Scientific Article

Planting density on roses cultivars ‘Avalanche’ and ‘Carola’ in Lages-SC [1]

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ABSTRACT

The objective of this work was to evaluate the productivity of the Avalanche and Carola roses cultivars, with white and red color, respectively, in three planting densities in the municipality of Lages-SC. The experiment was implemented at the Santa Catarina State University campus (UDESC), spacing 1.0 m between rows and 30, 40 and 50 cm between plants, totaling 168 m² of experiment in a protected environment. During harvesting the stems were cut with the largest possible stem length, leaving one yolk for the next budding. The evaluated variables were: flower stems production per plant, yield per area (floral stems / m²), floral stem mass (g), stem length (cm), floral button length (cm). The treatments consisted of two roseberry cultivars: Avalanche and Carola and three planting densities: 2.2, 2.5 and 3.3 plants per m². In each block, treatments were arranged at random, organized into subdivided plots. The plots were the cultivars and the subplots were the planting densities. Each subplot was composed of six plants, totaling 18 plants per plot and 144 plants throughout the experiment. The density of 3.3 plants / m² increased yield per growing area, without interfering in the quality of the floral stems of the cultivars Avalanche and Carola. The cultivar Carola produces longer flower stems than the cultivar Avalanche.

Keywords: *Rose spp.,* productivity, cut flower.

RESUMO

Densidade de plantio em rosas das cultivares ‘Avalanche’ e ‘Carola’ em Lages-SC

O objetivo deste trabalho foi avaliar a produtividade das cultivares de rosa ‘Avalanche’ e ‘Carola’, de coloração branca e vermelha, respectivamente, em três densidades de plantio no município de Lages-SC. O experimento foi implantado no campus da Universidade do Estado de Santa Catarina (UDESC), com espaçamento de 1,0 m entre fileiras e de 30, 40 e 50 cm entre plantas, totalizando 168 m² de experimento em ambiente protegido. Durante a colheita as hastes foram cortadas com o maior comprimento de haste possível, deixando uma gema para a próxima brotação. As variáveis avaliadas foram: produção de hastes florais por planta, produção por área (hastes florais/m²), massa da haste floral (g), comprimento da haste (cm), comprimento do botão floral (cm). Os tratamentos consistiram de duas cultivares de roseira: Avalanche e Carola e três densidades de plantio: 2,2; 2,5 e 3,3 plantas por m². Em cada bloco, foram distribuídos aleatoriamente os tratamentos, organizados em parcelas subdivididas. As parcelas foram as cultivares e as subparcelas foram as densidades de plantio. Cada subparcela foi constituída de seis plantas, totalizando 18 plantas por parcela e 144 plantas em todo o experimento. A densidade de 3,3 plantas/m² aumentou a produção por área de cultivo, sem interferir na qualidade das hastes florais das cultivares Avalanche e Carola. A cultivar Carola produz hastes florais mais longas que a cultivar Avalanche.

Palavras-chave: *Rosa spp.,* produtividade, flor de corte.

1. INTRODUCTION

The genus *Rosa* L. belongs to the Rosaceae family, and it is a woody perennial shrub, with deciduous leaves, composed by five or more leaflets and with the presence of stipules. Its flowers may have ten or more stamens and produce a pseudofruit (PETRY, 1999).

The production system of cut roses varies according to the region, with the classification for the group to which it belongs, with the habit of growth and with the cultivar. The production of roses in greenhouses is used on a larger scale, since it allows greater advantages to producers (OLIVEIRA et al., 2014).

A factor to be considered in the cultivation of roses is the planting density, which may influences the levels of shading between plants, the photosynthetic assimilation and development of the leaf area, and consequently, their productivity (ZIESLIN and MOR, 1990). The more plants densified per m² there will be more roots per m². Restriction on root development may affect many aspects

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related to vegetative and reproductive development, such as photosynthesis, leaf chlorophyll content, water and nutrient uptake, respiration, flowering, and yield (NESMITH and DUVAL, 1998).

