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Effect of fertigation on the cut rose growth and yield under semi-controlled conditions in Sulaymaniyah city

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Abstract

This study was conducted to determine the effect of different fertigation levels and intervals on growth, yield and flower quality of red cut rose (hybrid tea rose) under a semi-controlled condition at the Horticulture Department, College of Agricultural Engineering Sciences, University of Sulaimani. The experiment was laid out in RCBD design with six fertigation treatments, each with three replicates. The fertigation treatments comprised of 0, 0.5, 1 and 1.5 g/L of compound fertilizer (NPK+micro-nutrients) with two intervals (1 and 2 weeks). The results indicated that fertigation rate of 1.5 g/L and 1 g/L increased the flower yield and quality of flower significantly. Additionally, the main and interaction effects of fertigation rates and intervals was clearly observed in this study.

Key words: Rose, cut flower, fertigation, fertilizer level, Sulaymaniyah city

Introduction

The cut rose is considered as one of the most important cut flowers in the global floriculture trade and it is used in almost all events worldwide (Anderson 2003; Evans, 2009). Mainly, the required mineral elements for all the higher plants are relatively the same but the quantity, rate and timing of nutrient uptake by plants vary depending on plant varieties, soil characteristics, climate, the applied management techniques *etc.* Individual factors or combination of these factors can have a major influence on the nutritional need, nutrient content, and overall yield of any crop (Marschner, 1995; Jones *et al.*, 2015).

Fertilizer use is essential in horticulture and floriculture production; however, it is also one of the serious contemporary environmental issues (Evans *et al.,* 2007; Wainwright *et al.*, 2014). Applying fertilizer through an efficient method offers a vast potential for more accurately and timely crop nutrition and it provides an accurate and uniform application of nutrients to the wet areas, where the active roots are concentrated (Kafkafi and Kant, 2004). Fertigation method has an integral role in fertilization of various horticultural and floricultural crops for increasing the water and fertilizer use efficiency, restricting the incorporation of nutrients in the soil, effectively reducing the loss of fertilizer via leaching and runoff and thereby mitigating the ground water pollution. (Incrocci *et al.,* 2017; Elasbah *et al.*, 2019). Drip irrigation system is more efficient in water conserving, since there are reduced water losses through surface evaporation, less surface runoff, as well as minimal deep percolation (Li *et al.,* 2003; Khattab and El-Housini, 2019). Drip irrigation system has been widely adopted in Kurdistan region of Iraq in horticultural crop production field which make fertigation process applicable on the field.

Fertigation allows the plant roots to take up an adequate amount of the applied nutrients to meet their actual nutritional requirements, necessary for the appropriate growth and yield, throughout the growing season (Bar-Yosef, 1999; Manimaran *et al.,* 2017).

Roses are heavy feeder, especially hybrid rose which is considered as the heaviest feeder among different roses. Therefore, rose flower production requires a high level of fertilizer and irrigation water (Carnis, 1999; Schneider, 2009). Agricultural activities have already caused release of greenhouse gases and soil pollution due to improper fertilization, irrigation, and pesticide uses which have led to a serious environmental pollution and health problems worldwide (Tamimi *et al.,* 1999; Savci, 2012).

The aim of this study was to investigate the response of a red cut rose cultivar to fertigation of various macro- and micronutrients under a semi-controlled environmental condition in Sulaymaniyah city for optimization of pre-harvest macro- and micronutrients requirement and get better quality cut rose with high yield, meanwhile minimizing the rate of fertilizer use.

Materials and methods

This experiment was conducted at the experimental field of Horticulture Department, College of Agricultural Engineering Sciences, University of Sulaimani, Bakrajo district in Sulaymaniyah city. The study was carried out during the seasons of winter 2015 and spring 2016. Sulaymaniyah is a mountainous city located in Kurdistan region, northeastern of Iraq, on the border with Iran. Sulaymaniyah climate is semi-arid with hot dry summers and cold wet winters (Slemani.gov.krd, 2019).

Soil samples from experimental site were collected and analyzed for physico-chemical properties of the experimental soil as shown in Table 1.

Table 1. Physico-chemical properties of the experimental soil

Parameters	Soil test values
pH	7.51
Org. C (g kg^{-1})	20.8
$CaCO_3$ (g kg^{-1})	245
Total N ppm	0.11
E.C. (dSm^{-1})	0.4
Exchangeable bases (meq L^{-1})	
K^+	0.23
Mg^{+2}	1.8
Na^+	0.9
Ca^{+2}	2.5
Textural class	(%)
Sand	4.89
Silt	44.94
Clay	50.17
Textural class	Silty Clay

Two years old hybrid tea rose plants at equal height were planted in an open field at a spacing of 40 cm between plants in 60 cm spaced rows and then lined with polythene sheet tunnels during the winter. All plants were uniformly pruned to equal height (15 cm above bud union) during first week of January. After six weeks of pruning, when plants started sprouting the first fertigation of PRO.SOL.USA- fertilizer (Table 2) was applied according to the treatments up to runoff level while two further applications repeated at two weeks interval after 1st application. Weeding was done regularly to keep down the weeds.

