Research Journal of Agricultural Sciences
Volume 16; Issue 01 (Jan–Feb 2025); pp 111–115

Full Length Research Article

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Optimizing Spacing and Nutrient Doses for Enhanced Growth and Foliage Yield in *Dracaena fragrans* cv. Massangeana

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Received: 22 Nov 2024; Revised accepted: 16 Feb 2025

Abstract

This study investigates the effects of plant spacing and nutrient doses on the growth and yield of *Dracaena fragrans* cv. Massangeana, a popular ornamental cut foliage. The experiment was laid out in randomized block design with ten treatment combinations including two levels of spacing (S_1- 60 x 60 cm, S_2- 75 x 60 cm) and five levels of fertilizer dose (N_1- 24:6:12 N: P_2O_5: K_2O g/plant/year, N_2- 48:6:12 N: P_2O_5: K_2O g/plant/year, N_3- 72:6:12 N: P_2O_5: K_2O g/plant/year, N_4- 100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval, N5- absolute control). The results showed that a closer spacing of 60 x 60 cm (S_1) significantly boosted plant height, leaf count, leaf length, width, leaf area, fresh weight and dry weight of leaves and chlorophyll content. Among the nutrient treatments, application of fertilizer dose with the highest nitrogen concentration (N_3-72:6:12 N: P_2O_5: K_2O g/plant/year) showed superiority in most of growth and yield parameters including plant height, plant spread, leaf area, number of leaves, fresh and dry weight of leaves and roots, vase life, and chlorophyll content. Leaf longevity and leaf production interval were highest under absolute control (N_4).

***Key words*:** Dracaena, Massangeana, Cut foliage, Nutrient management, Corn plant

Cut greens or cut foliage, consisting of leaves and stems, are appreciated for their form, color, and freshness, and are currently in high demand due to their longevity. Cut greens or cut foliage, which include various leaves and stems harvested from plants, play a crucial role in floral arrangements and decorative displays [1]. These natural elements are valued not only for their aesthetic appeal—offering diverse forms, textures, and shades of green—but also for their ability to complement and enhance the visual impact of flowers and other ornamental components [2]. One of the key reasons for their increasing demand is their longevity. Compared to flowers, many types of cut foliage remain fresh for an extended period, making them a cost-effective and sustainable choice for florists, event planners, and home decorators. Their durability ensures that arrangements maintain their freshness and vibrancy for longer durations, reducing the need for frequent replacements [3]. Additionally, cut foliage is widely used in bouquets, wreaths, and interior décor due to its versatility. Certain varieties, such as eucalyptus, ferns, and ruscus, also offer subtle fragrances, adding another dimension to their appeal. With the growing preference for natural and eco-friendly décor solutions, cut greens have become a staple in the floral industry, driving their rising market demand [4].

The modern cut flower industry cannot flourish without the cut foliage sector, which has emerged as a thriving industry in many countries, as it is a crucial component of floral arrangements. Cut foliage has significant potential as an alternative to flowers, particularly during lean periods, yet it remains largely unexploited. The proportion of perishable decorative greens used as fillers in bouquet making has increased notably from about 5 percent to 20-25 percent [5]. A wide variety of tropical foliage plants make excellent sources for cut foliage, with humid tropical and subtropical climates, like those in India, providing ideal conditions for their cultivation.

Dracaenas, one of the most significant and diverse groups of cut foliage, are highly popular and extensively used in both landscaping and flower arrangements. Among different species of Dracaena, *Dracaena fragrans* cv. Massangeana (corn plant), a member of the Asparagaceae family is characterized by its broad arching leaves with a central yellow stripe. It is primarily popular as a houseplant, valued for its tolerance of a wide range of indoor conditions from full sun to low light conditions and is extensively used in flower arrangements [6]. In India, particularly in regions like Kerala with favourable climatic conditions for foliage plants, *Dracaena fragrans* 'Massangeana' can be cultivated as an intercrop. This adaptability and resilience make it a valuable addition to the cut foliage market.

The production of attractive cut foliage requires optimum crop management practices, especially with regard to spacing and fertilizer control. Sufficient spacing allows plants to spread their roots and access the necessary nutrients in the soil. Plants also require an adequate supply of both organic and

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Citation: Mohan N, Basheer SN, Sankar M, Fernandez S, Jayasree P. 2025. Optimizing spacing and nutrient doses for enhanced growth and foliage yield in *Dracaena fragrans* cv. Massangeana. *Res. Jr. Agril. Sci.* 16(1): 111-115.

inorganic nutrients in the proper form and at the right time to support their growth and development. The growing demand for this crop in domestic and international markets highlights the need for a proper package of practices, with specific recommendations on spacing and nutrient management, prompting the present study to standardize these practices for *Dracaena fragrans* cv. Massangeana.

