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# Field Evaluation of Some Cut Flower as Affected by Irrigation Water Quantity and Fertilizers

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## ABSTRACT

Farmers of Mediterranean countries are more confronted to water scarcity to Productivity of ornamental plants under the conditions of sandy soil. Irrigation systems and choosing the suitable method of fertilizer application is one of likely decisions to optimizing their irrigation and fertilizers strategies. The effect of irrigation water quantity (400, 600 and 800 $m^3$/fed.) and different rates (0.0, 0.5, 1.0 and 1.5%) of complete fertilizer on the growth rate, flowering characters and plant nutritional for *Xerochrysum bracteatum* Vent., *Acroclinium roseum* Hook. and *Statice sinuate* Mix. Plants was studies at the Experimental Farm of the Faculty of Environmental Agriculture Science, El-Arish, during two winter seasons (2010/2011 and 2011/2012). Results showed in most cases that application of irrigation water at level of (800 $m^3$/fed.) being the most effective and favorable treatment on increasing plant growth rate and flowering characters per plant and unit area. Application of complete fertilizer at the rates (1.0%) through irrigation water recorded the maximum values of plant growth rate, total carbohydrates, plant nutritional status and flowering characters. The interaction between the two factors of study in general, reflect significant effect on most studied parameters except few characters which were fluctuated in the two seasons.

**Key words:** Irrigation water quantity, complete fertilizer, fertigation method

## INTRODUCTION

The golden everlasting (*Xerochrysum bracteatum* Vent.) grown in the open field as a back ground for annual flowers attract butterflies to the garden. Dried flowers are long lasting-up to some years-and are used in floral arrangements and the cut flower industry (Bayer *et al*., 2002).

Pink paper daisy (*Acroclinium roseum* Hook.) is one of the most useful flowering annuals for gardens. It can be used in flower bed, borders and as a cut flower. The two plants belong to family Asteraceae and are grown in winter months. English Statice (*Statice sinuate* Mix.) Family Plambaginaceae is one of flowering annuals bedding plants usually used as a source of colors in the gardens in addition to its easy retaining the shape and colour winter and dry arrangements (Wilson, 1992).

It has been proved, particularly in the recent time, that for reaching maximum utilization efficiency of fertilizer and further increase of crop yields under sandy soil conditions, it can be achieved by possible means such as fertigation frequency, suitable fertilizers and adequate quantity of irrigation water. Advantage resulting from fertigation technique, by reducing the amount of fertilizer and interval between applications. Through this technique it is possible to maintain uniform level of nutrients and to control the nutrient supply in the soil in accordance with changing plants needs during the growth seasons (Vallotton *et al*., 2012).

Fertigation increased the availability of nutrient near the root zone with a reduction in leaching losses. Therefore, more growth of tuberose plants can be expected with fertigation having N P K and/or supplemented with micronutrients compared with normal fertilizer (Munikrishnappa *et al*., 2002) they added that application fertilizers through irrigation produced significantly higher vegetative parameters (plant height, number of tillers, leaf area, etc.), flowering parameter (days required for flowering and duration of flowering, spike and rachis length, diameter of floret, number of spike lets and spikes and florets) and cumulative flower yield/ha. The same trend were found by Bernstein *et al*. (2011) on *Ranunculus asiaticus* and Paul Jackson *et al*. (2012) on *Pinus palustris* seedlings.

Therefore, the aim of this work was to study the influence of irrigation water quantity and application of different levels of complete fertilizer through the drip irrigation system (fertigation) on the growth rate, flowering character and some chemical constituents for *Xerochrysum bracteatum* Vent., *Acroclinium roseum* Hook. and *Statice sinuate* Mix. plants.

## MATERIALS AND METHODS

This study was conducted during the two successive summer seasons of 2010/2011-2011/2012 under the conditions of sandy soil at the Experimental Farm of the Faculty of Environmental Agriculture Science, El-Arish, Suez Canal University. The objective of this investigation was to study the influence of irrigation water quantity and application of different levels of complete fertilizer through the drip irrigation system (fertigation) on the growth rate, flowering character and some chemical constituents for *Xerochrysum bracteatum* Vent., *Acroclinium roseum* Hook. and *Statice sinuate* Mix. plants.

This experiment included 12 treatments which were the combinations between three irrigation water quantities; i.e., 400, 600 and 800 $m^3$/fed. and four rates of complete fertilizer used contained macro and micro nutrients with commercial name of (Sangeral) consists of macro elements, total nitrogen 20% N (4.4% Ammonia-5.8% Nitrate-9.8% Urea), Phosphorus (20%$P_2O_5$), Potassium (20% $K_2O$), Mg (0.012%) Sulphur (0.04%) and microelements (as ppm) Fe (70), Zn (14), Cu (13), Mn (13), B (12) and Mo (12). The concentrations of complete fertilizer in the two seasons were zero, 0.5, 1.0 and 1.5%. These later three treatments were added as fertigation until the beginning of the flowering stage.

These treatments were arranged in a split plot design with three replicates. The irrigation water quantities were randomly distributed in the main plot while, the rates of fertilizers were in the sub plots. The area of experimental unit was 12.60 $m^2$ contain three dripper irrigation lines with 6 m in length and 70 cm. in width. One dripper line was used for measuring vegetative growth characters while the other two hines were used for flowering characters. A guard area (1.5 m wide) was left between the experimental units to avoid the overlapping infiltration of irrigation. Seeds of *Xerochrysum bracteatum* Hook., *Acroclinium roseum* L. and *Statice sinuate* Mix. plants were sown on October 10th during both seasons in plastic pots of 40 cm. diameter. The seedlings of a uniform size were transplanted to the field on November 5th during two seasons.

Drip irrigation system was used as a modified method of irrigation. The dripper lines with discharge of 1.3 L/h for each dripper at 1 bar were used. All experimental plots received equal amount of water during transplanting stage till 20 days from transplanting. The irrigation treatments started on 25 November in both seasons to study irrigation water quantity ($m^3$/fed.), number of irrigations, time and amount of water at every irrigation ($m^3$/fed. and/plot) during all growth stages of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants are shown in Table 1. The fertilizer rates (0, 0.5, 1.0 and 1.5%) were added through irrigation water every two weeks beginning 20 days after transplanting for four times. The other normal

Table 1: Irrigation water quantity, number of irrigation, time of every irrigation and amount of water at every irrigation during the growth stages of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants

| | | | Amount of water at every irrigation | |
|---|---|---|---|---|
| Irrigation water quantity ($m^{-3}$ fed.) | No. of irrigation | Time of every irrigation (minute) | $m^3$/plot (12.6 $m^2$) | $m^3$/fed. |
| 400 | 46 | 30 | 0.026 | 8.667 |
| 600 | 46 | 45 | 0.039 | 13.000 |
| 800 | 46 | 60 | 0.052 | 17.333 |