Table 2. The PRO.SOL.USA-fertilizer's nutrient elements and rates

Nutrient Elements	w/w %
Nitrogen	30 % (Ammonia 1.9 and urea 28.1 %)
Phosphate	P_2O_5 10 %
Potassium	K_2O 10 %
Boron	200 ppm
Chelated copper	500 ppm
Chelated iron	1000 ppm
Chelated manganese	500 ppm
Chelated zinc	500 ppm
Molybdenum	5 ppm

The experimental design: The experiment was setup in Randomized Complete Block Design (RCBD) with seven fertigation treatments. The experimental design was factorial combination of three concentration of fertilizer (0.5, 1, and 1.5 g/L) and two application intervals (1 application/week and 1 application/2 weeks) supplies along with control treatment. There were ten plants per treatment and each treatment was replicated thrice. Treatmet detail are as follows: T0: Control (no fertilizer application). T1: Concentration (0.5 g/L of water); fertigation intervals (once/week). T2: Concentration (0.5 g/L of water); fertigation intervals (once/2 weeks). T3: Concentration (1 g/L of water); application intervals (once/week). T4: Concentration (1 g/L of water); application intervals (once/2 weeks). T5: Concentration (1.5 g/L of water); application intervals (once/week). T6: Concentration (1.5 g/L of water); application intervals (once/2 weeks).

Data collection: Plants were allowed to grow then flower stalk length (cm), flower stalk diameter (cm), bud diameter (cm), flower diameter (cm), fresh weight of a flower (g) and dry weight of flower (g) were determined. These measurements were done on five plants from each experimental unit during flowering time.

Statistical Analysis: The data regarding all parameters were statistically analyzed using XLSTAT Software Program and means were compared according to Tukey's multiple range tests ($P \leq 0.05$).

Results and discussion

It is observed from data in Table 3 that flower diameter was significantly influenced by different levels of fertilizer rate and fertigation intervals. Considerably, smaller sized flowers were recorded in the control treatment (3.36 cm) compared with other treatments. Different fertigation intervals showed significant differences in the flower yield. The flower diameter (7.94 cm) was produced with application of 1.5 mg/L rate and once per week while (9.04 cm) diameter produced when fertigation was applied once every two weeks. The means of fertilizer concentration rates were also affected by fertilizer application intervals in hybrid rose plants. The main effects of treatments (0.5, 1, and 1.5 mg/L) had a higher effects with flower diameter means (8.28, 8.34 and 8.5 cm), respectively compared with control (3.7 cm), while fertigation intervals (once/week and once/2weeks) had no single effect on flower diameter and had comparatively similar results (7.16 and 7.25 cm) respectively. The biggest flower diameter (9.04 cm) was recorded in the treatment (1.5 g/L, once/2 weeks) (Table 3).

Table 3. Single and interaction effects of PRO.SOL.USA fertilizer application on flower diameter (cm)

Treatments	Fertigation intervals		PRO.SOL.USA
Concentration (g/L)	Once /week	Once /2 weeks	Fertilizer
Control	4.037^{c}	3.359^{d}	3.698^{b}
0.5 g/L	8.290^{b}	8.277^{b}	8.284^{a}
1.0 g/L	8.353^{b}	8.320^{b}	8.337^{a}
1.5 g/L	7.943^{b}	9.037^{a}	8.490^{a}
Application Intervals	7.156^{a}	7.248^{a}	

* Means having the same letter along the columns indicate no significant difference using Tukey's multiple range tests ($P \leq 0.05$).

Significantly higher flower bud diameter (2.51 cm) was recorded in the 0.5 mg/L with one fertigation per week treatment compared with other treatments. The lower flower bud diameter (0.29 cm) was recorded in control treatment, interval (once/week). Fertilizer rate mean was affected by the fertigation intervals in flower bud diameter. The mean of fertigation intervals had a single effect on flower bud diameter, one fertigation per week had a greater effect 1.83 cm compared with one fertigation per 2 weeks 1.75 cm. Additionally, PRO.SOL.USA fertilizer rates (0.5, 1, and 1.5 mg/L) also had a single effect on flower bud diameter (2.35, 2.29, 2.2 cm), respectively, compared with control 0.31 cm (Table 4).

The data recorded on flower stalk diameter showed significant ($P \leq 0.05$) differences among different fertilizer application rates and intervals. Among different rates, 1.5 g/L produced thicker flower stalks 0.64 cm compared with other treatments 0, 0.5, and 1 mg/L with 0.32, 0.53, and 0.54, respectively. The mean of fertigation intervals had an effect on flower stalk diameter, application with one fertigation per 2 weeks produced thicker

Table 4. Main and interaction effects of PRO.SOL.USA fertilizer application on flower bud diameter (cm)

Treatments Concentration (g/L)	Fertigation intervals		PRO.SOL.USA Fertilizer
	Once /week	Once /2weeks	
Control	0.290[d]	0.333[d]	0.311[c]
0.5 g/L	2.510[a]	2.200[c]	2.355[a]
1.0 g/L	2.353[b]	2.243[c]	2.298[a]
1.5 g/L	2.157[c]	2.243[c]	2.200[b]
Application Intervals	1.827[a]	1.755[b]	

* Means having the same letter along the columns indicate no significant difference using Tukey's multiple range tests ($P \leq 0.05$).

flower stalk 0.53 cm diameter compared with one fertigation per week application 0.49 cm flower stalk diameter (Table 5). These results are in agreement with the previous studies that the growth promotion gained through adding NPK fertilizer. This was reflected in improved growth and increased flower size due to increased chemical constituents of plant sepals (Ghafoor *et al.,* 2000; Parveen *et al.*, 2015).

