RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume 58 Issue 4: 676-680 (August 2024)

Effect of Spacing, Nutrition and Their Interaction on Growth and Yield of Nerium (*Nerium oleander* L.) cv. Pink Single

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10.18805/IJARe.A-6037

ABSTRACT

Background: Commercial cultivation of a crop needs improved agro techniques, such as optimum plant density, application of a required quantity of manures and fertilizers, *etc*. As such, for nerium cultivation no specific recommendations are available on spacing and nutrition requirements and majority of growers are practicing varied spacing with different nutritional levels. Optimum spacing helps not only in obtaining increased production of better quality but also in the proper utilization of land and other inputs. Excess use of fertilizers may result in wastage of resources apart from damage to plant, soil and environment, whereas, undernutrition leads to low production and poor-quality flowers. The current study aimed to standardize optimum plant spacing and nutrition for commercial production of Nerium.

Methods: This field investigation was started in 2018 and carried out up to 2019. The planting materials were planted at the College of Horticulture-Bengaluru with three levels of spacing combined with four levels of nutrition using a factorial randomized complete block design.

Result: The effect of spacing, nutrition and interaction studies of Nerium genotype 'Pink Single' for various growth and yield parameters showed significant differences for the growth and yield parameters studied. Among the interaction of different levels of spacing and nutrition, yield/hectare was higher (14.43 t) in S_2F_1 (1.2 m × 1.2 m, 5 kg FYM/plant + 90:180:180 g NPK/plant).

Key words: Agronomic practices, Apocynaceae, Flower yield, Ornamental plant, Shrub.

INTRODUCTION

Nerium (*Nerium oleander* L.) belongs to the family Apocynaceae and is native to the Mediterranean region extending to subtropical Asia, but is now well distributed in all the tropical and subtropical countries. Nerium is a perennial shrub; plants are easily propagated by cuttings or by layering and can be kept bushy and handsome by regular pruning after the flowering season is over. Nerium, flowers throughout the year, but are at their best during summer. Flesh Pink Single, Pink Double, Deep Rose, White Single and Deep Rosy Red flowers are common in both their single and double forms.

The successful cultivation of any crop is influenced by various factors, one such is the response of the crop to various agro techniques like different levels of spacing and nutrition. These things not only will help in obtaining production but also in proper utilization of land and other inputs (Bharadwaj and Kumar, 2001). However, no specific recommendations are available on spacing and nutrition requirements for the commercial cultivation of Nerium. Therefore, the present research is an attempt to bridge this knowledge gap in order to study the effects of different spacing levels and nutrition on the growth and yield of the Nerium genotype 'Pink single' to help the Nerium growing farming community.

MATERIALS AND METHODS

The planting material for spacing and nutritional studies, the 'Pink Single' genotype was procured from Krishnendra nursery located at Siddapura, Lalbagh, Bengaluru, Karnataka, India. The plant materials were planted at the College of Horticulture-Bengaluru with three levels of spacing *i.e*., S_1: 0.9 m × 0.9 m, S_2: 1.2 m × 1.2 m and S_3: 1.5 m × 1.5 m also combined with four levels of nutrition *i.e*., F_0: 5 kg FYM, F_1: 5 kg FYM + 90:180:180 g NPK/plant, F_2: 5 kg FYM + 120: 240: 240 g NPK/plant and F_3: 5 kg FYM + 150: 300: 300 g NPK/plant. The experiment was started in the year 2018 and carried out up to 2019 with a factorial randomized complete block design. Observations were recorded on five randomly selected plants in each replication for all the growth and yield traits such as plant

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How to cite this article: Manjula, B.S., Kulkarni, B.S. and Munikrishnappa, P.M. (2024). Effect of Spacing, Nutrition and Their Interaction on Growth and Yield of Nerium (*Nerium oleander* L.) cv. Pink Single. Indian Journal of Agricultural Research. 58(4): 676-680. doi: 10.18805/IJARe.A-6037.

Submitted: 12-08-2022 **Accepted:** 18-03-2023 **Online:** 28-04-2023

height, plant spread, number of branches, chlorophyll estimation, flower yield per plant and flower yield per hectare. For growth parameters, observations were recorded at 2 months interval from the date of planting until 300 DAP (Days after planting). Here results are provided for 300 DAP. Chlorophyll estimation was conducted at 300 DAP and yield data was recorded from 2018 to 2019.

RESULTS AND DISCUSSION

The data on growth and yield parameters are presented in the table (Table 1-3). There are significant differences in the parameters discussed in this paper.

