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Effect of Different K/Ca Ratios on Yield and Quality of Greenhouse Roses

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The rooted cuttings of rose (*Rosa hybrida* L.) were grown under greenhouse conditions in 25% turf + 75% soil. The experiment was set up in November 1999 and was completed after last harvest in April 2001. The purpose of this research was to determine the effect of different K/Ca ratios on some quality parameters, leaf nutrient status and yield of rose. The applied ratios were 1/1, 1/3 and 3/1. Results of analysis have shown that the higher K/Ca ratio increased the uptake of K and reduced the uptake of Ca. And also, the highest length of stem, number of extra class flower, number of first class flower, total yield and yield for November to March was found the highest K/Ca ratio (3/1) application.

Key Words: Rose, *Rosa hybrida* L., Nutrient status, K/Ca ratio, Quality parameters, Cut flower.

INTRODUCTION

Rose, more than a beautiful and a popular flower, is a great public institution. Up to the nineteenth century it was little more than an exhibition flower; now it is commercially grown nearly all around the world. This has been made possible by the introduction of new varieties and rootstocks that tolerate different environmental conditions. Of the 400 or more varieties used in the commercial cut rose trade, only a relatively narrow range of 60 rose varieties can be mass produced for export.

Worldwide, cut flowers are the most important crop and the most widely traded, with exports valued at about $ 3.685 million in 2000; 0.21% of this amount is realized in Turkey. However small this rate, Turkey is capable of producing large quantities of saleable quality roses the year round, cheaply and uniformly due to adequate climatic conditions, plenty of land and labour[1]. Bayindir district where the experiment was carried out is located in Ege Region and this region plays an important role by its 28% of total floricultural production[2].

Roses, like most plants, respond to a regular fertilization program and well balanced nutrient ratios are important for improving yield and quality parameters. On the other hand, producers usually program their fertilization depending upon their experiences or recommendations of other successful rose growers. Cut-flower roses base the best and the most accurate methods of fertilization upon soil test results.

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Most data in literature on effects of nutrient applications on nutrient status, quality parameters and yield of roses are limited with respect to the effects of different ratios of mineral nutrient application[3-7].

Potassium is one of the essential plant nutrients and while it does not become a part of the chemical structure of plants it plays many important regulatory roles such as activating different enzymes involved in plant growth and development, regulating water balance, effecting root growth, increasing crop resistance to disease and also increasing quality parameters of cut flowers[8]. Calcium plays an important role in plant growth and development, also in delaying the senescence process of fruits and vegetables. A sufficient supply of calcium to obtain a satisfactory post harvest life has also been demonstrated in ornamentals. One of the main functions of calcium is to give strength to the plant cell walls. Plants well-supplied with calcium have strong stems, leaves and flowers. Consequently they have a better resistance against diseases; plants grown at low calcium levels are more susceptible[8].

EXPERIMENTAL

Cut flower rose plants (*Rosa hybrida* L.) of the cultivar "Dallas" (red variety) were grown under drip irrigation in greenhouse conditions. Growing media consisted of 25% peat moss + 75% soil. Planting was in beds 1.1 m wide with a density of 9 plants m^{-2}. Roses were planted in 3 rows in each bed. The spacing between the plants in each row was 0.30 m. Temperature was controlled between 14–16°C at day time and artificial light was applied approximately 4 h a day during the winter in order to get 16 h of light per day. Support wires were stretched along the beds. All other cultural treatments such as pest management, disease control, pinching and pruning were done on time.

The experiment was designed in randomized blocks with 4 replications. Three K/Ca ratios: 3/1, 1/1 and 1/3 respectively 450/150 ppm, 150/150 ppm and 150/450 ppm were tested. 150 ppm N, 100 ppm P, 150 ppm K and 80 ppm MgO were incorporated to each experimental plot as basal dressing. Constant dose of 150 ppm N, 100 ppm P and Fetrilon Combi I (9% Mg, 10 ppm Fe, 3 ppm Cu, 5 ppm Zn, 8–10 ppm Mn, 1 ppm B) were applied constant dose during the experiment. NH_4NO_3 (33%), KNO_3 (13–46%), H_3PO_4 (85%) and $Ca(NO_3)_2$ were used as a source of nutrient elements. Analyses of variance and LSD test were used to evaluate differences between applications on nutrient status of leaves, some quality parameters and yield results statistically.

