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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 effects of different fertigation levels and intervals on growth, yield and flower quality of red cut rose (hybrid tea rose) under a semi-controlled condition during September 2015 - April 2016 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 had increased the flower yield and quality of flower significantly. Additionally, the single and interaction effects of fertigation rates and intervals had 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. Each 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 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 of fertilizers 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). Dripping 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 in order to meet their actual nutritional requirements which are 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 feeders among rose plants. Therefore, rose flower production requires a high level of fertilizer and irrigation water (Carnis, 1999; Schneider, 2009).

Agricultural activities have already caused releasing greenhouse gases and soil pollution due to improper fertilization, irrigation, and pesticide uses which had 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 application 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 with high yield of cut rose, meanwhile minimizing the rate of fertilizer use.

## Materials and methods

**Location**: This experiment was located 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 that semi-arid climate with hot dry summers and cold wet winters (Slemani.gov.krd, 2019).

Soil samples from experimental site were collected and analyzed

for some physico-chemical properties of the experimental soil as shown in (Table 1).

Table 1. Physicochemical 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 (see 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) fertilizer 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 /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 taken 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 single 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

| Treatments | Flower diameter (cm) | | |
|---|---|---|---|
| | Fertigation intervals | | PRO.SOL.USA Fertilizer |
| | Once /week | Once /2 weeks | |
| 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 the higher flower bud diameter value was recorded in the 0.5 mg/L with one fertigation per week treatment (2.51 cm) compared with other treatments. The lower value of 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 (see 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 rate 1.5 g/L had produced thicker

Table 4. Single and interaction effects of PRO.SOL.USA fertilizer application on flower bud diameter

| Treatments | Flower bud diameter (cm) | | |
|---|---|---|---|
| | Fertigation intervals | | PRO.SOL.USA Fertilizer |
| | Once /week | Once /2 weeks | |
| 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 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 flower stalk 0.53 cm diameter compared with one fertigation per week application 0.49 cm flower stalk diameter (Table 5). These results come in agreement with the previous studies that proof the growth promotion gained through adding NPK fertilizer which could be reflected in improving the growth and increase of the size of flowers due to increasing chemical constitutes 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

| Treatments | Flower stalk diameter (cm) | | |
|---|---|---|---|
| | 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, 1.5 g/L had produced taller flower stalks having height of 52.11 cm and bigger flower bud diameters with 0.5 g/L and once/week having diameter 2.51 cm, respectively (Tables 6 and 7). Previously reported results come in agreement with the present results shown in this study when higher plants including 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

| Treatments | Flower stalk height (cm) | | |
|---|---|---|---|
| | Fertigation intervals | | PRO.SOL.USA Fertilizer |
| | Once /week | Once /2 weeks | |
| 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] |
| Application 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. Single and interaction effects of fertigation on flower fresh weight

| Treatments | Flower fresh weight(g) | | |
|---|---|---|---|
| | 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] |
| Application 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 were indicated that there were differences between both fertigation intervals (once/week and once/2weeks).

Table 8. Single and interaction effects of fertigation on flower dry weight

| Treatments | Flower dryweight(g) | | |
|---|---|---|---|
| | Fertigation intervals | | PRO.SOL.USA Fertilizer |
| | Once /week | Once /2 weeks | |
| 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] |
| Application 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 ($P \leq 0.05$).

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. It is also proved from this experiment that the results give a clear evidence that different levels of fertigation regarding the fertilizer concentrations rates and intervals per week significantly affect cut rose 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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