducted in factorial randomized block design with three replications. The data were recorded on plant height (cm), plant spread (cm), stem diameter (cm), number of leaves, leaf diameter (cm), leaf length (cm), and number of stems harvested. Data recorded, thus were, analyzed using cpcs1 computer software to draw the appropriate conclusion.

Different shade levels significantly affected the plant height and plant spread (Table 1). Plant height was recorded maximum (61.30 cm) under 75% shade level. The close planting in S1 (30x30cm) resulted in tall plants as compared to S2 (30x40cm) and S3 (30x50 cm). It may be attributed to the fact that closer plant spacing resulted in more vertical growth. However, different shade levels exhibited non significant effect on plant height. However, plant spacing linearly increased the plant spread. Under closer plant spacing the plants exhibited lesser plant spread and *vice versa*. Shade levels did not exhibit any significant affect on plant spread. Stamps (1997) reported that the growth, both vertical and horizontal in case of *Ruscus* increased linearly with increasing shade levels from 30 to 80 per cent whereas the response of stem length and weight to shade level peaked in the 50-80% shade range.

Table 1: Effect of different shade levels and plant spacings on plant height and plant spread of *Ruscus hypophyllum* L.

Shade levels	Plant height (cm)			Mean	Plant spread (cm)			Mean
	S1 (30x30 m)	S2 (30x40cm)	S3 (30x50cm)		S1 (30x30 cm)	S2 (30x40 cm)	S3 (30x50cm)	
Open field conditions	25.87	23.00	20.93	23.27	40.25	46.13	51.37	45.91
50% shade	68.83	63.33	40.67	57.61	42.90	47.70	52.10	47.56
75% shade	68.83	59.82	55.33	61.30	43.17	46.70	53.03	47.63
Mean	54.48	48.72	38.98		42.11	46.84	52.16	
LSD (0.05)	Shade levels (A) =7.66 Spacing (B) = 6.65 AxB =N.S				Shade levels (A) =N.S. Spacing (B) = 2.51 AxB =N.S			

Table 2: Effect of different shade levels and plant spacings on stem diameter and number of leaves of *Ruscus hypophyllum* L.

Shade levels	Stem diameter (cm)			Mean	Number of leaves			**Mean**
	S1 (30x30cm)	S2 (30x40cm)	S3 (30x50cm)		S1 (30x30cm)	S2 (30x40cm)	S3 (30x50cm)	
Open field conditions	0.60	0.49	0.49	0.52	81.73	46.47	19.27	49.15
50% shade	0.61	0.57	0.52	0.56	89.40	55.00	27.73	57.37
75% shade	0.57	0.53	0.57	0.56	116.86	55.93	37.17	69.99
Mean	0.59	0.53	0.53		96.00	52.47	28.05	
LSD (0.05)	Shade levels (A) =N.S Spacing(B) = 0.41 AxB =N.S				Shade levels (A) =14.20 Spacing (B) = 13.11 AxB =N.S			

Stem diameter showed close relationship with plant density, while, different shade levels did not affect the same (Table 2). The number of leaves (phylloclades) produced per plant were maximum (69.99) under 75% shade levels, however, number of leaves per plant were maximum under S_1 (30x30cm) spacing. Heavy shades produce fewer but longer stems with large cladodes than the lower shade (Anonymous, 2006). The Number of leaves /stem is also reported high under 50-80% shade range (Stamps 1997).

Leaf size showed significant variation with respect to the different shade levels (Table 3). Leaf breadth was maximum (3.35 cm) in the plants which were grown under 75% shade level. It was also observed that leaves were broader (3.74 cm) in S1 (30 x30cm) which may be attributed to change in microclimatic conditions under high density planting resulting in positive effects on leaf expansion. Similar trends were also observed for leaf length. Heavy shades produces long stems with large sized leaves (cladodes in case of *Ruscus*) than the lower shade Anonymous (2006).

The *Ruscus* is sold in the market as cut stem which in turn has different uses. The different shade levels and plant spacings resulted in significant variations in the number of saleable cut stems harvested per plant. Amoung various shade levels, 75% shade level resulted in maximum number of cut stems (16.28) which were at par with 50% shade level (16.08). However, the cut stems harvested per plant were recorded maximum (16.67) under S1(30x30cm) spacing. The plant density under S1 (30x30 cm) spacing had maximum of 18 plant/m^2 as compared to S1 (15 plants/m^2) and S3 (12 plants /m^2) spacing. Thus, the cut stem harvested per plant were recorded maximum in the plants which were planted 30x30 cm apart. Marino *et al* (2003) concluded that higher planting density increases the number of stems and total fresh weight *Asparagus plumosus* Baker and *Asparagus densiflorus* Jessop cv.

Table 3: Effect of different shade levels and plant spacing on leaf (Cladode) size of *Ruscus hypophyllum* L.

Shade levels	Leaf breadth (cm)			Mean	Leaf length (cm)			Mean
	S1 (30x30cm)	S2 (30x40cm)	S3 (30x50cm)		S1 (30x30 m)	S2 (30x40cm)	S3 (30x50cm)	
Open	3.67	2.20	1.07	2.31	8.33	5.23	2.40	5.32
50% Shade	3.67	3.05	2.20	2.97	7.85	7.23	5.39	6.76
75% Shade	3.89	3.50	2.66	3.35	7.43	7.28	5.57	6.82
Mean	3.74	2.92	1.98		7.87	6.58	4.45	
LSD (0.05)	Shade levels (A) =0.18;Spacing (B) = 0.20 AXB=0.34				Shade levels (A) =1.02 ;Spacing (B) = 1.15 AXB =N.S			

Table 4: Effect of different shade levels and plant spacing on number of stems harvested per plant in *Ruscus hypophyllum* L.

Shade levels	Number of stems harvested per plant			Mean
	S1 (30x30 cm)	S2 (30x40cm)	S3 (30x50cm)	
Open	12.04	10.40	10.07	10.84
50% Shade	18.62	15.11	14.52	16.08
75% Shade	19.35	15.23	14.25	16.28
Mean	16.67	13.58	12.95	
LSD (0.05)	Shade levels =3.5; Spacing = 3.64, ;Shade x spacing =N.S			

It is concluded that *Ruscus hypophyllum* L. grown under 75% shade levels with 30x30 cm spacing and plant density of 18 plants per square meter, produced the maximum yield of cut stems with longer stem length.

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