Table 2: Some initial chemical and physical characteristics of soil, well water and manure source during 2010/2011 and 2011/2012 seasons

| | Soil | | Well water | |
|---|---|---|---|---|
| Well water | 1st season | 2nd season | 1st season | 2nd season |
| **Soluble ious meq $L^{-1}$ (soil paste extract)** | | | | |
| $Ca^{++}$ | 3.04 | 2.10 | 10.60 | 10.11 |
| $Mg^{++}$ | 2.11 | 2.20 | 5.80 | 5.19 |
| $Na^{+}$ | 1.18 | 4.49 | 32.70 | 33.74 |
| $K^{+}$ | 0.47 | 0.31 | 0.98 | 0.95 |
| Cl- | 1.02 | 2.30 | 40.50 | 38.43 |
| $CO_3^{--}$ | ,, | ,, | ,, | ,, |
| $HCO_3$- | 2.00 | 2.40 | 5.68 | 6.24 |
| $SO_4$-- | 3.78 | 4.40 | 3.90 | 4.63 |
| EC*e* ($dSm^{-1}$) | 0.68 | 0.91 | 5.00 | 5.06 |
| Concentration (ppm) | | | 3200 | 3400 |
| F.C % | 7.71 | 7.50 | | |
| **Particular size distributiou %** | | | | |
| pH (1:2.5) | 8.10 | 8.20 | | |
| Clay | 0.16 | 0.17 | | |
| Silt | 0.33 | 0.35 | | |
| Fine sand | 79.88 | 79.87 | | |
| Coarse sand | 19.63 | 19.61 | | |
| Soil texture | Sandy soil | Sandy soil | | |

agricultural treatments for growing were practiced. At the full open of the flower for *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants, the following data were recorded:

- Vegetative growth: plant height (cm), number of shoot/plant, shoot length (cm), fresh and dry weight/plant (g) and fresh and dry weight of roots/plant (g)
- Flowering characters: the flowering date (time from the final transplanting to showing the first flower in days), flowering period (days), inflorescence diameter (cm), inflorescence number/plant and vase life (days)
- Chemical analysis of leaves: The total carbohydrates content were determined according to DuBois *et al*. (1956). Nitrogen content was determined by the distillation in micro-Kjeldahl method (Black, 1965); phosphorus and potassium determination according to Olsen and Sommers (1982) and Jackson (1970), respectively

The physical and chemical soil characteristics and chemical analysis of well irrigation water used are shown in Table 2, as described by Piper (1950). Statistical analysis of variance was calculated according to Sendecor and Cochran (1980), Means separation was done according to LSD at 0.05 level.

## RESULTS AND DISCUSSION

### Vegetative growth characters

**Effect of irrigation water quantity:** Data presented in Table 3 show that increasing irrigation water supply exerted a marked and significant effect on all studied growth characters. Whereas, the maximum values of these characters were more distinct with application of irrigation water at 800 and 600 $m^3$/fed. in the first and second seasons, respectively. The highest value of plant height (cm), number of shoots/plant, shoot length (cm), fresh and dry weight of plant and roots (g) and fresh and dry weight of roots/plant (g) for the three plants were achieved when application of irrigation water at 800 $m^3$/fed., followed by intermediate irrigation quantity (600 $m^3$/fed.). While low level of water supply (400 $m^3$/fed.) gave the lowest values of vegetative traits of the three plants. These results are in agreement with those obtained by Silber *et al.* (2007) on *Leucadendron* found that water stress throughout the growth season induced significantly low vegetative growth and small heads and affected head dimensions or the number of marketable branches by diminishing the leaf dimensions. Lin *et al.* (2011) on chrysanthemum and Asrar and Elhindi (2011) on marigold they found that drought stress reduced growth vigor i.e., plant height, fresh and dry weights of shoot and plant (Alvarez *et al.*, 2011). The drought stress produced the smallest of *callistemon* plants after three months of drought, the leaf area, number of leaves and root volume decreased while root/shoot ratio and root density increased. The higher root hydraulic resistance in stressed plants caused decreases in leaf and stem water potentials resulting in lower stomatal conductance and indicating that water flow through the roots is a factor that strongly influences shoot water relations. In addition, water stress induced an active osmotic adjustment and led to decreases in leaf tissue elasticity in order to maintain turgor. Therefore, the water deficit produced changes in plant water relations, gas exchange and growth. Alvarez *et al.* (2009) found that moderate deficit irrigation fore carnations plants showed a slightly reduced total dry weight, plant height and leaf area. While, Severe Deficit Irrigation (SDI) had clearly reduced all the plant size parameters, lower number of shoots.

In this connection, the promoting effect with increasing water supply up to 600 $m^3$ and or 800 $m^3$/fed. on the growth rate may be due to the greatest role of water on all internal physiological metabolic processes in the plant. On the contrary, decreasing soil moisture content and/or application of lowest level of irrigation water 400 $m^3$/fed. being the inferior one on all the studied growth characters of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants in both seasons. Farooq *et al.* (2009) reported that reduced water uptake results in a decrease in tissue water contents and turgor. Therefore, under drought stress conditions, cell elongation in plants is inhibited by reduced turgor pressure. Likewise, drought stress also trims down the photo-assimilation and metabolites required for cell division as a consequence, impaired mitosis, cell elongation and expansion result in reduced plant height and growth. Similar trend of results were also reported by Payero *et al.* (2008), who suggest that quantifying the local crop response to irrigation is important for establishing adequate irrigation management strategies, irrigation significantly affected yields which increased with irrigation up to a point where irrigation became excessive.

**Effect of complete fertilizer rate:** The obtained results in Table 4 indicated that there was a constant and progressive increase in plant height number and shoot length per plant as well as, the fresh and dry weight of shoots and roots by increasing the application of complete fertilizer up to the highest rate, i.e., 0.1 and 1.5% through irrigation water (fertigation), but without showing