Plant height as influenced by spacing, nutrition and their interaction

At 300 DAP, among spacing levels, plant height was higher (128.16 cm) in S_1 (90 cm × 90 cm), which was on par with S_2 (1.2 m × 1.2 m) with 128.08 cm and the least plant height (125.77 cm) was recorded in S_3 (1.5 m × 1.5 m). More plant height at closer spacing might be due to heavy competition between plants for light, which resulted in elongation of the main stem and also might be due to the fact that the plants tend to grow vertically when they are crowded owing to the shadowing effect of the plants on one another. Results are in conformity with the findings of Balachandra *et al*. (2004) in ageratum, Srivastava *et al*. (2005) in marigold and in rice Uddin *et al*. (2010). Among nutrition levels, the highest plant height (133.94 cm) was recorded when plants were supplemented with 5 kg FYM/plant along with 90: 180: 180 g NPK/plant (F_1), which was on par (128.56 cm height) with F_2 (5 kg FYM/plant + 120: 240: 240 g NPK/plant). The least plant height (122.87 cm) was recorded in F_0 (5 kg FYM/plant). The reason behind this, might be due to better availability of nutrients leading to quick and better vegetative growth *i.e*., nitrogen along with phosphorous and potassium help to build vegetative growth by forming healthy roots and stems. The result is in accordance with the findings of Aboyeji and Babalola (2013) in *Thevetia peruviana* J. and Atta *et al*. (2010) in roselle. Among interactions, highest plant height (138.00 cm) was recorded in S_1F_1 (90 cm × 90 cm + 5 kg FYM/plant with 90: 180: 180 g NPK/plant), which was followed by S_1F_2 (90 cm × 90 cm + 5 kg FYM/plant with 120: 240: 240 g NPK/plant) and S_1F_0 (90 cm × 90 cm + 5 kg FYM/plant) with the values of 131.50 cm and 132.33 cm respectively. Least plant height (119.00 cm) was recorded in S_2F_0 (1.2 m × 1.2 m + 5 kg FYM/plant). This might be due to high competition for nutrient levels, light intensity and temperature in the plants planted at closer spacing, a similar trend was reported by Viradia and Singh (2004) in rose.

Plant spread as influenced by spacing, nutrition and their interaction

At 300 DAP, among spacing levels, plant spread was higher (3025.00 cm^2) in S_2 (1.2 m × 1.2 m), which was followed by

Table 1: Growth and yield parameters in Nerium cv. 'Pink Single' as influenced by various levels of spacing.

Treatments	Growth and yield parameters					
	Plant height (cm)	Plant spread (cm^2)	Number of branches	Chlorophyll content (mg/g)	Yield/plant (kg)	Yield/plant (t)
	300 DAP	300 DAP	300 DAP			
Spacing						
S_1	128.16	2731.00	35.75	1.11	1.22	9.59
S_2	128.08	3025.00	39.41	1.18	1.34	8.69
S_3	125.77	2767.50	36.45	1.14	1.26	8.26
S.Em. ±	0.40	33.00	0.66	0.01	0.03	0.09
C.D. at 5%	1.19	96.79	1.95	0.04	0.09	0.26

DAP- Days after planting; cm- Centimeter; cm^2- Centimeter square; mg/g- Miligram per gram; kg- Kilogram; t- Tonnes.

Table 2: Growth and yield parameters in Nerium cv. 'Pink Single' as influenced by various levels of nutrition.

Treatments	Growth and yield parameters					
	Plant height (cm)	Plant spread (cm^2)	Number of branches	Chlorophyll content (mg/g)	Yield/plant (kg)	Yield/plant (t)
	300 DAP	300 DAP	300 DAP			
Nutrition						
F_0	122.87	2394.44	31.22	0.81	0.76	8.41
F_1	133.94	3117.78	40.89	1.37	1.67	10.19
F_2	128.56	2974.56	39.06	1.03	1.62	9.52
F_3	124.00	2877.89	37.67	1.39	1.18	7.28
S.Em. ±	0.46	38.11	0.76	0.01	0.03	0.10
C.D. at 5%	1.37	111.77	2.25	0.05	0.10	0.30

DAP- Days after planting; cm- Centimeter; cm^2- Centimeter square; mg/g- Miligram per gram; kg- Kilogram; t- Tonnes.

