Original Research Article

Plant spacing combined with nitrogen nutrition affects loose flower production in *Rosa gruss-an-teplitz* under open conditions

ABSTRACT

Aims: The present investigation to study the effect of nitrogen and plant spacing for open grown roses for loose flower production was carried out.
Study design: The experiment was carried out using the factorial randomized block design (FRBD). It was laid out using three main spacing treatments combined with four sub-treatments of nitrogen levels.
Place and Duration of Study: Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana during 2020-21.
Methodology: Two years old plants were used for this study which were planted at three different spacings 70 x 100 cm, 70 x 90 cm and 70 x 80 cm. The plants were fertilized with four levels of nitrogen 0 g, 1.5 g, 2.0 g and 2.5 g per plant at monthly interval starting from pruning till one complete year.
Results: The treatment combination comprising of 2.0 g nitrogen per plant per month with plant spacing 70 x 100 cm (3960 plants/acre) resulted in maximum plant height (109.83 cm), plant spread (95.67 cm), flower diameter (6.83 cm), flower weight (3.45 g), number of flowers per plant (389.66), flower yield (0.85 kg) per plant and hence, flower yield (3348.47 kg) per acre. The flowering was recorded earlier in 2.0 g nitrogen under spacing 70 x 100 cm as it exhibited flowering in 64.00 days. The shelf life of flowers was recorded maximum (10.87 hrs) with 1.5 g nitrogen under 70 x 100 cm spacing which was statistically at par with 2.0 g nitrogen under 70 x 100 cm spacing.

Conclusion: The comparison of various treatments that were used in the study revealed that the treatment consisting of S_1 (70 x 100 cm) + N_2 (2.0 g N/plant/month or 7.92 kg N/acre/month) had a significant effect in improving the plant growth and flower yield of *Rosa gruss-an-teplitz* in open field conditions in Punjab. It can further be concluded that the nitrogen @ 95.04 kg per year (206.24 kg urea per year) can be applied to get maximum flower yield of *Rosa gruss-an-teplitz*.

Keywords: *Rosa gruss-an-teplitz,* nitrogen, spacing, loose flower

1. INTRODUCTION

Rosa gruss-an-teplitz, belongs to Rosaceae family, commonly known as '*Desi Rose'*, is one of the beautiful red roses of the old garden rose section. It is commonly classified as a Bourbon rose (old garden rose) but it is a mixture of Bourbon, China and Tea Roses. It is considered as one of the best Bourbon roses having attractive, crimson coloured flowers[1]. It is perennial in nature. It is commercially grown throughout India for its loose flowers. Owing to meager land holdings of small and marginal farmers, flower crops hold good potential for their sustenance and *Rosa gruss-an-teplitz*is one of them, as it produces flowers almost throughout year. The demand of its flowers also persists for a longer period of the year. It fetches premium price in the loose flower market, hence is preferred by Indian farmers. It has potential to generate handsome income particularly for farmers with very less land holdings surrounding big and small cities.

For proper growth and flowering, plants require optimum nutrition and space to grow.Nitrogen is one of the most important elements required by the plants for the completion of their life cycle as it is of immense importance for promotes growth and development of the plant[2]. For commercial cultivation, there must be optimum plant spacing for better vegetative growth and reproductive gains, since there is no specific recommendation of plant nutrition and spacing as is evident from its

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cultivation under various systems which offer its lower yield as compared to its maximum physiological yield.

Keeping the importance of this crop in view, the present investigation was carried out to standardize the nitrogen and spacing for *Rosa gruss-an-teplitz* for loose flower production under open conditions.

2. MATERIAL AND METHODS

Two years old plants were used as the plants have stabilized in yield of loose flowers. The plants were planted at three different spacings (S) viz. S_1 (70 x 100 cm), S_2 (70 x 90 cm) and S_3 (70 x 80 cm) accommodating 3960, 4410 and 4950 plants per acre respectively. The plants were pruned in the month of January and were supplied with basal dose of 20 g each of P and K. After that the plants were fertilized with nitrogen (N) as N_0 (0 g), N_1 (1.5 g), N_2 (2.0 g) and N_3 (2.5 g) per plant at monthly interval starting from January onwards. Nitrogen was applied in the form of urea amounting 0 g, 3.26 g, 4.34 g and 5.43 g urea for 0 g, 1.5 g. 2.0 g and 2.5 g N respectively. Cultural practices such as irrigation, weeding etc. were followed as and when required. The observations of plant height, plant spread, days to flower bud appearance, days to flowering, flower diameter, flower weight, number of flowers per plant, flower yield per plant, flower yield per acre and flower shelf life were recorded. The data was statistically analyzed using SAS softwareusing Tukey's HSD test.The interaction results of nitrogen and spacing have been discussed to interpret the conclusions out of this study.

