

Responses of Different Morphological Attribute of *Rosa hybrida* L. cv. Kardinal to Saline Water Irrigation

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Abstract Salinity remained as a serious threat to agricultural land in all over the world. Salt stress conditions affect all aspects of plant growth and development. When we raised plant in different levels of NaCl, it caused the change not only in morphological characteristics, but also had adverse effect on physiological characteristics of the plant. Among seven levels of salinity, T₀ showed better result against other treatments. T₀ (canal water) proved the best treatment for all the understudy characters such as plant height decreased significantly with the increase in salinity level. Plant height, number of leaves plant⁻¹, number of branches plant⁻¹, leaf area, number of flower plant⁻¹, flower diameter, flower quality, fresh weight of flower, dry weight of a flower presented superior results in canal water rather than 2.5 dS/m, 5 dS/m, 7.5 dS/m, 10 dS/m, 12.5 dS/m and 15 dS/m salinity levels.

Keywords *Rosa hybrid*, Salinity, NaCl, Kardinal, Canal water,

Agricultural productivity is severely affected by soil salinity and the damaging effect of salt accumulation in agricultural soils has become an important environmental concern [6]. Higher concentration of soluble salts in soil causes reduction and delay in germination of seeds of many species, it is observed that salts may affect germination rate to a greater extent than the germination percentage [7]. Seeds with high germination percentage under salt stress may be expected to achieve high germination percentage and rapid seedling establishment and hence ultimate high yield [8]. Most of the ornamental plants are glycophytes and vary as salt-susceptible to fairly salt-resistant. Salinity has deleterious effect on plant growth, nutritional balance, flowering marketable quality of plant, including visual injury, flower distortion and reduced stem length [9]. Salinity stops growth and, in high concentration, changes plant morphological characteristics and their anatomy and has lethal affect on plant organism [10]. Growth, yield and quality decrease may occur due to a decrease in the ability of plants to take up water from the soil solution and the destruction of soil structure caused by salinity [11].

Now a day's different farming techniques have been introduced to overcome the problems of saline areas or the area which is under other stresses conditions [12]. Salt resistant plants give better result because they have the ability to uptake more water in such condition under saline soil while in most cases salinity retards the plant growth because of saline soils requires resources as there is a limited availability of quality water and low soil permeability [13]. Singh, [14] claimed that *Rosa damascene* can be successfully grown on salt affected soil having pH of 7.8 to 8.8 due to high salt uptake. Skiminia, [15] described that salt tolerance in ornamental to four levels of salinity having ECe of 140, 300, 600 and 1200 (10⁻⁵) mhos and reported that *Aurocaria heterophylla*, *Asparagus densiflorus* and *Hibiscus rosasinensis* considered the salt tolerance plants. Keeping in view the potential of plant salt tolerance in the literature, the present study was conducted aims to assess the effect of salinity on different morphological features of *Rosa hybrida* L. cv. Kardinal and to checks the response of the plants under salt stress conditions and its tolerance level.

1. Introduction

Soil salinity is a condition characterized by high concentration of soluble salts. Soils are classified as saline when the electrical conductivity (EC) is 4 dS m⁻¹ or more [1]. Among various a biotic stresses, salinity is the major factor that reduces/harms the plant growth and development, decreases germination and ultimately decreases plant establishment and yield. The salinity is a major problem for all the countries in the world. The total global area of salt-affected soils has been recorded to be about 830 million hectares [2]. Salinity affects 19.5 percent of irrigated land and 2.1 percent of dry land agriculture in the world [3]. Most of the saline soil has arisen from natural causes, by the accumulation of salt for a long period of time in arid to semi-arid regions of the world [4]. Plants get different necessary nutrients which are available to the plants in soluble form and the plant enlargement is decreased by unnecessary addition of these soluble salts [5].