S_3 (1.5 m × 1.5 m) with 2767.50 cm^2 and the least plant spread (2731.00 cm^2) was recorded in S_1 (90 cm × 90 cm). This may have been due to the fact that the optimum quantum of light intensity has reached this level compared to closer spacing. These observations were in conformity with the results of Singh and Dadlani (1988) and Sujatha and Singh (2003) in rose. Among nutrition levels, the highest plant spread (3117.78 cm^2) was recorded when plants were supplemented with 5 kg FYM/plant along with 90: 180: 180 g NPK/plant (F_1), which was followed by 2974.56 cm^2 in F_3 (5 kg FYM/plant + 150: 300: 300 g NPK/plant). The least plant spread (2394.44 cm^2) was recorded in F_0 (5 kg FYM/plant). This result was similar to the findings of Anamika and Lavanya (1990) in rose. This might be due to better availability of nutrients leading to quick and better vegetative growth. Among interactions, highest plant spread (4050.00 cm^2) was recorded in S_2F_1 (1.2 m × 1.2 m + 5 kg FYM/plant with 90: 180: 180 g NPK/plant), which was followed by S_2F_2 (1.2 m × 1.2 m + 5 kg FYM/) with 3166.67 cm^2. Least plant spread (2100.00 cm^2) was recorded in S_1F_0 (90 cm × 90 cm + 5 kg FYM/plant).

Number of branches as influenced by spacing, nutrition and their interaction

At 300 DAP, among the spacing treatments, the number of branches was maximum (39.41) in S_2 while minimum (35.75) was noticed in S_1. This may be due to the fact that the optimum quantum of light intensity has reached this level compared to closer spacing. Among the nutrient levels, the number of branches was higher (40.89) in F_1, while the lowest (31.22) was noticed in F_0 at 300 DAP. Increase in the number of branches per plant might be due to stimulation of growth by the nutrient application. Similar results were obtained by Singh *et al*. (2004). These results were in line with the findings of Girase *et al*. (1976) and Bhattacharjee (1988) in rose. Among the interactions, the maximum number of branches was (49.67) recorded in S_2F_1, while the minimum (29.33) was recorded in S_1F_0. The wider availability of space creates less competition among the plants and might encourage the growth of more roots and shoots with better utilization of nutrients by them. The wider spacing also leads to more compact growth, with less internodal length and more number of branches compared to the plants grown under a closer spacing regime. These results were in accordance with the findings of Sunitha *et al*. (2007) and Singh *et al*. (2008) in marigold.

Chlorophyll content as influenced by spacing, nutrition and their interaction

Spacing influenced significantly the chlorophyll content at the grand growth stage. Among various levels of spacing, chlorophyll content was higher (1.18 mg/g) in S_2 (1.2 m × 1.2 m), which was on par with S_3 (1.5 m × 1.5 m) with 1.14 mg/g and the least chlorophyll content was recorded in S_1 (90 cm × 90 cm) with 1.11 mg/g. Among various levels of nutrition, chlorophyll content was higher (1.39 mg/g) in F_3 (5 kg FYM + 150:300:300 g NPK/plant), which was on par with F_1 (5 kg FYM + 90: 180: 180 g NPK/plant) with 1.37 mg/g. The least chlorophyll content was recorded in F_0 (5 kg FYM/plant) with 0.81 mg/g). This may be due to optimum nitrogen application and its availability to a greater extent for the uptake of nitrogen by the plants. Phosphorus might have increased the uptake of nitrogen by the plants due to which the chlorophyll content increased. Similar findings were also reported by Girish (2006) in heliconia.

Table 3: Growth and yield parameters in Nerium cv.'Pink Single' as influenced by interaction of various levels of spacing and nutrition.

Treatments	Growth and yield parameters					
	Plant height (cm)	Plant spread (cm^2)	Number of branches	Chlorophyll content	Yield/plant (kg)	Yield/plant (t)
	300 DAP	300 DAP	300 DAP	(mg/g)		
			Interaction			
S_1F_0	132.33	2100.00	29.33	0.46	0.56	5.90
S_1F_1	138.00	2383.33	31.33	0.99	0.79	9.43
S_1F_2	131.50	2700.00	33.00	0.97	0.93	9.90
S_1F_3	128.33	2703.33	31.67	1.00	0.83	10.43
S_2F_0	119.00	2600.00	35.83	1.12	0.90	5.70
S_2F_1	124.67	4050.00	49.67	1.99	2.10	14.43
S_2F_2	122.00	3166.67	42.00	1.19	2.03	13.83
S_2F_3	125.67	3107.00	37.00	1.28	1.80	12.30
S_3F_0	120.93	2650.00	34.00	0.61	0.65	2.43
S_3F_1	130.00	3100.00	40.00	1.82	1.90	8.20
S_3F_2	129.67	2833.67	41.67	1.34	1.70	7.33
S_3F_3	126.00	2700.00	41.00	1.01	1.40	6.30
S.Em. ±	0.81	66.00	1.33	0.03	0.06	0.18
C.D. at 5%	2.38	193.59	3.90	0.09	0.18	0.53

DAP- Days after planting; cm- Centimeter; cm^2- Centimeter square; mg/g- Miligram per gram; kg- Kilogram; t- Tonnes.

Yield parameters were significantly influenced by different levels of spacing, nutrition and interactions (Table 1-3).