Table 3: Effect of irrigation water quantity on some growth characters of *Xerochrysum bracteatum, Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| Treatments | Plant height (cm) | | No. of shoots/plant | | Shoot length (cm) | | Fresh weight/plant (g) | | Dry weight/plant (g) | | Fresh weight of roots/plant (g) | | Dry weight of roots/plant (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water Quantity ($m^3$/fed.) | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | | | | |
| 400 | 51.14 | 53.58 | 4.06 | 5.23 | 42.38 | 41.39 | 47.59 | 49.06 | 10.69 | 11.90 | 8.68 | 9.00 | 1.33 | 1.59 |
| 600 | 63.19 | 64.41 | 7.47 | 8.22 | 55.67 | 56.11 | 53.41 | 55.26 | 11.60 | 12.00 | 9.35 | 10.22 | 1.65 | 1.86 |
| 800 | 86.94 | 88.74 | 11.07 | 11.80 | 60.47 | 60.27 | 67.92 | 68.97 | 13.41 | 14.89 | 10.08 | 12.00 | 2.12 | 2.90 |
| LSD 0.05 | 3.04 | 3.12 | 2.62 | 1.65 | 3.59 | 3.60 | 3.22 | 3.56 | 1.02 | 1.05 | 0.60 | 0.60 | 0.38 | 0.39 |
| ***Statice sinuate* plants** | | | | | | | | | | | | | | |
| 400 | 77.38 | 73.47 | 10.00 | 9.33 | 35.92 | 37.99 | 49.74 | 52.18 | 13.40 | 15.06 | 5.28 | 5.69 | 2.53 | 2.65 |
| 600 | 85.67 | 97.69 | 14.51 | 15.03 | 41.89 | 44.26 | 67.30 | 69.64 | 16.98 | 18.26 | 6.22 | 6.58 | 2.90 | 3.01 |
| 800 | 98.17 | 99.97 | 18.39 | 19.87 | 43.76 | 46.40 | 76.63 | 77.11 | 20.69 | 23.99 | 7.73 | 7.80 | 2.94 | 3.12 |
| LSD 0.05 | 2.30 | 2.42 | 1.80 | 2.01 | 2.29 | 2.37 | 2.53 | 2.69 | 0.73 | 0.76 | 0.47 | 0.63 | 0.05 | 0.07 |
| ***Acroclinium roseum* plants** | | | | | | | | | | | | | | |
| 400 | 34.87 | 35.21 | 6.47 | 6.95 | 21.37 | 23.70 | 32.45 | 34.90 | 8.33 | 9.43 | 4.51 | 5.02 | 1.06 | 1.04 |
| 600 | 42.69 | 44.35 | 7.87 | 8.24 | 28.69 | 26.35 | 39.55 | 40.35 | 9.19 | 10.31 | 5.42 | 5.69 | 1.35 | 1.47 |
| 800 | 53.59 | 55.67 | 7.96 | 8.47 | 31.25 | 32.57 | 41.35 | 43.52 | 10.66 | 11.36 | 6.03 | 5.97 | 1.44 | 1.52 |
| LSD 0.05 | 2.10 | 3.11 | 0.71 | 0.72 | 2.26 | 2.92 | 2.43 | 2.37 | 0.94 | 0.99 | 0.75 | 0.57 | 0.06 | 0.09 |

Table 4: Effect of complete fertilization on some growth characters of *Xerochrysum bracteatum, Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| | Plant height (cm) | | No. of shoots/plant | | Shoot length (cm) | | Fresh weight/plant (g) | | Dry weight/plant (g) | | Fresh weight of roots/plant (g) | | Dry weight of roots/plant (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| Fertilization | season | season | season | season | season | season | season | season | season | season | season | season | season | season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | | | | |
| Control | 50.57 | 52.01 | 5.67 | 5.87 | 38.89 | 37.96 | 43.51 | 44.30 | 10.93 | 11.24 | 5.13 | 5.63 | 1.94 | 2.01 |
| 0.5% | 65.07 | 66.99 | 6.06 | 6.99 | 40.34 | 41.36 | 47.97 | 48.97 | 11.52 | 11.57 | 9.17 | 10.25 | 1.52 | 1.75 |
| 1.0% | 78.94 | 80.70 | 8.44 | 8.27 | 45.67 | 46.00 | 56.47 | 58.70 | 13.54 | 13.97 | 10.69 | 11.17 | 2.13 | 2.17 |
| 1.5% | 84.88 | 87.32 | 10.67 | 11.87 | 50.80 | 51.38 | 60.21 | 63.25 | 15.52 | 15.99 | 11.04 | 12.14 | 2.78 | 2.65 |
| LSD 0.05 | 3.20 | 3.46 | 1.72 | 1.82 | 3.56 | 3.29 | 3.71 | 3.90 | 2.18 | 2.30 | 0.69 | 0.86 | 0.44 | 0.48 |
| ***Statice sinuate* plants** | | | | 0.80 | 0.81 | | | | | | | | | |
| Control | 78.37 | 74.26 | 9.67 | 10.00 | 33.04 | 34.06 | 35.58 | 36.70 | 9.63 | 9.98 | 7.60 | 8.03 | 1.27 | 1.30 |
| 0.5% | 85.67 | 87.69 | 11.00 | 12.33 | 38.36 | 39.99 | 53.37 | 55.37 | 16.87 | 18.32 | 6.00 | 6.98 | 2.76 | 2.95 |
| 1.0% | 91.16 | 93.95 | 15.56 | 16.00 | 46.14 | 46.60 | 71.12 | 73.02 | 22.66 | 23.35 | 6.78 | 7.85 | 3.03 | 3.24 |
| 1.5% | 92.44 | 96.10 | 17.33 | 18.67 | 48.64 | 51.26 | 74.57 | 75.33 | 24.62 | 25.04 | 7.63 | 8.63 | 3.44 | 3.62 |
| LSD 0.05 | 3.66 | 3.86 | 2.93 | 2.95 | 3.49 | 3.54 | 4.23 | 4.96 | 1.49 | 1.50 | 0.96 | 0.99 | 0.06 | 0.09 |
| ***Acroclinium roseum* plants** | | | | | | | | | | | | | | |
| Control | 34.37 | 35.03 | 6.22 | 6.33 | 16.26 | 15.96 | 28.46 | 27.95 | 7.37 | 6.35 | 4.69 | 4.33 | 1.03 | 1.00 |
| 0.5% | 40.69 | 42.33 | 7.44 | 8.00 | 18.67 | 19.87 | 36.58 | 37.06 | 9.25 | 9.62 | 5.37 | 5.47 | 1.21 | 1.32 |
| 1.0% | 43.59 | 45.67 | 7.78 | 8.01 | 23.34 | 25.57 | 39.27 | 40.36 | 9.95 | 10.13 | 6.13 | 6.35 | 1.35 | 1.34 |
| 1.5% | 46.03 | 49.57 | 8.11 | 7.99 | 31.37 | 31.65 | 40.37 | 40.62 | 10.35 | 10.54 | 6.36 | 6.45 | 1.45 | 1.37 |
| LSD 0.05 | 3.27 | 2.29 | 1.98 | 1.99 | 1.63 | 1.68 | 3.66 | 4.02 | 0.54 | 0.52 | 0.42 | 0.47 | 0.05 | 0.05 |

significant difference between them. Similar results were obtained by Munikrishnappa *et al.* 2002) on tuberose; Silberbush and Lieth (2004) on rose, Chang *et al.* (2010) on *Anthurium andreanum* and Ahmad *et al.* (2012) on celosia, zinnia and sunflower plants.

From the forgoing results, it could be concluded that the promoting effect of using complete fertilizer through irrigation water on the growth rate of *Xerochrysum bracteatum, Acroclinium roseum* and *Statice sinuate* plants might due to the following reasons. Fertilizers availability is fitted to nutritional need of the plant during its growth cycle, fertilizer elements already pass to the roots faster than uniformity of fertilizers distribution. Moreover, as for positive effect of both macro elements and microelements in fertigation, more nutrient availability especially near the root zone might have increased the transport of metabolites to support the growth (Banker and Mukhopadyay, 1990). Fertigation allows the controlled placement of nutrients near the plant roots, reducing fertilizer losses through leaching into the groundwater (Gardenas *et al.*, 2005; Barradas *et al.*, 2012). Similarly, K might have influenced the cell division and thus cambial growth leading to more number of leaves (Parthiban *et al.*, 1991). Once more number of leaves are formed, availability of photo assimilates increases to affect plant growth. Hence, more plant height and tiller number of tuberose were observed in fertigation with NPK supplemented with 0.1 or 0.5% Zn. (Munikrishnappa *et al.*, 2002) on gladiolus.