MATERIALS AND METHODS

The present investigation was carried out in Department of Floriculture and Landscaping, College of Agriculture, Vellanikkara. One year old rooted cuttings of *Dracaena fragrans* cv. Massangeana was used for the study. The experiment was laid out in randomized block design with two levels of spacing viz., S_1: 60 x 60 cm and S_2: 75 x 60 cm and five levels of nutrient doses viz., N_1: 24:6:12 NPK g/plant/year, N_2: 48:6:12 g/plant/year, N_3: 72: 6: 12 g/plant/year, N_4:100g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval and N_5: absolute control with three replications. Bed was prepared at a size of 5 m x 1.2 m with 18 plants in each bed. Farm yard manure at 10 t/ha and entire dose of P_2O_5 were applied as basal dose. N and K_2O were applied in two equal split doses at six months interval.

Observations on vegetative characters viz., plant height, plant spread, number of leaves per plant, leaf length, leaf width, leaf area, fresh weight and dry weight of leaf, fresh weight and dry weight of root and root length were recorded at six and twelve months after planting. Other observations such as leaf longevity, leaf production interval, number of leaves harvested and vase life of the plants under each treatment were also recorded during the experimental period. The total chlorophyll content of the leaves for each treatment was measured at the end of the experiment. The data on the observations recorded were statistically analyzed using GRAPES software and wherever the treatment effects were significant, critical differences were computed.

RESULTS AND DISCUSSION

Effect of plant spacing on plant growth and yield characters

The growth and yield characteristics of *Dracaena fragrans* cv. Massangeana were significantly affected by plant spacing, with the exception of vase life and leaf production interval. Plants grown at a closer spacing of 60 x 60 cm (S_1) demonstrated superior growth traits, including highest plant height (71.91 cm, 93.68 cm at 6 and 12 months after planting respectively), greater number of leaves (27.34, 45.24 at 6 and 12 MAP respectively), larger leaf length (54.09 cm, 59.85 cm at 6th and 12th MAP respectively) and width (7.78 cm, 8.25 cm at 6th and 12th MAP respectively), number of leaves harvested (35.52 leaves at 12 MAP) as well as higher fresh and dry leaf weight as well as higher chlorophyll content (1.59mg/g) (Table 1-3). These findings are consistent with other studies in *D. fragrans* cv. Massangeana [7]. In contrast, plants cultivated under the wider 75 x 60 cm (S_2) spacing outperformed in terms of plant spread (78.19 cm, 98.27 cm at 6th and 12th MAP), fresh weight (72.82 g, 143.05 g at 6 and 12 MAP respectively) and dry weight of root (10.48 g, 28.68 g at 6th and 12th MAP respectively), root length (63.04 cm, 76.83 cm respectively), and enhanced leaf longevity (349 days) as in (Table 3. Similar results were also observed in *D. reflexa* [8]. This indicates that while closer spacing promotes above-ground growth, wider spacing fosters stronger root development and extends the longevity of the leaves. Closer spacing promotes above-ground growth as plants compete for light and stretch upward, often at the expense of root development. Closer spacing also resulted in higher chlorophyll content that might be due to increased competition for light, prompting plants to produce more chlorophyll to maximize photosynthesis efficiency.

Table 1 Effect of spacing and nutrient doses on plant characters (6 MAP)