In the cultivation of roses, the higher density of plants increases the leaf area index, makes the plants bigger, increases the number of plants with mass / m² ratio, increases the number of flowers / m², but also, causes higher plant mortality, decreases of the individual mass / plant ratio, stem diameter and flower quality (DE VRIES and DUBOIS, 1988).

Considering the scarcity of information on planting density in the cultivation of roses and the importance of this crop to the national and international floriculture market, this study aims to evaluate the effect of three planting densities between two rose cultivars, Avalanche and Carola.

2. MATERIAL AND METHODS

The study was conducted in a greenhouse at the College of Agroveterinary Science (CAV) of Santa Catarina State University, located in Lages, Santa Catarina State (27°47'06"S, 50°18'12"W and 923 m a.s.l.). The climate is classified as Cfb, according to Köppen, which is characterized by mild summers and well distributed rainfall along the year. The annual average temperature is 15,6 °C.

The greenhouse used was of the arch type, with metallic structure; upper and lateral cover made by transparent low density polyethylene; longitudinal laterals composed of curtains for temperature and relative humidity control; and maximum height of 3,0 m.

The soil type is Cambisol, characterized by high content of clay and organic matter. Before planting, dolomitic limestone was applied in order to elevate the soil pH until 6,0. Planting and maintenance fertilization were performed according to the recommendations of the Manual de Adubação e Calagem by Rede Oficial de Laboratórios de Análise de Solo para o Rio Grande do Sul e Santa Catarina.

Treatments consisted of two rose cultivars (*Rosa spp.*), Avalanche and Carola, and three planting densities: 2.2, 2.5 and 3.3 plants per m². Both cultivars were grafted on *Rosa multiflora* and were planted in four rows. The experiment was laid out in randomized complete block, each row being considered as a block, and treatments arranged in a split plot manner. The rose cultivars were arranged in main plots, while the planting densities were subjected to sub-plot. The densities were established by standardization of 1.0 m between rows and spacing the plants every 0.5, 0.4 and 0,3 with each other to obtain the aimed densities (2.2, 2.5 and 3.3 plants/m²). Each sub-plot consisted of six plants, totalizing 18 plants by plot and 144 plants in the whole experiment. For the evaluations, the four central plants of each sub-plot were considered.

The planting was carried out on January 7th, 2013. During the first three weeks, floral buds were removed in order to prioritize the development of leaves to promote energy accumulation in the plants. From February onwards, one flower bud per stem was allowed to develop. The harvests and the evaluations were made twice a month (once every 15 days), between February and June. In July, the plants went into dormancy, and in September, the winter pruning was done, leaving four branches per plant and four buds per branch. In the month of October they returned to present vegetative growth, and in December the harvests and evaluations were resumed.

The variables analyzed were: yield per plant (number of flower-stems per plant), yield per growing area (flower-stems /m²), flower-stem mass (g), stem length (cm), and flower length (cm). The floral-stem mass was obtained by the use of an electronic scale, and the stem and floral button lengths were measured with ruler.

For data statistical analysis, we performed the analysis of variance (ANOVA) considering a 2x3x6 factorial scheme, organized as sub-subdivided plots in time: two cultivars, three planting densities and six months of harvest. When significant effects of density and month of harvest were detected, the Turkey's range test was performed ($p<0.05$).

3. RESULTS AND DISCUSSION

For yield per plant and yield per area, main effects from cultivars or its interaction with the other factors were not significant in the analysis of variance. Thus, yield results are presented only for the main effects of density and harvest month, in addition to the interaction of these two factors (Table 1).

Table 1. Mean yield of flower-stems of ‘Avalanche’ and ‘Carola’ roses bushes planted in different densities, in Lages-SC.