**Effect of interaction between irrigation water quantity and fertilizer rates:** The obtained results in Table 5 showed that the irrigation water at 800 $m^3$/fed in combined with 1.5% of complete fertilizer as a fertigation had a marked high values in the plant height, number of branches, shoots length and fresh and dry weight of shoot and roots, followed by the combination between such complete fertihzer rate with 600 $m^3$/fed of irrigation water but insignificant between them in plant height, number of shoots and fresh and dry weight of roots/plant.

Consequently, it could be suggested that the growth behavior of *Xerochrysum bracteatum, Acroclinium roseum and Statice sinuate* plants varied significantly according to irrigation water quantity and the used rates of complete fertilizer as fertigation. Similar results were reported regarding the effect of interaction between fertilizer and irrigation by Hanson *et al.* (2006) found that to develop irrigation and fertigation management tools that maximize production, yet minimize adverse environmental effects.

**Chemical constituents**

**Effect of irrigation water quantity:** Data presented in Table 6 showed that there was a consistent and significant increase in total chlorophyll and total carbohydrate in the tissues of *Xerochrysum bracteatum, Acroclinium roseum* and *Statice sinuate* leaves by increasing soil moisture and/or increasing water supply. Whereas the maximum values in this respect were obtained by application of the highest level of irrigation water, i.e., (800 $m^3$/fed). On the contrary, the lowest values of all photosynthetic pigments were achieved via application of relatively lowest level of water supply (400 $m^3$/fed.). These results were hold true in the two investigated seasons.

It is known that the water quantity can ever be a directly limiting factor in chlorophylls content and is important in increasing the availability of nitrogen and other minerals and increasing its absorption by the plant so increasing total chlorophylls content in the leaves (Chen *et al.*, 2010). The obtained results are in agreement with those reported by Katsoulas *et al.* (2006) on rose plants and Bolla *et al.* (2010) suggest on rose that mild water stress caused a decline in leaf chlorophyll and chlorophyll fluorescence, negative effect on photosynthetic rate and stomatal conductance leading to a limited supply of metabolic energy and therefore to plant growth restriction.

Table 5: Interaction effect of irrigation water quantity on some growth characters of *Xerochrysum bracteatum*, *Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| Treatments | | Plant height (cm) | | No. of shoots/plant | | Shoot length (cm) | | Fresh weight/plant (g) | | Dry weight/plant (g) | | Fresh weight of roots/plant (g) | | Dry weight of roots/plant (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water quantity ($m^3$/fed.) | Fertilization | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | | | | | |
| 400 | Control | 50.57 | 52.01 | 4.45 | 4.47 | 18.89 | 17.96 | 35.12 | 36.88 | 9.63 | 9.68 | 7.60 | 7.63 | 1.27 | 1.30 |
| | 0.5% | 51.14 | 53.58 | 4.98 | 4.52 | 19.35 | 19.58 | 35.84 | 37.85 | 9.75 | 9.81 | 7.74 | 7.84 | 1.29 | 1.31 |
| | 1.0% | 57.28 | 60.85 | 5.02 | 5.11 | 20.11 | 20.27 | 36.27 | 38.98 | 9.98 | 9.99 | 8.25 | 8.51 | 1.30 | 1.32 |
| | 1.5% | 62.23 | 63.48 | 5.36 | 5.89 | 20.47 | 20.58 | 37.51 | 39.45 | 10.69 | 11.10 | 8.68 | 9.00 | 1.33 | 1.56 |
| 600 | Control | 63.19 | 64.41 | 5.17 | 5.83 | 20.34 | 21.36 | 39.97 | 38.97 | 10.80 | 11.70 | 9.02 | 9.41 | 1.57 | 1.61 |
| | 0.5% | 65.07 | 68.91 | 6.36 | 6.95 | 22.15 | 22.35 | 41.51 | 42.54 | 10.98 | 11.12 | 9.35 | 9.82 | 1.65 | 1.86 |
| | 1.0% | 70.95 | 71.58 | 8.47 | 8.27 | 24.25 | 24.51 | 42.98 | 44.25 | 11.05 | 11.58 | 9.62 | 10.29 | 1.71 | 1.91 |
| | 1.5% | 76.58 | 79.58 | 10.64 | 10.81 | 25.79 | 26.69 | 43.48 | 45.22 | 11.29 | 11.68 | 9.81 | 10.58 | 1.80 | 2.10 |
| 800 | Control | 78.94 | 80.70 | 6.67 | 6.82 | 23.95 | 24.15 | 47.47 | 48.52 | 11.52 | 11.77 | 9.87 | 10.95 | 1.82 | 2.11 |
| | 0.5% | 82.94 | 82.74 | 7.06 | 7.99 | 25.36 | 26.36 | 55.54 | 56.98 | 12.86 | 12.99 | 10.45 | 11.09 | 2.11 | 2.41 |
| | 1.0% | 83.48 | 85.28 | 9.44 | 9.27 | 26.89 | 27.58 | 56.54 | 58.77 | 13.54 | 13.97 | 10.69 | 11.17 | 2.13 | 2.57 |
| | 1.5% | 85.83 | 87.39 | 11.67 | 12.84 | 27.30 | 28.35 | 60.41 | 63.20 | 15.52 | 15.99 | 11.04 | 12.14 | 2.78 | 2.65 |
| LSD 0.05 | 1.45 | 1.63 | 2.07 | 2.09 | 0.36 | 0.25 | 1.15 | 1.02 | 1.08 | 2.14 | 2.37 | 0.87 | 0.89 | 0.25 | |
| ***Statice sinuate* plants** | | | | | | | | | | | | | | | |
| 400 | Control | 77.31 | 73.42 | 7.62 | 8.10 | 33.22 | 34.47 | 43.52 | 44.23 | 10.99 | 11.28 | 4.13 | 4.63 | 1.93 | 2.14 |
| | 0.5% | 78.37 | 74.26 | 8.00 | 8.23 | 33.95 | 34.25 | 45.65 | 46.21 | 11.21 | 12.58 | 5.34 | 5.58 | 1.99 | 2.05 |
| | 1.0% | 81.36 | 84.26 | 8.15 | 8.99 | 34.58 | 35.64 | 47.64 | 50.62 | 12.51 | 12.69 | 5.42 | 5.49 | 2.29 | 2.32 |
| | 1.5% | 85.67 | 87.69 | 9.54 | 8.11 | 35.75 | 37.17 | 49.15 | 52.19 | 13.44 | 15.12 | 5.57 | 5.62 | 2.52 | 2.62 |
| 600 | Control | 90.16 | 91.95 | 9.27 | 10.06 | 35.96 | 36.24 | 50.25 | 50.51 | 16.89 | 16.33 | 5.28 | 5.69 | 2.74 | 2.88 |
| | 0.5% | 91.36 | 91.98 | 11.04 | 12.37 | 41.52 | 44.42 | 53.37 | 55.74 | 17.59 | 18.05 | 5.75 | 5.64 | 2.90 | 2.87 |
| | 1.0% | 93.79 | 92.87 | 12.56 | 13.04 | 42.36 | 44.98 | 56.98 | 57.91 | 18.54 | 18.71 | 5.92 | 5.99 | 2.91 | 2.99 |
| | 1.5% | 94.43 | 96.10 | 14.31 | 15.61 | 43.56 | 45.19 | 57.44 | 59.23 | 19.36 | 20.11 | 6.22 | 6.58 | 2.96 | 2.95 |
| 800 | Control | 95.67 | 97.69 | 10.67 | 10.14 | 44.96 | 46.14 | 66.45 | 67.13 | 20.74 | 21.36 | 5.62 | 6.14 | 2.99 | 3.00 |
| | 0.5% | 96.36 | 96.96 | 12.00 | 13.33 | 45.91 | 48.62 | 69.32 | 70.26 | 21.64 | 21.58 | 6.71 | 7.11 | 3.03 | 3.01 |
| | 1.0% | 97.84 | 98.61 | 14.51 | 14.01 | 46.44 | 50.95 | 71.75 | 73.58 | 22.25 | 23.44 | 7.09 | 7.62 | 3.13 | 3.25 |
| | 1.5% | 98.17 | 99.97 | 15.37 | 15.62 | 48.45 | 51.77 | 74.51 | 75.74 | 24.75 | 25.14 | 7.73 | 7.80 | 3.45 | 3.61 |
| LSD 0.05 | | 1.45 | 1.51 | 1.53 | 1.65 | 0.29 | 0.29 | 1.02 | 1.15 | 10.10 | 2.69 | 2.86 | 0.93 | 1.04 | 0.14 |