Second and third leaflet leaves from flowering shoots were sampled before harvesting time in order to determine nutrient status of the plants[9]. Leaf analysis was carried out on the homogenized sample oven dried at 65°C to constant weight. Total N was determined by using the micro-Kjeldahl method. Mg was determined by atomic adsorption spectrophotometer; Eppendorf Flamephotometer determined K and Ca after ashing at 550°C and extraction in 1/4 nitric-perchloric acid. P was determined by vanadate-molybdate yellow colorimetric method[10].

Harvests of roses were taken at intervals during the growing season. Quality parameters measurements were made, including length of stem, thickness of stem

and classification of flowers with regard to their general appearance. Roses were categorized into 3 classes depending on size, shape and fullness of buds, colour of flower, quality of leaf size and colour, freedom from pests and diseases, uniform maturity of flowers. Classes were defined as extra class, first class and second class. Number of flowers produced per plant during November to March and March to May was also determined and statistically compared.

To control homogeneity of experimental area and determination of nutrient contents in terms of soil fertility, soil samples representing each block were taken and analyzed for N, P, K, Ca, Mg and micronutrients. Soil analyses were carried out according to Kacar[11] by using standard analysis protocols.

RESULTS AND DISCUSSION

No deficiency or toxicity symptoms of nutrient elements appeared during the growing period. Data for soil analysis are provided in Table-1. According to the results pH was slightly acidic, $CaCO_3$ low, organic matter content medium, total nitrogen sufficient, texture loam, available P, K, Ca sufficient, available Mg rich, available Fe, Zn, Mn, Cu sufficient and no salt effect was determined.

TABLE-1
PHYSICAL AND CHEMICAL PROPERTIES OF THE EXPERIMENTAL SOIL

pH	$CaCO_3$ (%)	T. salt (%)	Organic matter (%)	Total N (%)	Sand (%)	Silt (%)	Clay (%)	Texture
6.5	1.78	0.054	2.3	0.125	44.16	34.00	21.84	Loam
				Available (mg kg^{-1})				
P	K	Ca	Mg	Fe	Zn	Mn	Cu	
2.08	210	1475	297	6	2	3	4	

Data for plant analysis are given in Table-2. The analyzed parameters of the leaf nutrient status showed that N (%) values ranged between 2.63–3.98, P (%) values ranged between 0.21–0.31, K (%) values ranged between 0.93–2.98, Ca (%) values ranged between 0.93–1.54 and Mg (%) values ranged between 0.28–0.48 in the different K/Ca ratio blocks.

TABLE-2
EFFECTS OF TREATMENTS ON AVERAGE MINERAL COMPOSITION OF LEAVES

Treatments K/Ca	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
1/1	2.95b	0.26	1.80b	1.10B	0.37
1/3	2.88b	0.26	1.13b	1.43A	0.44
3/1	3.70a	0.27	2.51a	1.03B	0.33
LSD	0.611	—	0.703	0.228	—

Mean separation in each column by LSD test. Small and capital letters significant at $p \leq 0.01$ and 0.05, respectively. Absence of letters indicates not significantly different.