Month	Planting density												Mean			
	2.2 plants/m²				2.5 plants/m²				3.3 plants/m²							
Yield per plant (no. flower-stems)																
Feb	1.3	±	0.5	ns	1.0	±	0.0	ns	1.2	±	0.4	ns	1.1	±	0.1	b
Mar	1.2	±	0.3	-	1.3	±	0.3	-	1.3	±	0.2	-	1.3	±	0.1	b
Apr	1.3	±	0.3	-	1.5	±	0.4	-	1.3	±	0.3	-	1.4	±	0.1	b
May	1.3	±	0.3	-	1.2	±	0.3	-	1.3	±	0.3	-	1.3	±	0.1	b
Jun	1.3	±	0.3	-	1.2	±	0.2	-	1.1	±	0.4	-	1.2	±	0.1	b
Dec	2.4	±	0.9	-	2.8	±	0.8	-	2.9	±	1.1	-	2.7	±	0.3	a
Mean	1.5	±	0.5	ns	1.6	±	0.7	-	1.5	±	0.7	ns	-	±	-	-
Yield per growing area (flower-stems / m²)																
Feb	2.5	±	0.9	abA	2.5	±	0.0	Ab	3.9	±	1.2	Ab	3.0	±	0.8	b
Mar	2.4	±	0.5	bA	3.3	±	0.8	Ab	4.4	±	0.8	Ab	3.0	±	1.0	b
Apr	2.5	±	0.6	abA	3.8	±	1.1	Ab	4.3	±	1.1	Ab	4.0	±	0.9	b
May	2.6	±	0.7	abA	2.9	±	0.7	Ab	4.5	±	0.9	Ab	3.0	±	1.0	b
Jun	2.7	±	0.7	abA	3.1	±	0.6	Ab	3.8	±	1.2	Ab	3.0	±	0.5	b
Dec	4.7	±	1.7	aC	7.1	±	2.1	Ba	9.5	±	3.8	Aa	7.0	±	2.4	a
Mean	3.0	±	0.9	C	4.0	±	1.7	B	5.0	±	2.2	A	-	±	-	-

Means followed by uppercase letters in the rows and lowercase letters in the columns do not differ by Tukey’s range test ($p<0,05$).
ns = not significant by ANOVA ($p<0,05$).
Mean ± standart deviation.

The number of flower-stems per plant was not affected by the density, however, it was influenced by the month of harvest. Between February and June, rose bushes averaged 1.3 flower-stems per plant per month. The higher yield per plant was observed in December, when both cultivars produced an average of 2.7 floral-stems per plant. Since the yield capacity per plant was not affected by the spacing between plants, a higher density of rose plants increased the yield per area. The highest yield per area was obtained in the density of 3.3 plants/m², with a monthly average of 5 flower-stems per m² per month, which represented 25 and 66% increase compared to the yields obtained at densities of 2.5 and 2.2 plants/m², respectively.

For all the physical characteristics of the flower-stems, no effect of the density was found. For all variables, there was a predominant effect of the month of harvest, and a cultivar effect was found only for stem length (Table 2). The results found in this study are in agreement with the results found in other studies, where increases were observed in the production of floral stems associated to the increase or stabilization of the physical characteristics of roses (KOOL, 1996; DAMBRE et al., 2000; HASSANEIN, 2010; ZANÃO JÚNIOR et al., 2014).

Table 2. Characteristics of flower-stems of 'Avalanche' and 'Carola' rose bushes, grown in Lages-SC