Table 5: Continue

| Treatments | | Plant height (cm) | | No. of shoots/plant | | Shoot length (cm) | | Fresh weight/plant (g) | | Dry weight/plant (g) | | Fresh weight of roots/plant (g) | | Dry weight of roots/plant (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water quantity ($m^3$/fed.) | Fertilization | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Acroclinium roseum* plants** | | | | | | | | | | | | | | | |
| 400 | Control | 34.48 | 35.72 | 4.28 | 4.31 | 16.29 | 15.94 | 28.44 | 27.98 | 7.37 | 6.35 | 4.31 | 4.41 | 1.00 | 1.03 |
| | 0.5% | 37.26 | 38.26 | 5.41 | 5.24 | 16.59 | 16.92 | 29.36 | 30.01 | 7.58 | 7.62 | 4.55 | 4.61 | 1.04 | 1.05 |
| | 1.0% | 39.65 | 40.36 | 6.55 | 6.01 | 17.52 | 17.98 | 30.28 | 32.19 | 8.02 | 8.21 | 4.62 | 4.66 | 1.05 | 1.05 |
| | 1.5% | 40.54 | 42.85 | 6.11 | 6.99 | 18.56 | 19.79 | 32.46 | 34.92 | 8.33 | 9.43 | 4.71 | 4.78 | 1.06 | 1.06 |
| 600 | Control | 39.36 | 40.98 | 6.22 | 6.33 | 20.75 | 21.42 | 36.57 | 37.22 | 9.19 | 10.01 | 4.69 | 4.74 | 1.06 | 1.06 |
| | 0.5% | 42.96 | 42.56 | 7.44 | 8.00 | 21.44 | 22.63 | 37.85 | 39.29 | 9.12 | 10.25 | 4.85 | 4.89 | 1.10 | 1.19 |
| | 1.0% | 43.89 | 44.57 | 7.78 | 8.31 | 22.38 | 23.58 | 38.99 | 39.58 | 9.51 | 10.64 | 5.42 | 5.69 | 1.35 | 1.47 |
| | 1.5% | 44.78 | 45.48 | 8.11 | 7.92 | 23.59 | 24.01 | 39.52 | 40.34 | 9.91 | 10.89 | 6.03 | 5.97 | 1.44 | 1.52 |
| 800 | Control | 42.69 | 42.75 | 6.62 | 6.37 | 24.55 | 23.45 | 40.35 | 40.60 | 9.95 | 11.13 | 5.37 | 5.47 | 1.21 | 1.32 |
| | 0.5% | 43.96 | 44.18 | 7.42 | 8.05 | 26.57 | 27.29 | 40.99 | 42.19 | 10.12 | 11.01 | 5.84 | 5.89 | 1.25 | 1.29 |
| | 1.0% | 46.35 | 46.52 | 7.70 | 8.51 | 28.74 | 27.46 | 41.11 | 43.02 | 10.51 | 11.12 | 6.13 | 6.35 | 1.35 | 1.34 |
| | 1.5% | 48.26 | 49.59 | 8.19 | 8.74 | 31.53 | 32.48 | 41.38 | 43.57 | 10.66 | 11.36 | 6.36 | 6.45 | 1.45 | 1.37 |
| LSD 0.05 | | 20.39 | 20.36 | 1.52 | 1.54 | 0.29 | 00.30 | 10.02 | 10.05 | 20.45 | 20.15 | 0.94 | 0.81 | 0.26 | 0.27 |

Table 6: Effect of irrigation water quantity on some chemical constituents of *Xerochrysum bracteatum*, *Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| Treatments | Total chlorophyll | | Total carbohydrate % | | N% | | P% | | K% | |
|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water quantity ($m^3$/fed.) | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | |
| 400 | 1.87 | 1.95 | 23.67 | 25.16 | 2.05 | 2.13 | 0.18 | 0.10 | 2.95 | 3.24 |
| 600 | 2.05 | 2.14 | 24.51 | 26.36 | 2.18 | 2.43 | 0.15 | 0.18 | 3.11 | 2.94 |
| 800 | 2.28 | 2.32 | 26.25 | 28.37 | 2.83 | 2.45 | 0.19 | 0.12 | 2.99 | 3.15 |
| LSD 0.05 | 0.11 | 0.12 | 0.36 | 0.36 | 0.05 | 0.06 | 0.06 | 0.07 | 0.09 | 0.08 |
| ***Statice sinuate* plants** | | | | | | | | | | |
| 400 | 1.96 | 2.01 | 20.34 | 21.36 | 1.93 | 1.97 | 0.16 | 0.19 | 3.43 | 3.56 |
| 600 | 2.28 | 2.41 | 23.64 | 24.96 | 2.05 | 2.23 | 0.12 | 0.18 | 3.58 | 3.82 |
| 800 | 2.51 | 2.64 | 22.28 | 25.37 | 2.27 | 2.68 | 0.11 | 0.12 | 3.48 | 3.59 |
| LSD 0.05 | 0.15 | 0.16 | 0.33 | 0.34 | 0.06 | 0.05 | 0.07 | 0.07 | 0.08 | 0.07 |
| ***Acroclinium roseum* plants** | | | | | | | | | | |
| 400 | 1.68 | 1.85 | 30.81 | 31.01 | 3.21 | 3.31 | 0.40 | 0.40 | 3.56 | 3.52 |
| 600 | 2.36 | 2.51 | 32.79 | 33.25 | 3.86 | 3.58 | 0.44 | 0.42 | 3.67 | 3.59 |
| 800 | 2.85 | 2.92 | 31.96 | 32.08 | 3.71 | 3.61 | 0.41 | 0.41 | 3.48 | 3.52 |
| LSD 0.05 | 0.17 | 0.16 | 0.98 | 1.00 | 0.06 | 0.05 | 0.08 | 0.07 | 0.07 | 0.08 |

It is quite clear from data in Table 6 that application of irrigation water at (800 $m^3$/fed.) being the most effective and favorable treatment which recorded in most cases the maximum increment of N, P and K concentration in the leaves. On the contrary, increasing soil moisture stress and/or application of the lowest water quantity (400 $m^3$/fed.) being the inferior one on the content of N, P and K in the three plants. Similar findings were also reported by Khattab *et al.* (2002) on *Salvia splendens* plants. The superiority of increasing water supply on the content of N, P and K elements in the leaves of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants due to that increasing soil moisture content caused a marked effect on increasing the solubility of such elements in the soil which led to promote the absorbing efficiency of such elements by the plants.