2. Materials and Methods

Experiment was conducted in pots at Floriculture Research Area, University of Agriculture, Faisalabad during year (2012-13) in order to investigate the effects of salinity on growth and flowering quality of *Rosa hybrida* L.cv. Kardinal. The experiment was laid out in the Randomized Complete Block Design (RCBD) with seven different treatments of salinity ranging from 2.5 dS/m to 15 dS/m salinity each with three replications. Seedlings of month were transplanted in the pots (20 cm diameter and 22 cm depth) containing a mixture of silt and leaf manure in the ratio of 1:1 as a growth medium. These seedlings were allowed to establish for 20 days before the start of applying different salinity levels (2.5, 5.0, 7.5, 10.0, 12.5, 15.0 dS/m of NaCl salt of solution). The experiment was comprised of weighing the soil that was 1500gm (growth medium) in each pot and the salinity levels were developed artificially by adding the solution of 2.5, 5.0, 7.5, 10.0, 12.5, 15.0 dS/m of NaCl salt solution along with control. Data for different morphological attributes was collected as:

Plant height (cm) and number of leaves plant⁻¹ as by Wood and Roper [16] With the help of leaf area meter leaf Area (cm²) calculated by formula as

$$\text{Leaf Area} = \frac{\text{Maximum Length} \times \text{Maximum breadth}}{4} \times \pi$$

Number of branches plant⁻¹ was counted per plant and then average was worked out. Number of flowers plant⁻¹ was counted regularly during blooming period of the crop and then average was worked out, for size of flower (cm) diameter of all flowers was measured with the help of vernier caliper and their average was taken out. For fresh weight of a flower (g) one flower from each plant was collected randomly and then weighed for its fresh weight in grams on electric balance and their average was worked out and for dry weight of a flower (g) flowers were dried in oven at 65°C for 48 hours and then weight on electric balance. In this way, dry weight of flowers was recorded. Fresh and dry weight ratio of flower was calculated by dividing the fresh weight over dry weight of a flower and average ratio was computed. Flower quality evaluation was done by adopting the method described by Cooper and spokas [17] and Dest and Guillard [18].

2.1. Statistical Analysis

Standard procedure was followed to record the data. Data collected was analyzed by performing analysis of variance (ANOVA) and treatment means were compared according to Duncan's Multiple Range Test at 5 % level of probability [19].

3. Results

3.1. Effect of NaCl Salinity on Plant Height (cm)

Plant height data revealed highly significant results for different levels of NaCl (Table 2). Comparison of means revealed significant superiority of T₀ (canal water) over rest of the treatments by producing 51.43 cm height and T₁ (2.5 dS/m) secured the second position by producing plant height (51.17 cm). T₃ (5dS/m) and T₄ (7.5 dS/m) were statistically similar. Minimum plant height was obtained at T₆ (15 dS/m). T₃ (5dS/m) and T₄ (7.5 dS/m) were statistically similar. Minimum plant height was obtained at T₆ (15 dS/m) (Table 1). The results presented in table (Table 3) exhibited that plant height is positively correlated with flower quality, number of leaves, number of branches, number of flowers, fresh weight, dry weight, diameter of flower and leaf area, whereas negatively associated with fresh and dry weight ratio of the flower.

3.2. Effect of NaCl salinity on Number of Leaves Plant⁻¹

Statistical analysis for these indices has reflected highly significant results in relation to NaCl levels (Table 2). Mean values for number of leaves exhibited that T₀ (canal water) produced more number of leaves (39.44) plant⁻¹. T₁ (2.5 dS/m) and T₂ (5 dS/m) secured second and third position by producing 37.63 and 30.45 number of leaves plant⁻¹. T₃ (7.5 dS/m) produced 27.21 leaves which was followed by T₄ (10 dS/m) and T₅ (12.5 dS/m) by producing 18.11 and 14.55 leaves, respectively. T₆ (15 dS/m) produced minimum number of leaves (9.63) (Table 1). Number of leaves plant⁻¹ are positively correlated with number of branches, number of flowers, fresh weight, dry weight of a flower, flower diameter and leaf area. While it was negatively correlated with fresh and dry weight ratio of flowers, (Table 3).