Treatments		Six months after planting										
		Plant height (cm)	Plant spread (cm)	No. of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of leaf (g)	Dry weight of leaf (g)	Fresh weight of root (g)	Dry weight of root (g)	Root length (cm)
Spacing	S_1	73.60^a	74.10^b	27.34^a	54.09^a	7.782^a	216.51^a	13.29^a	2.91^a	67.28^b	8.86^b	54.14^b
	S_2	68.73^b	78.19^a	24.72^b	51.05^b	7.471^b	193.85^b	10.82^b	2.38^b	72.82^a	10.49^a	63.05^a
CD (0.05)		2.61	2.14	1.42	1.36	0.20	6.88	1.23	0.38	3.11	0.90	5.01
	N_1	65.34^c	69.86^c	26.78^b	50.35^c	8.08^{bc}	191.11^c	11.91^a	2.44^{cd}	71.72^c	8.72^c	41.87^d
	N_2	81.90^a	78.96^b	29.00^{ab}	57.95^a	7.71^b	235.11^a	12.48^a	3.10^{ab}	84.08^b	11.68^b	79.63^b
	N_3	81.46^a	88.29^a	30.24^a	56.15^a	7.67^a	229.22^a	13.48^a	3.20^a	95.12^a	15.73^a	89.78^a
	N_4	70.68^b	77.44^b	23.18^c	52.75^b	7.47^b	202.66^b	13.21^a	2.57^{bc}	61.58^d	7.57^c	55.08^c
	N_5	56.46^d	66.17^d	20.96^c	45.67^d	7.19^c	167.78^d	9.23^b	1.92^d	37.75^e	4.68^d	26.60^e
CD (0.05)		4.12	3.38	2.24	2.16	0.31	10.8	1.95	0.61	4.92	1.42	7.92
CV		4.77	3.66	7.09	3.39	3.37	4.37	13.30	19.06	5.79	12.14	11.15

Effect of nutrient doses plant growth and yield characters

Different nutrient doses also had significant influence on the various growth and yield characters of *Dracaena fragrans* cv. Massangeana. Plant height was maximum with the application of the N_3 nutrient dose (72:6:12 N: P_2O_5: K_2O g/plant/year), which was on par with N_2 (48:6:12 N: P_2O_5: K_2O g/plant/year) at 6 MAP (81.90 cm, 81.46 cm) and 12 MAP (109.11 cm, 105.84 cm). Plant spread varied significantly based on the nutrient doses applied, with the plants receiving N_3 treatment (72:6:12 N: P_2O_5: K_2O g/plant/year) recording the highest plant height (88.29 cm, 116.51cm at 6 and 12 MAP respectively), followed by N_2 throughout the experimental period. N_3 was also found to record the highest number of leaves (30.24, 46.36 at 6 and 12 MAP respectively). Considering the leaf length, longest leaves were observed in N_2 (57.94 cm, 63.62 cm at 6 and 12 MAP respectively) which on par with N_3. In contrast, width of the leaf was the highest under N_3 treatment (8.07 cm, 8.62 cm at 6 and 12 MAP respectively) followed by N_2. Similarly, leaf area was also maximum in plants grown under both N_2 (235.11 cm^2) and N_3 nutrient doses. As for the fresh and dry weight of both leaves and roots, the N_3 nutrient application proved to be the most effective, surpassing all other treatments (Table 1-2). It was evident that the application of nutrients, particularly nitrogen, resulted in improved vegetative growth. Nitrogen, being a crucial component of proteins, nucleic acids, and nucleotides, plays a vital role in plant metabolism, particularly in cell division and elongation, thus contributing to increased plant height. These findings are consistent with the studies conducted on *Dracaena sanderiana* L. [9] and *Araucaria heterophylla* [10].

Table 1 Effect of spacing and nutrient doses on plant characters (6 MAP)

Treatments		Twelve months after planting										
		Plant height (cm)	Plant spread (cm)	No. of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of leaf (g)	Dry weight of leaf (g)	Fresh weight of root (g)	Dry weight of root (g)	Root length (cm)
Spacing	S_1	93.32^{a}	93.49^{b}	45.24^{a}	59.85^{a}	8.25^{a}	253.49^{a}	17.56^{a}	6.19^{a}	134.87^{b}	25.57^{b}	64.87^{b}
	S_2	86.33^{b}	98.37^{a}	36.15^{b}	55.82^{b}	7.76^{b}	217.13^{b}	15.19^{b}	5.62^{b}	143.05^{a}	28.68^{a}	76.84^{a}
CD (0.05)		2.39	3.84	3.79	3.67	0.23	22.98	1.24	0.35	2.21	0.68	4.13
	N_1	79.85^{c}	92.68^{c}	42.40^{ab}	53.78^{bc}	7.95^{b}	219.11^{c}	15.67^{b}	5.69^{b}	131.56^{b}	26.68^{c}	71.24^{c}
	N_2	105.84^{a}	100.65^{b}	46.06^{a}	63.62^{a}	8.12^{b}	243.95^{b}	17.15^{b}	6.31^{a}	182.84^{a}	30.71^{b}	85.32^{b}
	N_3	109.11^{a}	116.52^{a}	46.36^{a}	61.92^{a}	8.62^{a}	282.46^{a}	19.41^{a}	6.83^{a}	185.44^{a}	35.94^{a}	96.64^{a}
	N_4	85.22^{b}	92.83^{c}	38.34^{b}	59.19^{ab}	7.81^{bc}	236.07^{b}	16.39^{b}	5.68^{b}	104.49^{c}	24.48^{d}	68.28^{c}
	N_5	69.10^{d}	76.99^{d}	30.32^{c}	50.66^{c}	7.52^{c}	194.93^{c}	13.25^{c}	5.00^{c}	90.49^{d}	17.79^{e}	32.78^{d}
CD (0.05)		3.78	6.06	5.98	5.80	0.36	36.33	1.95	0.55	3.503	1.078	6.54
CV		3.47	5.21	12.3	8.27	3.78	12.73	9.86	7.71	2.07	3.27	7.61