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3. RESULTS AND DISCUSSION

The vegetative growth parameters like plant height and spread were found to be significantly affected by nitrogen and spacing levels (Table 1). The maximum (109.50 cm) plant height was observed in the treatment S_1N_2comprising of 2.0 g nitrogen per plant per month with plant spacing 70 x 100 cm which was statistically at par (108.50 cm) with S_1N_3, whereas minimum plant height was observed with S_2N_1. Similar trend was recorded for plant spread also. From these results, it is clear that higher level of nitrogen and spacing enhanced the plant height and spread. This is attributed due to the fulfilment of nitrogen requirement and availability of other nutrients along with sunlight under more spacing which enhances the photosynthesis, cell multiplication and metabolic transportation. Higher levels of nitrogen application were reported to increase the vegetative growth in rose cv. 'Super Star'[3].The obtained results of vegetative growth are in close conformity with thoseas reported in rose[4]. The findings of the present investigation are also confirmed with the results reported in rose cv. 'Gladiator' as lower plant density resulted in more plant spread due to availability of more open space[5].

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The non-significant effect had been recorded on the flower bud appearance but days to flowering was significantly affected by spacing and nitrogen levels (Table 1). The treatment S_1N_2comprising of 2.0 g N/plant/month with plant spacing of 70 x 100 cmexhibited slightly early flowering (64.00 days), while S_3N_0 and S_3N_1 exhibited late flowering and were at par with each other.

It is evident from the results that early flowering was obtained under more spacing and higher nitrogen level. The beneficial effects of nitrogen in the plant physiology and metabolism are largely attributed along with more plant spacing which provide an opportunity for more sunlight and nutrients to the plants as there is less competition among the roots for nutrients. The results obtained in this study are in conformity with the results reportedin rose cv. 'Charisma' as it was found that application of higher dose (30 g/plant) of nitrogen resulted in early flowering[6].

Table 1. Effect of spacing and nitrogen on growth and floral parameters in *Rosa gruss-an-teplitz*

	Plant height (cm)				Plant spread (cm)				Days to flower bud appearance				Days to flowering			
	S_1 (70 × 100 cm)	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Me**
N_0 (0g/plant/ month)	95.53 ^{E}	95.00 ^{E}	95.72 ^{DE}	**95.42 ^{c}**	87.83 ^{D}	90.33 ^{C}	83.83 ^{E}	**87.33 ^{c}**	54.83 ^{A}	55.77 ^{A}	55.91 ^{A}	**55.50 ^{a}**	66.33 ^{BC}	68.00 ^{AB}	69.17 ^{A}	**67.83 ^{a}**
N_1 (1.5g/plant/ month)	100.80 ^{C}	94.13 ^{E}	95.17 ^{E}	**96.70 ^{c}**	92.67 ^{B}	91.18 ^{BC}	82.83 ^{EF}	**88.89 ^{b}**	54.30 ^{A}	54.88 ^{A}	55.72 ^{A}	**54.97 ^{ab}**	65.00 ^{CD}	66.00 ^{BCD}	68.67 ^{A}	**66.56 ^{b}**
N_2 (2.0g/plant/ month)	109.83 ^{A}	103.92 ^{B}	98.58 ^{CD}	**104.11 ^{a}**	95.67 ^{A}	94.55 ^{A}	81.67 ^{F}	**90.63 ^{a}**	54.10 ^{A}	54.20 ^{A}	54.19 ^{A}	**54.16 ^{b}**	64.00 ^{D}	64.50 ^{CD}	65.00 ^{CD}	**64.50 ^{c}**
N_3 (2.5g/plant/month)	108.50 ^{A}	99.58 ^{C}	94.58 ^{E}	**100.89 ^{b}**	95.17 ^{A}	87.17 ^{D}	83.08 ^{EF}	**88.47 ^{b}**	54.10 ^{A}	54.36 ^{A}	55.95 ^{A}	**54.80 ^{ab}**	64.17 ^{CD}	64.67 ^{CD}	68.00 ^{AB}	**65.61 ^{b}**
Mean	**103.67 ^{a}**	**98.16 ^{b}**	**96.01 ^{c}**		**92.83 ^{a}**	**90.81 ^{b}**	**82.85 ^{c}**		**54.33 ^{b}**	**54.80 ^{ab}**	**55.44 ^{a}**		**64.88 ^{c}**	**65.79 ^{b}**	**67.71 ^{a}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