3.3. Effect of NaCl Salinity on Number of Branches Plant⁻¹

Data regarding number of branches plant⁻¹ is presented in (Table 2) as analysis of variance after having it been subjected to statistical analysis indicated highly significant results. It is obvious from mean table (Table 1) that T₀ (canal water) produced maximum number of branches (6.05). T₁ (2.5 dS/m) and T₂ (5 dS/m) behaved significantly alike from statistical point of view with average number of branches 5.96 and 5.85, respectively. T₆ (15 dS/m) produced only 3.29 branches plant⁻¹. This represents highly adverse effects of salinity on the number of branches. Number of branches plant⁻¹ are positively correlated with number of leaves, number of flowers, fresh weight, dry weight, flower diameter and leaf area while negatively correlated with fresh and dry weight ratio flowers (Table 3).

3.4 Effect of NaCl Salinity on Leaf Area (cm²)

leaf area was processed for statistical analysis and is presented in (Table 2) as analysis of variance and statically

analysis reflected highly significant results for NaCl levels. T₀ (canal water) secured superiority over all other treatments with average leaf area of 18.53 cm². T₁ (2.5 dS/m) obtained 16.98 cm² leaf area followed by T₂ with leaf area of 15.81 cm². T₃ (7.5 dS/m) and T₄ (10 dS/m) were statistically at par whereas T₅ (12.5 dS/m) and T₆ (15 dS/m) were statistically similar with each other.

3.5. Effect of NaCl Salinity on Number of Flowers Plant⁻¹

Number of flowers plant⁻¹ data indicated highly significant results for NaCl levels (Table 2). Values of treatment means (Table 2) exhibited that T₀ (canal water) produced maximum number of flowers (4.46). T₁ (2.5 dS/m) and T₂ (5 dS/m) secured second and third position by producing 4.25 and 4.00 flowers respectively. Minimum numbers of flowers were produced by T₆ (15 dS/m) and it was statistically at equivalence with T₅ (12 dS/m). Number of flowers plant⁻¹ is positively correlated with, fresh weight, dry weight, flower diameter and leaf area. While number of flowers plant⁻¹ has negative association with ratio of fresh and dry weight of flowers (Table 3).

3.6. Flower Diameter

Flower diameter was processed for analysis of variance and results obtained revealed highly significant difference among different salinity levels (Table 2). Comparison of means (Table 1) exhibited that T₀ (canal water) excelled rest of treatments by producing large sized flowers as compared to all other treatments. Data revealed that T₀ (canal water) produced maximum diameter (2.1 cm) of a flower followed by T₁ (2.5 dS/m) which was statistically different from rest of the treatments. T₆ (15 dS/m) produced minimum flower diameter (1.8 cm) followed by T₅ (12.5 dS/m) with flower diameter of (1.9 cm). T₄ (10 dS/m) was statistically at par with T₃ (7.5 dS/m). Flower diameter had positive correlation with leaf area (Table 3).

3.7. Effect of NaCl Salinity on Flower Quality:

Flower quality processed for analysis of variance highly significant for NaCl salinity levels (Table 2). Mean values for flower quality indicated (Table 2) that T₀ (canal water) produced better quality flowers with a rating of (8.26). T₁ (2.5 dS/m) and T₂ (5 dS/m) secured second and third position with flower quality of 8.01 and 7.59, respectively. T₃ (7.5 dS/m) and T₄ (10 dS/m) were statistically at par with flower quality of 7.28 and 7.15, respectively. T₆ (15 dS/m) produced poor quality (5.29) flowers followed by 6.06 which was produced by T₅ (12.55 dS/m). Flower quality is positively

correlated with number of leaves while flower quality has negative association fresh and dry weight ratio of flowers (Table 3).

3.8. Effect of NaCl Salinity on Fresh Weight of A Flower (g)

Fresh weight of a flower were presented as analysis showed highly significant results for NaCl levels (Table 2). In order to make a comparison of various NaCl levels, their values were arranged in descending order (Table 2). Mean values for fresh weight of a flower revealed that T₀ (canal water) produced maximum fresh weight (6.95 g) followed by T₁ (2.5 dS/m) with fresh weight of 6.85 g. T₂ (5 dS/m) and T₃ (7.5 dS/m) produced 6.73g and 6.48 g fresh weight respectively. T₅ (12 dS/m) was significantly different from T₄ (10 dS/m). Minimum fresh weight (6.15 g) was produced by T₆ (15 dS/m). Fresh weight of a flower is positively correlated with dry weight, flower diameter and leaf area while it is negatively correlated with ratio of fresh and dry weight of flowers (Table 3).