Table 5. Single and interaction effects of PRO.SOL.USA fertilizer application on flower stalk diameter (cm)

Treatments concentration (g/L)	Fertigation intervals		PRO.SOL.USA Fertilizer
	Once /week	Once /2 weeks	
Control	0.242[e]	0.400[d]	0.323[c]
0.5 g/L	0.533[c]	0.523[c]	0.528[b]
1.0 g/L	0.591[b]	0.500[c]	0.546[b]
1.5 g/L	0.600[b]	0.677[a]	0.639[a]
Application Intervals	0.492[b]	0.525[a]	

* Means having the same letter along the columns indicate no significant difference using Tukey's multiple range tests ($P \leq 0.05$).

The observations recorded on flower stalk height revealed significant ($P \leq 0.05$) differences among different fertigation rates and intervals. Among different rates and intervals, 0.5 g/L (once/week) produced bigger flower bud diameter (2.51 cm) and 1.5 g/L produced taller flower stalks having height of 52.11 cm (Tables 4 and 6). Present results are in agreement with the studies on roses treated with NPK in combination with other nutrients (Zeboon, 2016; Al-Azzawi and Al-Ibadi, 2017). Some other studies indicated that the use of combination of macro- and micro nutrients had significant effects on garlic and snake cucumber plants growth and yield (Shiferaw *et al.,* 2013; Ali *et al.,* 2017; Mnagd and Abed-Algalany, 2017).

Table 6. Single and interaction effects of PRO.SOL.USA fertilizer application on flower stalk height (cm)

Treatments Concentration (g/L)	Fertigation intervals		PRO.SOL.USA Fertilizer
	Once/week	Once/2weeks	
Control	16.740[g]	19.307[f]	18.023[d]
0.5 g/L	40.757[d]	43.890[c]	42.324[b]
1.0 g/L	45.000[b]	38.222[e]	41.611[c]
1.5 g/L	51.887[a]	52.100[a]	51.994[a]
Fertigation intervals	38.596[a]	38.380[a]	

* Means having the same letter along the columns indicate no significant difference using Tukey's multiple range tests ($P \leq 0.05$).

Table 7 shows comparison between the treatments regarding flower fresh weight. The data indicated that there was a significantly higher fresh weight of flowers (11.963 g) in the treatment (1.5 g/L fertigation, once/2weeks) while control had given a minimum fresh weight of flowers (4.543 g) within once/week intervals.

Table 7. Main and interaction effects of fertigation on flower fresh weight (g)

Treatments Concentration (g/L)	Fertigation intervals		PRO.SOL.USA Fertilizer
	Once/week	Once/2 weeks	
Control	4.687[e]	4.543[e]	4.615[c]
0.5 g/L	10.345[b]	8.997[c]	9.671[b]
1.0 g/L	9.983[b]	8.790[cd]	9.387[b]
1.5 g/L	8.330[d]	11.963[a]	10.147[a]
Fertigation Intervals	8.336[a]	8.573[a]	

* Means having the same letter along the columns indicate no significant difference using Tukey's multiple range tests ($P \leq 0.05$).

As shown in Table 8, comparison between the treatments indicated that there was a significantly higher dry weight of flowers (2.43 g) in the treatment 1.5 g/L fertigation (once/2weeks). It was also noticed that control showed minimum dry weight of flowers (0.68 g). Fertigation rate (g/L) means indicated that there were differences between both fertigation intervals (once/week and once/2weeks).

Table 8. Main and interaction effects of fertigation on flower dry weight (g)

Treatments Concentration (g/L)	Fertigation intervals		PRO.SOL.USA Fertilizer
	Once/week	Once/2weeks	
Control	0.849[e]	0.678[f]	0.764[c]
0.5 g/L	2.013[b]	1.960[bc]	1.987[b]
1.0 g/L	2.023[b]	1.877[d]	1.925[b]
1.5 g/L	1.867[cd]	2.427[a]	2.147[a]
Fertigation Intervals	1.688[a]	1.723[a]	

* Means having the same letter along the columns indicate no significant difference using Tukey's multiple range tests ($P \leq 0.05$).

In conclusion, the present study shows that fertigation (PRO. SOL.USA Fertilizer) has a positive effect on rose production and significantly affected the yield and quality of cut rose. The results of the present investigation give a clear evidence that different levels of fertigation and intervals significantly affect cut rose production with respect to plant growth and flower yield. The main and interaction effects of fertigation rates and intervals had clearly observed in this study.

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