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The flower diameter, flower weight and number of flowers per plant were found to be significantly affected by nitrogen and plant spacing (Table 2). The treatment comprising 2.0 g nitrogen per plant per month with spacing 70 x 100 cmresulted in maximum (6.83 cm) flower diameter and highest average flower weight (3.45 g) when compared to other treatments. Similarly, the same treatment also exhibited maximum (389.66) number of flowers per plant.

It was found that nitrogen and plant spacing significantly influenced the yield parameters like flower yield per plant and per acre (Table 3). The treatment comprising 2.0 g nitrogen per plant per month with plant spacing 70 x 100 cm resulted inhighest yield (0.85 kg) per plant. As the total yield per plant was recorded with S_1N_2 treatment consequently the same treatment has recorded significantly highest yield (3348.47 kg) on the per acre basis. As it is evident from the yield recorded that with same plant spacing but with no nitrogen application, the total loose flower yield was 1929.88 kg per acre and was significantly less from the treatments fertilized with nitrogen.

It is obvious from the data that maximum flower diameter, flowers per plant, flower weight, flower yield per plant and flower yield per acre were recorded in plants supplied with higher nitrogen under less plant density. It can be explained by the beneficial effects of graded level of nitrogen and optimal suspected suitable plant density on the plant growth. Better availability of nutrients during the whole growing period makes the plant strong enough to produce more flowers with more weight by using the assimilated food. Flower diameter results are in close affinity of the results obtained in rose cv. 'Gruss-an-teplitz' as maximum flower diameter was recorded by application of higher nitrogen[7]. It had been also reported that lower plant density resulted in maximum flower diameter in marigold[8].Regarding number of flowers per plant, similar findings were obtained in rose[9] and in *Rosa damascena*[10]as it was found that application of higher levels of nitrogen resulted in maximum number of flowers per plant. It had been reported that application of higher dose of nitrogen @ 500 kg/ha/year resulted in flowers with more weight in rose cv. 'Arjun'[11]. Similar results were obtained in rose cv. 'Gladiator' where it was reported that applying 30 g nitrogen per plant significantly increased the flower weight[12]. It was reported that higher nitrogen resulted in more flowers per plant, hence more yield per plant in *Rosa gruss-an-teplitz*[13]. It had been reported that lower plant density resulted in more yield per plant in rose cultivars[14]. More flower yield per unit area was also obtained in rose cv. 'Gruss-an-teplitz'[7] and in *Rosa damascena*[15].

The loose flowers of the rose are to be transported to the local markets and in some cases to distant markets, hence shelf life is also evaluated which is presented in Table (3). The treatment combination comprising 1.5 g nitrogen per plant per month with spacing 70 x 100 cm has exhibited a significant influence on shelf life and it was found that shelf life was highest (10.87 hrs) with this treatment. Moreover, shelf life was influenced by seasonal variations in temperature but highest (10.87 hrs) shelf life was recorded in treatment S_1N_1 in each season. Seasonal data is not presented in this manuscript.

It may be noted from the table 3 that the shelf life has increased with the application of nitrogen but still higher application (2.0 and 2.5 g) has not exhibited the anticipated effects. As, it is evident from the decrease in shelf life as recorded. These results are in contradiction with those as reported in rose cv. 'Charisma' that application of higher nitrogen resulted in maximum flower shelf life[6]. Higher levels of nitrogen also resulted in decrease in shelf life as similar results were obtained in three greenhouse cultivars of rose ('After Glow', 'Obsession' and 'Royalty') that after a certain level, no benefit can be achieved by applying higher nitrogen doses[16]. Later on, it was confirmed again that higher rate of nitrogen reduced the consistency of cut flowers in rose[17]. The above mentioned results are also in affinity in case of spacing levels, as it was found that lowest plant density resulted in maximum shelf life of flowers in rose cv. 'Gladiator'[5].