3.9. Effect of NaCl salinity on dry weight of flower (g)

Dry weight of a flower (g) was processed for statistical analysis exhibited highly significant results for NaCl levels (Table 2). In mean table (Table 1), dry weight (1.43 g) was recorded in T₀ (canal water) which was statistically similar to dry weight (1.40 g) of T₁ (2.5dS/m). Similarly T₃ (7.5 dS/m) and T₂ (5 dS/m) were statistically at par with each other by producing dry weight of 1.27 g and 1.25 g, respectively. Minimum dry weight (1.10 g) was observed by T₄ (15 dS/m) followed by T₅ (12.5 dS/m). Dry weight of a flower is positively correlated with flower diameter and leaf area. While it is negatively correlated with ratio of fresh and dry weight of flowers (Table 3).

3.10. Fresh and Dry Weight Ratio

Fresh and dry weight ratio of flower is presented in depicted highly significant results for NaCl levels (Table 2). Treatments means (Table 1) revealed that T₀ (canal water) secured top position regarding fresh and dry weight ratio (5.60g). T₁ (2.5 dS/m) and T₂ (5 dS/m) obtained second and third positions with 5.43 g and 5.22 g ratio, respectively. T₃ (7.5 dS/m) and T₄ (10 dS/m) were statically similar. The minimum fresh and dry weigh ratio (4.86) was observed by T₆ (15 dS/m) which was at par with 4.87g ratio of T₅ (12.5 dS/m). Ratio of fresh and dry weight of flowers is negatively correlated with flower diameter and leaf area (Table 3).

Table 1. Variation in morphological attributes of *Rosa hybrida* L.cv. Kardinal under different salinity levels

Treatments	Plant height (cm)	Number of leaves plant ⁻¹	Number of branches plant ⁻¹	Leaf area (cm ²)	Number of flowers plant ⁻¹	Flower diameter (cm)	Flower quality	Fresh weight of a flower (g)	Dry weight of flower (g)	Fresh and dry weight ratio
T ₀	51.43	39.44	6.05	18.53	4.46	2.1	8.26	6.95	1.43	5.60
T ₁	51.17	37.63	5.96	16.98	4.25	2.1	8.01	6.85	1.40	5.43
T ₂	49.80	30.45	5.85	15.81	4.00	2.0	7.59	6.73	1.27	5.22
T ₃	48.81	27.21	5.58	13.48	3.66	2.0	7.28	6.48	1.25	5.12
T ₄	46.80	18.11	5.15	12.51	3.22	1.9	7.15	6.33	1.21	4.99
T ₅	44.47	14.55	3.54	10.99	2.96	1.9	6.06	6.24	1.15	4.87
T ₆	42.80	9.63	3.29	10.14	2.74	1.8	5.29	6.15	1.10	4.86

Table 2. Mean squares of absolute values for morphological attributes of *Rosa hybrida* L.cv. Kardinal under different salinity levels

SOS	df	Plant height (cm)	Number of leaves plant ⁻¹	Number of branches plant ⁻¹	Leaf area (cm ²)	Number of flowers plant ⁻¹	Flower diameter (cm)	Flower quality	Fresh weight of a flower (g)	Dry weight of flower (g)	Fresh and dry weight ratio
Varieties	2	17.606	0.768	0.034	13.463	0.332	0.007	0.112	0.149	0.017	0.228
Replicate	6	32.882	397.858	4.032	29.585	1.312	0.041	3.414	0.296	0.046	0.236
Error	12	4.413	0.369	0.063	0.342	0.032	0.002	0.017	0.002	0.003	0.007

Table 3. Correlation between different morphological characters of *Rosa hybrida* L. cv. Kardinal as influenced by various salinity levels