Table 3 Effect of spacing and nutrient doses on leaf longevity, leaf production interval, number of leaves harvested, vase life and total chlorophyll content

Treatments		Twelve months after planting				
		Leaf longevity (days)	Leaf production interval (days)	No. of leaves harvested	Vase life (days)	Chlorophyll content (mg/g)
Spacing	S_1	346.17^{b}	17.23	35.53^{a}	23.79	1.59^{a}
	S_2	349.01^{a}	17.31	26.06^{b}	23.29	1.54^{b}
CD (0.05)		1.65	NS	3.7	NS	0.01
	N_1	346.02^{b}	15.52^{c}	32.32^{ab}	20.85^{c}	1.61^{c}
	N_2	342.01^{c}	14.88^{c}	36.01^{a}	25.25^{b}	1.70^{b}
	N_3	337.66^{d}	13.35^{d}	36.82^{a}	31.80^{a}	1.81^{a}
	N_4	356.20^{a}	22.37^{a}	28.60^{b}	21.95^{c}	1.51^{d}
	N_5	356.06^{a}	20.23^{b}	20.21^{c}	17.85^{d}	1.21^{d}
CD (0.05)		2.61	1.03	5.85	2.42	0.01
CV		0.62	4.93	15.66	8.47	0.89

Both leaf longevity (149.37 days) and leaf production interval (16.36 days) were found to be the highest under the N_4 (100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval) whereas, N_3 recorded the lowest number of days for these parameters. The gradual nutrient release from FYM support slow, sustained plant growth, unlike the faster vegetative growth under higher nitrogen doses. This may extend the leaf production interval and subsequently higher leaf longevity.

Plants grown under N_3 also produced the highest number of leaves (36.82 leaves) by the end of the experiment. The longest vase life (43.95 days) was exhibited by plants grown under the N_3 (72:6:12 N: P_2O_5: K_2O g/plant/year) treatment, followed by N_2 (48:6:12 N: P_2O_5: K_2O g/plant/year), as plants supplied with higher doses of nitrogen might be benefited from enhanced tissue strength, delayed senescence, and improved water retention, all of which contribute to prolonged freshness after cutting. Similarly, higher vase life was observed with higher dose of nitrogen in gladiolus [11]. In terms of chlorophyll content, the highest chlorophyll content of 1.81 mg/g was recorded in plants grown under the N_3 (72:6:12 N: P_2O_5: K_2O g/plant/year) treatment. Whereas N_5 (absolute control) was found inferior in terms of all the parameters observed (Table 3). Similar results were observed in *Dracaena fragrans* Massangeana [12] and *Yucca rupicola* [13]. Higher nitrogen dose promote robust vegetative growth as nitrogen is a critical component of chlorophyll, amino acids, and proteins which are essential for photosynthesis and cell division. Increased nitrogen availability enhances the synthesis of photosynthetic pigments, leading to improved photosynthetic efficiency and energy production. This ultimately results in greater plant height, spread, and higher leaf length, width and area, contributing to enhanced fresh weight and dry weight of leaves.