Table 2. Effect of spacing and nitrogen on flower diameter, flower weight and number of flowers per plant in *Rosa gruss-an-teplitz*

	Flower diameter (cm)				Flower weight (g)				Number of flowers per plant			
	S_1 (70 × 100 cm)	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**
N_0 (0g/plant/month)	5.87 BCD	5.80 BCDE	5.59 CDE	**5.75 c**	2.54 E	2.42 E	2.65 DE	**2.54 c**	267.53 FGH	263.01 GH	238.43 H	**256.32 d**
N_1 (1.5g/plant/ month)	6.08 B	5.92 BC	5.86 BCD	**5.95 b**	3.02 BC	2.71 CDE	2.76 BCDE	**2.83 b**	297.64 DEF	288.67 EFG	265.58 FGH	**283.96 c**
N_2 (2.0g/plant/ month)	6.83 A	6.16 B	5.56 CDE	**6.18 a**	3.45 A	3.05 BC	2.94 BCD	**3.15 a**	389.66 A	336.90 BC	315.70 CDE	**347.42 a**
N_3 (2.5g/plant/month)	6.52 A	5.45 E	5.55 DE	**5.84 bc**	3.13 AB	3.06 BC	2.74 CDE	**2.98 b**	354.37 BC	323.17 BCD	284.63 EFG	**320.72 b**
Mean	**6.33 a**	**5.83 b**	**5.64 c**		**3.03 a**	**2.81 b**	**2.77 b**		**327.30 a**	**302.94 b**	**276.08 c**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at P < 0.05.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

Table 3. Effect of spacing and nitrogen on shelf life and yield parameters in *Rosa gruss-an-teplitz*

	Flower yield per plant (kg)				Flower yield per acre (kg)				Flower shelf life (hrs)			
	S_1 (70 × 100 cm)	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**	**S_1 (70 × 100 cm)**	**S_2 (70 × 90 cm)**	**S_3 (70 × 80 cm)**	**Mean**
N_0 (0g/plant/ month)	0.49 FG	0.46 FG	0.41 G	**0.45 d**	1929.88 F	2039.88 EF	2015.05 EF	**1994.94 d**	8.28 E	9.00 C	8.17 E	**8.48 c**
N_1 (1.5g/plant/ month)	0.59 DE	0.52 EF	0.47 FG	**0.53 c**	2319.12 DE	2310.94 DE	2334.05 DE	**2321.37 c**	10.87 A	9.63 B	9.48 B	**9.99 a**
N_2 (2.0g/plant/ month)	0.85 A	0.69 BC	0.59 DE	**0.71 a**	3348.47 A	3040.72 AB	2909.81 BC	**3099.66 a**	10.82 A	9.60 B	9.38 B	**9.93 a**
N_3 (2.5g/plant/ month)	0.75 B	0.64 CD	0.52 EF	**0.64 b**	2972.54 B	2842.11 BC	2575.61 CD	**2796.75 b**	9.00 C	8.28 E	8.74 D	**8.67 b**
Mean	**0.67 a**	**0.58 b**	**0.50 c**		**2642.50 a**	**2558.41 ab**	**2458.63 b**		**9.74 a**	**9.13 b**	**8.94 c**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at P < 0.05.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

4. CORRELATION

On calculation of correlation between spacing, nitrogen and yield, it has been found that these are positively (0.099) correlated with each other. This implies that the spacing and nitrogen have significant influence on the increase in loose flower yield in *Rosa gruss-an-teplitz*.

5. CONCLUSION

It can be concluded that optimum nitrogen application and plant density enhanced the growth and flower yield in *Rosa gruss-an-teplitz*. The comparison of various treatments that were used in the study revealed that the treatment consisting of S_1 (70 x 100 cm) + N_2 (2.0 g N/plant/month or 7.92 kg N/acre/month) had a significant effect in improving the plant growth and flower yield of *Rosa gruss-an-teplitz* in open field conditions in Punjab.

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