**Effect of fertilizer rates:** It is obvious from data recorded in Table 7 that the maximum values chlorophyll and carbohydrate were obtained with application of the highest fertilizer rate (1 and 1.5%). Adverse effect, however was recorded by fertigated of the lowest fertilizer rate of complete fertilizer (0.5%) and without fertilizer treatments was the inferior one.

In this connection, the promoting effect of complete fertilizer on increasing the photosynthetic pigments is probably due to the enhancing effect of the suitable fertigation, directly or indirectly on increasing the availability and absorption of the essential nutrient elements, specially nitrogen, iron and magnesium which are necessary for enzymes activation and formation of chloroplasts and chlorophyll as reported by Silberstein and David (1987). Moreover, the favorable effect of potassium on photosynthetic pigments as due to that potassium promotes assimilation rate of $CO_2$ and photosynthetic capacity (Haeder and Mengel, 1974).

Data presented in Table 7 showed clearly that all used rates of fertigation resulted in different values of N, P and K elements content in the leaves of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants. Maximum values by addition the rates of 1.5 and 0.1% through

Table 7: Effect of complete fertilization on some chemical constituents of *Xerochrysum bracteatum, Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| | Total Chlorophyll content (mg gm$^{-1}$) | | Total carbohydrate % | | N% | | P% | | K% | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatments Fertilization | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | |
| Control | 1.98 | 1.99 | 19.73 | 21.02 | 1.83 | 1.89 | 0.01 | 0.09 | 2.27 | 2.31 |
| 0.5% | 2.33 | 2.51 | 22.85 | 24.02 | 2.38 | 2.12 | 0.11 | 0.19 | 2.63 | 2.69 |
| 1.0% | 2.47 | 2.52 | 27.12 | 30.25 | 2.37 | 2.45 | 0.12 | 0.13 | 3.27 | 3.30 |
| 1.5% | 2.82 | 2.86 | 29.54 | 32.26 | 2.63 | 2.80 | 0.13 | 0.14 | 3.85 | 3.95 |
| LSD 0.05 | 0.52 | 0.61 | 0.41 | 0.45 | 0.45 | 0.47 | 0.37 | 0.47 | 0.45 | 0.72 |
| ***Statice sinuate* plants** | | | | | | | | | | |
| Control | 1.86 | 1.75 | 17.45 | 18.69 | 1.53 | 1.69 | 0.08 | 0.09 | 2.84 | 2.99 |
| 0.5% | 2.21 | 2.39 | 19.71 | 21.66 | 1.99 | 1.98 | 0.16 | 0.12 | 3.52 | 3.58 |
| 1.0% | 2.39 | 2.42 | 24.47 | 26.85 | 2.36 | 2.58 | 0.17 | 0.18 | 3.77 | 3.89 |
| 1.5% | 2.68 | 2.59 | 26.73 | 28.70 | 2.46 | 2.68 | 0.11 | 0.14 | 3.86 | 3.89 |
| LSD 0.05 | 0.50 | 0.60 | 0.95 | 0.99 | 0.51 | 0.52 | 0.22 | 0.14 | 0.24 | 0.26 |
| ***Acroclinium roseum* plants** | | | | | | | | | | |
| Control | 1.47 | 1.50 | 27.11 | 27.90 | 2.51 | 2.94 | 0.35 | 0.35 | 3.04 | 2.64 |
| 0.5% | 1.99 | 2.01 | 28.20 | 28.35 | 3.02 | 2.98 | 0.36 | 0.34 | 3.41 | 3.24 |
| 1.0% | 2.48 | 2.65 | 35.91 | 36.05 | 3.56 | 3.49 | 0.45 | 0.35 | 3.62 | 3.56 |
| 1.5% | 2.71 | 2.69 | 38.20 | 38.66 | 3.59 | 3.58 | 0.45 | 0.42 | 3.69 | 3.30 |
| LSD 0.05 | 0.73 | 0.84 | 1.13 | 1.15 | 0.24 | 0.25 | 0.21 | 0.17 | 0.15 | 0.14 |

irrigation water compared without fertigation treatment. On the other hand, there were slight different values among all treatments which applied with fertilizer through drip irrigation (fertigation). Application of fertilizers through irrigation system (fertigaiton) reduced leaching of added fertilizer. The obtained results are in accordance with Marfa *et al.* (2002) and Khalil *et al.* (2004), who showed that application of nitrogen and potassium fertilizers at the rate of 100 kg N+140 kg $K_2O$/fed. through irrigation water recorded the maximum values of growth rate and photosynthetic pigments, whereas, application of the balance rate of nitrogen and potassium at the level of (60 kg N+60 kg $K_2O$/fed.) being the superior treatment regarding plant nutritional status (N, P, K content and their total uptake) on plants.

**Effect of interaction between irrigation water quantity and fertilizer rates:** Data in Table 8 generally showed that the highest level of irrigation water (800 m$^3$/fed) and application of the highest rate of fertigation (1 and 1.5%) being the superior treatment on the content of total chlorophyll, as well as total carbohydrates in the two seasons. On the other hand, effect of the interaction between irrigation water supply at (400 m$^3$/fed.) and rate of 0.5% fertilizer recorded the minimum values of chlorophyll in both seasons.

The obtained results in Table 8 showed also that application 800 m$^3$/fed. of irrigation water combined with 0.1 and 1.5% of fertilizer recorded the maximum increments in N, P and K content in the leaves of *Xerochrysum bracteatum, Acroclinium roseum* and *Statice sinuate* while, the lowest level of water supply combined with low rate of fertilizer 0.5% gave the lowest values in this respect. (Li *et al.*, 2004) suggest that applying nitrogen as fertigation at the beginning of an irrigation cycle has an advantage on promoting yield and fertilizer use efficiency.