Effect of interaction between spacing and nutrient doses

The results indicate that the interaction between spacing and nutrients had less impact on most growth and yield parameters, with only a few exceptions. Significantly taller plants were found in the S_1N_3 (spacing of 60 cm x 60 cm with nutrient dose of 72:6:12 N: P_2O_5: K_2O g/plant/year) treatment recording 84.34 cm at six months after planting which was found to be on par with S_1N_2 (spacing of 60 cm x 60 cm with nutrient dose of 48:6:12 N: P_2O_5: K_2O g/plant/year) recording 83.80 cm, while the shortest plants were recorded in the S_1N_5 (spacing of 60 cm x 60 cm with absolute control), S_2N_5 (spacing of 75 cm x 60 cm with absolute control), and S_2N_1 (spacing of 75 cm x 60 cm with nutrient dose of 24:6:12 N: P_2O_5: K_2O g/plant/year) treatment combinations. This result is in accordance with the result obtained in heliconia [14]. S_1N_3 produced the highest number of leaves (31.2 leaves at six months after planting), while the lowest number of leaves were observed in S_2N_4 (spacing of 75 cm x 60 cm with 100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval) and S_2N_5. Additionally, leaf length was greatest (61.04 cm) in S_1N_3, followed by S_1N_2, whereas minimum leaf length was noted in S_1N_5 and S_2N_5 (Table 4-5). Longest leaf production interval was observed in S_2N_4 (spacing of 75 x 60 cm with nutrient dose of 100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval) recording 22.50 days which was on par with S_1N_4 (spacing of 60 x 60 cm with nutrient dose of

100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval) recording 22.23 days. Whereas the shortest leaf production intervals were recorded in the S_2N_3 (spacing of 75 x 60 cm with absolute control) with 12.67 days and S_1N_3 (spacing of 60 x 60 cm with absolute control) with 14.03 days (Table 6).

Table 4 Effect of S x N interaction on the plant characters (6 MAP)

Treatments	Six months after planting										
	Plant height (cm)	Plant spread (cm)	No. of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of leaf (g)	Dry weight of leaf (g)	Fresh weight of root (g)	Dry weight of root (g)	Root length (cm)
$S_1 \times N_1$	70.42^{cd}	72.30	29.26^{abc}	51.54^{cd}	7.52	195.76	12.47	2.50	70.17	8.46	38.07
$S_1 \times N_2$	83.80^{a}	76.63	27.96^{bc}	61.04^{a}	7.87	258.71	13.25	3.54	79.33	10.10	68.83
$S_1 \times N_3$	84.34^{a}	86.40	31.20^{a}	59.26^{a}	8.44	255.10	15.86	3.53	92.40	14.66	84.40
$S_1 \times N_4$	74.56^{bc}	75.17	26.49^{cd}	53.01^{bc}	7.88	205.40	14.79	2.80	59.00	7.33	54.00
$S_1 \times N_5$	54.89^{e}	60.00	21.83^{ef}	45.63^{e}	7.19	167.59	10.13	2.18	35.50	3.76	25.40
$S_2 \times N_1$	60.27^{e}	67.42	24.34^{de}	49.15^{d}	7.41	186.47	11.34	2.38	73.27	8.967	45.67
$S_2 \times N_2$	80.01^{ab}	81.28	30.04^{bc}	54.86^{b}	7.56	211.51	11.70	2.66	88.83	13.26	90.43
$S_2 \times N_3$	78.58^{ab}	90.19	29.28^{abc}	53.04^{bc}	7.71	203.34	11.11	2.87	97.83	16.80	95.17
$S_2 \times N_4$	66.79^{d}	79.70	19.87^{f}	52.49^{bc}	7.47	199.93	11.64	2.34	64.17	7.80	56.17
$S_2 \times N_5$	58.03^{e}	72.35	20.09^{f}	45.71^{e}	7.20	167.98	8.32	1.66	40.00	5.60	27.80
CD (0.05)	5.83	NS	3.17	3.05	NS	NS	NS	NS	NS	NS	NS
CV	4.77	3.66	7.09	3.39	3.37	4.37	13.31	19.06	5.79	12.14	11.15

S_1- 60 x 60 cm, S_2- 75 x 60 cm, N_1- 75:6:12 NPK g/plant/year, N_2- 48:6:12 NPK g/plant/year, N_3- 24:6:12 NPK g/plant/year, N_4- 100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval, N_5- absolute control

Table 5 Effect of S × N interaction on the plant characters (6 MAP)