Analyses of variance for the effects of treatments on leaf nutrient status are presented at Table-3. The results indicate that no differences were found between replications during the experiment, confirming that the experimental area did not

affect the treatments. The differences between the ratios were statistically significant with respect to the N content of leaves. A higher N content was found in high K/Ca ratio (3/1) indicating positive relationship between K and N uptake and the same with those reported for plant nutrient uptake by other authors[8]. The treatments had no statistical significant effect on P and Mg content of leaves. The higher K/Ca (3/1) ratio increased the uptake of K and reduced uptake of Ca, contrasting the results for the lower K/Ca ratio (1/3) (Table-2). Huett[5] reported that the high Ca application increased Ca and reduced K concentration in leaves, stems and flowers. The antagonism of these elements was a major factor, so that recommendations of fertilization programs call for a good balance of nutrient elements for optimum nutrition of rose plants. Damke and Bhattacharjee[4] in their study of N, P and K fertilization on yield of *Rosa hybrida* report that different fertilization programs play a significant role on yield and nutrient uptake. Cabera[3] and Boztok *et al.*[12] also reported similar results as different ratios of nutrient elements affect nutrient uptake, yield and quality properties.

TABLE-3
COMBINED VARIANCE ANALYSES TABLE FOR LEAF ANALYSES

Source of variance	Calculated F values				
	N	P	K	Ca	Mg
Replicates	0.851 ns	0.156 ns	0.273 ns	0.638 ns	0.264 ns
K/Ca ratios	15.397**	0.130 ns	26.305**	10.387*	4.060 ns

ns: not significant; * significant at alpha level 5%; ** significant at alpha level 1%

Data for quality analysis are provided in Table-4. The analysis of results showed that length of stem values ranged between 53–74 cm, number of extra class flowers ranged between 1–6 flowers/plant, number of first class flowers ranged between 3–9 flowers/plant, number of second class flower ranged between 1–4 flowers/plant, and total yield ranged between 7–16 flowers/plant in the different K/Ca ratio blocks.

TABLE-4
EFFECTS OF TREATMENTS ON SOME QUALITY PARAMETERS OF PLANTS
(Average of replications)

Treatments (K/Ca)	Length of stem (cm)	Extra class	First class	Second class	Total yield	November to March	March to May
		Flower plant^{-1}					
1/1	64ab	2B	5b	3	10ab	3b	7
1/3	58b	1B	4b	3	8b	1c	7
3/1	70a	4A	7a	2	13a	5a	8
LSD	9.292	1.731	1.514	—	3.578	1.514	—

Mean separation in each column by LSD test. Small and capital letters significant at $p \leq 0.01$ and 0.05, respectively. Absence of letters indicates not significantly different.

Results of variance analysis showed that differences among applied ratios were significant for the quality characters investigated except number of second-class flowers and yield for March to May (Table-5). The highest length of stems, number of extra class flowers, number of first class flowers, total yield and yield for November to March was found with the highest K/Ca ratio (3/1) application.

TABLE-5
COMBINED VARIANCE ANALYSES TABLE FOR SOME QUALITY PARAMETERS

Source of variance	Calculated F values						
	Length of stem	Extra class	First class	Second class	Total yield	November to March	March to May
Replicates	0.761 ns	0.667 ns	10.000**	0.250 ns	2.075 ns	2.000 ns	0.769 ns
K/Ca ratio	15.397**	9.333*	28.000**	1.500 ns	14.910**	48.000**	0.923 ns

ns: not significant; * significant at alpha level 5%; ** significant at alpha level 1%

Torre *et al.*[14] reported that a high K concentration in the substrate is known to enhance elongation. Our results indicate significant relationships between the highest number of flowers per plant in the winter harvests (November to March) and the highest K/Ca ratio (3/1) due to high K application may be enhancing resistance to cold stress. Also increasing level of K was found effective in overcoming environmental stress situations[13].

Conclusions

Nutrient status, yield and quality parameters of cut flower rose are under considerable influences of well-balanced fertilization program, especially ratios of macronutrient elements. An improved yield and better quality are also possible by adequate fertilization including balanced ratio of K/Ca under moderate nutrient elements supplying soil conditions. One year's data are not sufficient to draw firm conclusions, but the results of the present work suggest that different ratios of K/Ca could be a way to increase the efficiency of nutrient elements, yield and quality of roses. Moreover, the data seem to indicate that the application of 3/1 ratios is more effective than the other ratios on studied parameters.

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