Table 8: Interaction effect of irrigation water quantity on some chemical constituents of *Xerochrysum bracteatum, Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| Treatments | | Total Chlorophyll content (mg/gm) | | Total carbohydrate % | | N% | | P% | | K% | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water quantity ($m^3$/fed.) | Fertilization | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | |
| 400 | Control | 1.65 | 1.81 | 18.44 | 21.36 | 1.71 | 1.84 | 0.07 | 0.08 | 2.24 | 2.28 |
| | 0.5% | 1.84 | 1.92 | 21.42 | 23.69 | 2.01 | 2.20 | 0.13 | 0.11 | 2.51 | 2.63 |
| | 1.0% | 2.05 | 2.13 | 28.21 | 27.85 | 2.38 | 2.49 | 0.12 | 0.11 | 3.16 | 3.18 |
| | 1.5% | 2.14 | 2.21 | 30.58 | 29.37 | 2.40 | 2.52 | 0.12 | 0.13 | 3.49 | 3.39 |
| 600 | Control | 1.87 | 1.96 | 19.34 | 20.26 | 1.83 | 1.95 | 0.09 | 0.00 | 2.32 | 2.45 |
| | 0.5% | 1.91 | 2.00 | 22.60 | 24.37 | 2.09 | 2.15 | 0.11 | 0.11 | 2.72 | 2.84 |
| | 1.0% | 2.24 | 2.35 | 26.56 | 28.37 | 2.63 | 2.41 | 0.13 | 0.12 | 3.41 | 3.46 |
| | 1.5% | 2.39 | 2.42 | 29.54 | 33.58 | 2.60 | 2.66 | 0.17 | 0.14 | 3.55 | 3.58 |
| 800 | Control | 1.98 | 2.03 | 21.40 | 22.24 | 1.96 | 2.01 | 0.09 | 0.01 | 2.25 | 2.28 |
| | 0.5% | 2.36 | 2.39 | 24.50 | 24.33 | 2.16 | 2.74 | 0.15 | 0.03 | 2.67 | 2.76 |
| | 1.0% | 2.57 | 2.61 | 26.60 | 29.99 | 2.60 | 2.78 | 0.12 | 0.14 | 3.26 | 3.27 |
| | 1.5% | 2.64 | 2.70 | 28.50 | 30.58 | 2.61 | 2.86 | 0.13 | 0.15 | 3.31 | 3.49 |
| LSD 0.05 | 0.72 | 0.86 | 2.35 | 2.06 | 0.52 | 0.48 | 0.47 | 0.44 | 0.43 | 0.71 | |
| ***Statice sinuate* plants** | | | | | | | | | | | |
| 400 | Control | 1.69 | 1.85 | 16.31 | 18.37 | 1.40 | 1.68 | 0.08 | 0.09 | 2.75 | 2.79 |
| | 0.5% | 2.11 | 2.25 | 17.34 | 18.66 | 1.80 | 1.98 | 0.09 | 0.01 | 3.47 | 3.68 |
| | 1.0% | 2.24 | 2.28 | 22.66 | 23.65 | 2.19 | 2.35 | 0.12 | 0.12 | 3.66 | 3.89 |
| | 1.5% | 2.29 | 2.31 | 24.37 | 25.33 | 2.33 | 2.45 | 0.12 | 0.12 | 3.85 | 3.96 |
| 600 | Control | 1.99 | 2.00 | 18.43 | 19.99 | 1.45 | 1.69 | 0.09 | 0.10 | 2.91 | 3.00 |
| | 0.5% | 2.36 | 2.39 | 19.34 | 21.55 | 1.84 | 1.99 | 0.10 | 0.10 | 3.60 | 3.46 |
| | 1.0% | 2.51 | 2.49 | 24.37 | 26.86 | 2.32 | 2.65 | 0.13 | 0.13 | 3.91 | 3.89 |
| | 1.5% | 2.59 | 2.60 | 27.01 | 30.00 | 2.41 | 2.68 | 0.13 | 0.13 | 3.93 | 3.89 |
| 800 | Control | 2.20 | 2.24 | 18.99 | 20.96 | 1.81 | 1.96 | 0.09 | 0.01 | 2.87 | 2.89 |
| | 0.5% | 2.25 | 2.31 | 21.34 | 23.30 | 2.08 | 2.35 | 0.12 | 0.12 | 3.51 | 3.68 |
| | 1.0% | 2.62 | 2.66 | 26.36 | 28.66 | 2.55 | 2.66 | 0.13 | 0.13 | 3.76 | 3.78 |
| | 1.5% | 2.68 | 2.69 | 28.70 | 31.26 | 2.65 | 2.90 | 0.13 | 0.14 | 3.81 | 3.89 |
| LSD 0.05 | 0.83 | 0.91 | 1.86 | 1.96 | 0.41 | 0.52 | 0.22 | 0.24 | 0.24 | 0.27 | |
| ***Acroclinium roseum* plants** | | | | | | | | | | | |
| 400 | Control | 1.52 | 1.64 | 25.02 | 25.69 | 2.324 | 2.32 | 0.31 | 0.34 | 2.14 | 2.15 |
| | 0.5% | 1.72 | 1.71 | 26.33 | 27.01 | 2.475 | 2.52 | 0.34 | 0.35 | 3.11 | 3.10 |
| | 1.0% | 1.79 | 1.85 | 35.58 | 35.87 | 2.601 | 2.61 | 0.36 | 0.35 | 3.21 | 3.20 |
| | 1.5% | 1.83 | 1.89 | 36.54 | 36.59 | 3.025 | 2.96 | 0.39 | 0.38 | 3.29 | 3.21 |
| 600 | Control | 1.64 | 1.69 | 25.54 | 25.88 | 2.486 | 2.42 | 0.32 | 0.30 | 2.21 | 2.30 |
| | 0.5% | 1.86 | 1.92 | 27.37 | 27.79 | 2.694 | 2.62 | 0.35 | 0.36 | 3.15 | 3.21 |
| | 1.0% | 1.97 | 2.01 | 35.69 | 36.02 | 3.011 | 2.98 | 0.37 | 0.32 | 3.30 | 3.24 |
| | 1.5% | 2.15 | 2.34 | 38.54 | 38.87 | 3.164 | 3.15 | 0.41 | 0.40 | 3.54 | 3.43 |
| 800 | Control | 1.94 | 2.01 | 27.22 | 27.70 | 2.794 | 2.64 | 0.34 | 0.33 | 2.23 | 2.31 |
| | 0.5% | 2.26 | 2.34 | 29.48 | 30.03 | 2.812 | 2.81 | 0.35 | 0.33 | 3.17 | 3.16 |
| | 1.0% | 2.57 | 2.62 | 37.26 | 37.47 | 3.451 | 3.31 | 0.37 | 0.35 | 3.32 | 3.32 |
| | 1.5% | 2.73 | 2.87 | 39.56 | 38.69 | 3.432 | 3.44 | 0.46 | 0.42 | 3.57 | 3.54 |
| LSD 0.05 | | 1.01 | 1.06 | 1.95 | 2.00 | 0.26 | 0.25 | 0.18 | 0.17 | 0.17 | 0.18 |