Yield per plant as influenced by spacing, nutrition and their interaction

Among various levels of spacing, yield/plant was higher (1.34 kg) in S_2 (1.2 m × 1.2 m), which was on par with S_3 (1.5 m × 1.5 m) with 1.26 kg. The least (1.22 kg) yield/plant was recorded in S_1 (90 cm × 90 cm). Higher flowering in wider spacing may be due to optimum growth parameters *viz*., plant spread, number of branches, leaf length, leaf width, chlorophyll content and leaf area which helped in the production of more photosynthates resulting in greater accumulation of dry matter which in turn directly or indirectly leads to the production of more flower yield. These observations are in conformity with the results obtained for roses by Bhattacharya *et al*. (2000) and Nagaraju *et al*. (2003) and in cluster bean by Deka *et al*., 2015. Among various levels of nutrition, yield/plant was higher (1.67 kg) in F_1 (5 kg FYM/plant with 90:180:180 g NPK/plant), which was followed by F_2 (5 kg FYM/plant + 120: 240: 240 g NPK/plant) with 1.62 kg. The least flower yield/plant (0.76 kg) was recorded in F_0 (5 kg FYM/plant). The higher flower yield per plant is due to the optimum application of nutrients. A similar trend was reported in roses by Mukesh and Chattopadhyay (2001), Nagaraju *et al*. (2003) and Singh *et al*. (2004). Among the interactions, yield/plant was higher (2.10 kg) in S_2F_1 (1.2 m × 1.2 m, 5 kg FYM/plant + 90:180:180 g NPK/plant), which was followed by S_2F_2 (1.2 m × 1.2 m, 5 kg FYM/plant + 120: 240: 240 g NPK/plant) with 2.03 kg. The least flower yield/plant was recorded in S_1F_0 (90 cm × 90 cm + 5 kg FYM/plant) with 0.56 kg. The trend is same as that of Hussain (2012) in rose. This might be due to efficient utilization of space, light and nutrients.

Yield per hectare as influenced by spacing, nutrition and their interaction

Among various levels of spacing, yield/hectare was higher (9.59 t) in S_1 (90 cm × 90 cm, which was followed by S_2 (1.2 m × 1.2 m) with 8.69 t. The least (8.26 t) yield/hectare was recorded in S_3 (1.5 m × 1.5 m). Higher yield per hectare recorded at closer spacing accrued primarily due to the increased plant population, despite compromise in yield per plant. Similar results were obtained in rose by Sujatha and Singh (2003), Viradia and Singh (2004), Bhattacharya *et al*. (2001). Among various levels of nutrition, yield/ hectare was higher (10.19 t) in F_1 (5 kg FYM/plant with 90:180:180 g NPK/plant), which was followed by F_2 (5 kg FYM/plant + 120:240:240 g NPK/plant) with 9.52 t. The least flower yield/ hectare (8.41) was recorded in F_0 (5 kg FYM/plant). The higher flower yield per plant is due to the application of the optimum dose of nutrients. A similar trend was reported in roses by Mukesh and Chattopadhyay (2001), Nagaraju *et al*. (2003) and Singh *et al*. (2004). Among the interactions, yield/ hectare was higher (14.43 t) in S_2F_1 (1.2 m × 1.2 m, 5 kg FYM/plant + 90:180:180 g NPK/plant), which was followed by S_2F_2 (1.2 m × 1.2 m, 5 kg FYM/plant + 120:240:240 g NPK/plant) with 13.83 t. The least flower yield/plant was recorded in S_3F_0 (1.5 m × 1.5 m + 5 kg FYM/plant) with 2.43 t. The trend is same as that of Hussain (2012) in rose. This might be due to efficient utilization of space, light and nutrients.

CONCLUSION

Among the different levels of interaction of spacing and nutrition at 300 DAP, highest plant height (138.00 cm) was recorded in S_1F_1 (90 cm × 90 cm + 5 kg FYM/plant with 90: 180: 180 g NPK/plant), highest plant spread (4050.00 cm^2) was recorded in S_2F_1 (1.2 m × 1.2 m + 5 kg FYM/plant with 90: 180: 180 g NPK/plant), the maximum number of branches was (49.67) recorded in S_2F_1; chlorophyll content was higher (1.39 mg/g) in F_3 (5 kg FYM + 150:300:300 g NPK/plant); yield/plant was higher (1.67 kg) in F_1 (5 kg FYM/ plant with 90:180:180 g NPK/plant) and yield/ hectare was higher (10.19 t) in F_1 (5 kg FYM/plant with 90:180:180 g NPK/plant) were noticed.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru for providing the facilities.

Conflict of interest

All authors declare that they have no conflict of interest.

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