Month	Cultivar								Mean			
	Avalanche				Carola							
Flower-stem weight (g)												
Feb	18.5	±	4.2	ns	18.4	±	4.6	ns	18.5	±	0.1	c
Mar	20.4	±	3.7	-	18.0	±	3.4	-	19.2	±	1.7	c
Apr	27.5	±	8.1	-	24.7	±	12.9	-	26.1	±	2.0	b
May	28.2	±	6.7	-	28.9	±	10.8	-	28.6	±	0.5	b
Jun	33.0	±	19.8	-	38.9	±	15.1	-	35.9	±	4.2	a
Dec	32.7	±	7.3	-	29.3	±	5.4	-	31.0	±	2.4	a
Mean	26.7	±	6.1	ns	26.4	±	7.8	-	-	±	-	-
Stem length (cm)												
Feb	15.3	±	4.6	Bb	32.9	±	9.2	Ac	24.1	±	12.4	d
Mar	16.8	±	5.1	Bb	29.4	±	3.7	Ac	23.1	±	8.9	d
Apr	22.4	±	5.9	Bab	33.5	±	8.4	Ac	27.9	±	7.8	cd
May	21.9	±	2.1	Bab	41.4	±	9.2	Abc	31.7	±	13.8	bc
Jun	32.3	±	15.9	Bab	51.3	±	12.3	Aa	41.8	±	13.4	a
Dec	28.5	±	4.2	Ba	44.8	±	4.5	Aab	36.6	±	11.5	ab
Mean	22.8	±	6.6	B	38.9	±	8.4	A	-	±	-	-
Flower bud length (cm)												
Feb	3.9	±	0.4	Ac	4.4	±	0.6	Aab	4.1	±	0.4	c
Mar	3.8	±	0.2	Ac	3.5	±	0.3	Ac	3.7	±	0.2	d
Apr	4.5	±	0.3	Ab	4.1	±	0.5	Abc	4.3	±	0.3	bc
May	4.3	±	0.4	Abc	4.1	±	0.3	Abc	4.2	±	0.1	c
Jun	4.7	±	0.4	Ab	4.6	±	0.6	Aab	4.7	±	0.1	bc
Dec	5.4	±	0.5	Aa	5.5	±	0.4	Aa	5.4	±	0.1	a
Mean	4.5	±	0.6	ns	4.4	±	0.7	-	-	±	-	-

Means followed by the same uppercase letter in the row do not differ by f-test ($p<0.05$).
Means followed by the same lowercase letter in the column do not differ by Tukey's range test ($p<0,05$).
ns = not significant by ANOVA ($p<0,05$).
Mean ± standart deviation.

Floral stem mass and bud length were similar between the two cultivars, however, the average stem length of Carola cultivar was 41% higher than that of Avalanche. Both cultivars presented the average stem length of 40 to 60 cm, however, in this study, the Avalanche cultivar obtained a lower average than the Carola roses. The quality categories of roses are determined by the length of their stems (MATSUNAGA et al., 1995; SANTOS et al., 2002). Stem lengths greater than 70 cm are those of higher quality, and lower quality categories are determined every 10 cm of reduction in stem length obtained at harvest, and roses with stem length less than 30 cm are discarded by the market (MATSUNAGA et al., 1995). For the florists, long-handled roses are more interesting and valued, for the simple reason that the work with roses of longer stems is more dynamic, making possible the preparation of flower arrangements of different sizes, unlike the roses of short stems, which reduce the range of possibilities for floral arrangements.

The highest values of mass, stem length and flower bud length were observed in the months of June and December. The higher quality of the flower stems observed in June may be related to the accumulation of carbohydrates that occurred in the plants during the previous months, which allowed them to develop both the aerial part and the root system, resulting in the production of flower-stems with higher values of mass (stem + flower), stem and flower lengths compared to those from previous months. After the winter pruning, the accumulated reserves before dormancy served as energy source for a limited number of buds, which provided more nutrients reaching the flower stems (ADHIKARI et al., 2011). Thus, in December, the peak of production in number of flower-stems per area was observed, with the same quality as that observed in June.

4. CONCLUSIONS

- The density of 3.3 plants / m² increased yield per growing area, without interfering in the quality of the floral stems of the cultivars Avalanche and Carola.
- The cultivar Carola produces longer flower stems than the cultivar Avalanche.

AUTHOR CONTRIBUTION

FEAB: planning, execution of experiment, statistic and writing. RA: execution of experiment, statistic and writing. SL: planning, execution of experiment and writing. AAK: writing and writing correction. LR: writing and writing correction.

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