Characters	Plant Height	Flower Quality	Number of leaves/ plant	Number of branches/ plant	Number of flowers/ plant	Fresh weight	Dry weight	Fresh/ Dry weight Ratio	Flower diameter
Flower Quality	0.759**								
Number of leaves/ plant	0.828**	0.933**							
Number of branches/ plant	0.796**	0.941**	0.904**						
Number of flowers/ plant	0.856**	0.859**	0.932**	0.871**					
Fresh weight	0.611*	0.878**	0.902**	0.784**	0.797**				
Dry weight	0.620*	0.835**	0.870**	0.760**	0.732**	0.875**			
Fresh/ Dry weight Ratio	-0.549*	-0.882**	-0.833**	-0.786**	-0.710**	-0.927**	-0.86**		
Flower diameter	0.780**	0.912**	0.909**	0.852**	0.927**	0.841**	0.756**	-725**	
Leaf Area	0.610**	0.892**	0.901**	0.796**	0.817**	0.984**	0.890**	-926**	0.852**

**Highly Significant at 5% level of significance

*Significant at 5% level of significance)

3. Discussion

For plant height, saline irrigation water function as a natural alternate to growth retardants (used by many grower to reduce plant height) and high concentration of salinity badly affects plant height. Similar findings were also reported by Patil and Wahmare [20] for the plant height in which they observed that plant growth at four salinity levels and all indices significantly declined with rising salinity levels. The occurrence of high concentrations of chlorine in the leaves eventually leads to leaf injury. Reduction in growth of plants under salt stress can be attributed to necrosis of the leaves which reduces the photo synthetically active area. These results are in accordance with findings of Cornish *et al* [21] who argued that by increasing NaCl irrigated water in chrysanthemum, numbers of leaves are reduced. It has been suggested that a restriction of Na transport from roots to shoots takes place, to shoots takes place, minimizing Na accumulation in leaves. Plants might protect themselves from sodium toxicity by minimizing the transport to the shoots. These observations were compared with Nolan *et al*. [22] and Mostafa *et al*. [23] who argued that salinity application decreased number of branches in *Datura innoxia*. Salinity causes loss of cell turgor and reduces leaf expansion rates. This, in turn, leads to reduction in the leaf area available for photosynthesis and a loss of productivity. Similar results were obtained by Ergazieva and Rakhimbaev [24] and Jesche and Stelter [25] who observed significant decrease in leaf area with increase in salinity level in irrigation water for lilac. Results for number of flowers were in accordance with Hughes and Hanan [26], Ishida *et al*. [27] and Speck and Sonneveld [28]. Similar reports have been described by Sonneveld arid Voogt [30] who attributed that gerberas, anthurium and chrysanthemum flower production decreased with increasing salinity levels. Any factor that interferes with nitrogen assimilation could cause a reduction in rose flowers production. One of these factors may be salinity which has shown to decrease the number of flowers. It indicated that diameter of a flower decreases with increasing salinity levels. These results are in line with the findings of Jesche and Stelter [25] who reported that increasing salinity levels result a negative effect on flower size in rose. Salinity effects also (depend on the type and concentration of salt used and on the plant species being tested. However, the presence of salts in irrigation water decreases flower quality and therefore leads to a lower economic benefit from the crop. So, it can be concluded that optimum level of salinity is very important in order to get best flower quality of Rosa, as indicated by Safi and Sawwan [31]. Rose plant growth is influenced by several factors such as light, temperature, relative humidity etc., but when environmental conditions are optimal, salinity appears to be one of the limiting factors for flower production. These results are in accordance with the findings of Speck and Sonneveld [28] who argued significant decrease in fresh weight of flowers by increasing salinity levels in *Anthurium andreanum*. Observations for dry weight were supported by

the findings of Devit and Morris [29] who observed decline in dry weight with increasing salinity levels for *Petunia hybrida*. The decrease of total flower weight of rose was affected relatively by a decrease in the number of flowers and also related to decrease of the weight per flower. These results are in link with findings of Ishida *et al*. [27].

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