Treatments	Twelve months after planting										
	Plant height (cm)	Plant spread (cm)	No. of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of leaf (g)	Dry weight of leaf (g)	Fresh weight of root (g)	Dry weight of root (g)	Root length (cm)
$S_1 \times N_1$	85.69	89.29	49.63	58.24	8.25	245.26	16.34	5.947	129.15	24.327	72.38
$S_1 \times N_2$	106.97	98.47	49.62	66.19	8.16	270.68	17.56	6.670	177.01	29.550	70.58
$S_1 \times N_3$	111.29	114.50	51.23	64.04	8.93	300.56	21.48	7.157	181.54	34.363	88.25
$S_1 \times N_4$	90.58	90.86	42.82	59.55	8.09	245.74	17.63	5.917	99.78	23.630	64.71
$S_1 \times N_5$	72.07	74.35	32.93	51.23	7.82	205.19	14.79	5.263	86.86	15.963	28.45
$S_2 \times N_1$	74.02	96.08	35.18	49.33	7.65	192.96	15.00	5.433	133.96	29.037	70.10
$S_2 \times N_2$	104.72	102.82	42.52	61.06	8.08	217.21	16.73	5.957	188.66	31.880	100.07
$S_2 \times N_3$	106.94	118.53	41.50	59.79	8.31	264.35	17.34	6.507	189.33	37.520	105.03
$S_2 \times N_4$	79.85	94.80	33.86	58.83	7.53	226.43	15.15	5.450	109.19	25.333	71.86
$S_2 \times N_5$	66.13	79.63	27.72	50.08	7.22	184.67	11.70	4.737	94.11	19.630	37.12
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV	3.47	5.21	12.13	8.27	3.78	12.73	9.86	7.706	2.07	3.27	7.61

S_1- 60 x 60 cm, S_2- 75 x 60 cm, N_1- 75:6:12 NPK g/plant/year, N_2- 48:6:12 NPK g/plant/year, N_3- 24:6:12 NPK g/plant/year, N_4- 100 g FYM/plant at 4 months interval + foliar spray of NPK 19:19:19 @ 0.5% at 6 months interval, N_5- absolute control

Table 6 Effect of S × N interaction on leaf longevity, leaf production interval, number of leaves harvested, vase life and chlorophyll content

Treatments	Leaf longevity (days)	Leaf production interval (days)	No. of leaves harvested	Vase life (days)	Chlorophyll content (mg/g)
$S_1 \times N_1$	343.87	14.40^{de}	39.63	19.36	1.63^{e}
$S_1 \times N_2$	341.16	15.57^{cd}	39.62	26.12	1.72^{c}
$S_1 \times N_3$	337.53	14.03^{ef}	42.15	32.52	1.84^{a}
$S_1 \times N_4$	354.15	22.23^{a}	33.34	22.26	1.52^{g}
$S_1 \times N_5$	354.15	19.90^{b}	22.89	18.71	1.25^{i}
$S_2 \times N_1$	348.18	16.63^{c}	25.01	22.34	1.58^{f}
$S_2 \times N_2$	342.86	14.20^{de}	32.40	24.37	1.68^{d}
$S_2 \times N_3$	337.79	12.67^{f}	31.50	31.09	1.78^{b}
$S_2 \times N_4$	358.24	22.50^{a}	23.86	21.64	1.49^{h}
$S_2 \times N_5$	357.98	20.57^{b}	17.52	16.99	1.17^{j}
CD (0.05)	NS	1.46	NS	NS	0.02
CV	0.62	4.93	15.66	8.47	0.89

The S × N interaction also had significant influence on chlorophyll content of the leaves. The treatment combination S_1N_3 (spacing of 60 cm x 60 cm with nutrient dose of 72:6:12 N: P_2O_5: K_2O g/plant/year) resulted in the highest chlorophyll concentration, measuring 1.84 mg/g. Higher plant density creates a denser canopy, increasing shading and limiting light availability to the lower leaves. In response, plants produce more chlorophyll to optimize light absorption under these conditions. Nitrogen plays a crucial role in this process as it is a key component of amino acids and proteins, including enzymes like glutamine synthetase and glutamate synthase, which are essential for synthesizing chlorophyll precursors. In contrast, the lowest chlorophyll content was observed in both S_1N_5 (spacing of 60 cm x 60 cm with absolute control) and S_2N_5 (spacing of 75 cm x 60 cm with absolute control) as shown in (Table 6). Similar results were observed in Nerium [15] and cabbage [16].

CONCLUSION

Different nutrient doses, particularly nitrogen, and plant spacing significantly influenced the growth and foliage yield of *Dracaena fragrans* cv. Massangeana. Spacing of 60 x 60 cm promoted better vegetative growth with enhanced plant height, leaf area, number of leaves per plant, fresh weight and dry weight of leaves while wider spacing of 75 x 60 cm improved root development, including fresh and dry root weight, root length, and leaf longevity. The nutrient dose of 72:6:12 N: P_2O_5: K_2O g/plant/year, with higher nitrogen, was optimal for most of the growth and yield traits. Thus, based on the above study, a spacing of 60 x 60 cm and a nutrient dose of 72:6:12 N: P_2O_5: K_2O g/plant/year can be recommended for better vegetative growth and foliage yield in *Dracaena fragrans* cv. Massangeana.

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