Table 9: Effect of irrigation water quantity on some flowering characters of *Xerochrysum bracteatum*, *Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| Treatments | Days to first flower open | | Flowering period (days) | | Inflorescence diameter (cm) | | Flowering shoots Number/plant | | No. of Inflorescence/plant | | Vase-life (days) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water Quantity ($m^3$/fed.) | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | | |
| 400 | 91.64 | 90.12 | 47.54 | 51.030 | 4.37 | 4.95 | 10.71 | 9.83 | 19.60 | 19.31 | 9.06 | 9.32 |
| 600 | 95.51 | 94.83 | 51.92 | 56.040 | 5.68 | 5.85 | 12.41 | 13.45 | 20.47 | 21.44 | 10.65 | 12.91 |
| 800 | 97.24 | 96.92 | 57.83 | 61.020 | 6.10 | 6.57 | 13.97 | 12.55 | 21.11 | 22.47 | 14.74 | 14.05 |
| L.S.D. 0.05 | 2.41 | 2.61 | 2.87 | 3.010 | 0.19 | 0.20 | 1.67 | 1.78 | 2.13 | 2.23 | 1.51 | 1.52 |
| ***Statice sinuate* plants** | | | | | | | | | | | | |
| 400 | 107.19 | 108.12 | 75.73 | 78.30 | 6.52 | 6.85 | 11.71 | 13.44 | 24.05 | 25.62 | 8.83 | 9.05 |
| 600 | 100.45 | 101.21 | 86.33 | 89.50 | 8.63 | 8.90 | 14.12 | 15.55 | 37.34 | 37.64 | 11.46 | 12.08 |
| 800 | 102.28 | 102.32 | 97.76 | 96.70 | 9.90 | 9.55 | 17.71 | 18.38 | 41.81 | 42.72 | 13.14 | 14.76 |
| LSD 0.05 | 1.91 | 2.03 | 2.76 | 2.94 | 0.17 | 0.19 | 1.80 | 1.81 | 3.02 | 2.91 | 0.34 | 0.36 |
| ***Acroclinium roseum* plants** | | | | | | | | | | | | |
| 400 | 90.87 | 91.93 | 32.34 | 34.00 | 4.41 | 4.44 | 7.08 | 7.67 | 7.69 | 7.96 | 7.27 | 7.57 |
| 600 | 93.69 | 93.12 | 36.81 | 38.00 | 5.40 | 5.43 | 8.75 | 9.37 | 9.68 | 9.47 | 9.45 | 9.55 |
| 800 | 94.85 | 94.31 | 42.32 | 42.90 | 5.61 | 5.67 | 9.58 | 9.36 | 11.33 | 10.33 | 10.71 | 10.63 |
| L.S.D. 0.05 | 1.24 | 1.55 | 3.72 | 2.92 | 0.15 | 0.15 | 1.51 | 1.54 | 5.14 | 4.64 | 1.32 | 1.18 |

## Flowering characters

**Effect of irrigation water quantity:** Data presented in Table 9 indicated that the different quantities of irrigation water exerted a marked and significant effect on flowering characters of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants. Whereas, application of irrigation water at a level of 800 $m^3$/fed. being the most effective and favorable treatment as well as recorded the maximum values in this respect. On the contrary, the lowest values of flowering characters were obvious with application of lowest level of irrigation water and/or increasing soil moisture water stress. The superiority effect of irrigation water at the level of 800 $m^3$/fed. during the growing seasons on *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants is directly owing to the increase in plant growth rate and its dry matter content, as well as, plant minerals uptake so, the flowering can be considered as the final resultant of all physiological and metabolic processes in the plant.

Furthermore water use efficiency, leading to increase the availability and absorption of nutrient elements necessary for flowering precursors of a class of compounds which ultimately forms amino acids and hormones leading to an earlier flowering, gave many lateral branches and number of flowers/plant. Also, increase the flower duration, for enough amount of water need for keeping flower cells in turgidity status (Bastug *et al.*, 2006). Also, increasing in flower dry weight may be due to the increase in flower diameter or flower number or both as reported by Katsoulas *et al.* (2006). A better understanding of the effects of irrigation on flower production and quality of rose plants can help to propose optimal irrigation scheduling.

**Effect of fertilizer rates:** The obtained data in Table 10 indicated that the highest increment of flowering characters were recorded by application of complete fertilizer through irrigation water (fertigation), as compared with control treatment. The highest values of the flowering characters

Table 10: Effect of complete fertilization on some flowering characters of *Xerochrysum bracteatum*, *Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| | Days to first flower open | | Flowering period (days) | | Inflorescence diameter (cm) | | Flowering shoots Number/plant | | No. of Inflorescence/plant | | Vase-life (days) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments Fertilization | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | | |
| Control | 90.93 | 89.54 | 52.03 | 49.02 | 3.33 | 3.54 | 6.45 | 6.47 | 12.62 | 12.36 | 9.05 | 9.32 |
| 0.5% | 91.32 | 90.72 | 50.72 | 52.43 | 5.32 | 4.92 | 9.78 | 10.81 | 18.68 | 18.33 | 10.63 | 12.23 |
| 1.0% | 95.74 | 94.23 | 54.24 | 56.71 | 5.89 | 5.59 | 11.21 | 12.11 | 20.66 | 20.36 | 12.72 | 12.47 |
| 1.5% | 97.13 | 96.40 | 62.73 | 65.25 | 6.42 | 6.54 | 12.97 | 13.48 | 22.38 | 21.93 | 13.52 | 13.54 |
| LSD 0.05 | 3.04 | 3.15 | 3.23 | 3.77 | 1.22 | 1.25 | 1.93 | 1.98 | 1.33 | 1.25 | 1.72 | 1.96 |
| ***Statice sinuate* plants** | | | | | | | | | | | | |
| Control | 105.23 | 102.42 | 74.71 | 77.34 | 5.02 | 5.25 | 10.44 | 11.14 | 25.00 | 26.66 | 8.81 | 9.09 |
| 0.5% | 107.82 | 108.43 | 84.32 | 87.55 | 6.89 | 6.47 | 12.71 | 12.41 | 30.36 | 31.69 | 11.43 | 12.08 |
| 1.0% | 109.54 | 109.24 | 94.74 | 96.75 | 8.78 | 8.49 | 15.12 | 16.55 | 35.86 | 36.00 | 13.15 | 13.75 |
| 1.5% | 110.53 | 110.14 | 95.71 | 98.31 | 9.45 | 9.42 | 18.78 | 20.33 | 37.36 | 40.36 | 14.32 | 14.56 |
| LSD 0.05 | 2.24 | 2.55 | 2.043 | 2.42 | 1.09 | 1.10 | 2.12 | 1.10 | 1.12 | 1.24 | 0.34 | 0.35 |
| ***Acroclinium roseum* plants** | | | | | | | | | | | | |
| Control | 90.91 | 90.22 | 42.31 | 44.02 | 3.31 | 3.33 | 6.22 | 6.33 | 7.66 | 6.96 | 7.45 | 6.22 |
| 0.5% | 90.22 | 91.64 | 46.82 | 48.01 | 4.74 | 4.23 | 7.44 | 7.62 | 8.68 | 8.46 | 9.59 | 8.38 |
| 1.0% | 91.63 | 92.12 | 52.33 | 52.94 | 5.12 | 5.45 | 7.78 | 8.01 | 10.33 | 9.36 | 10.02 | 9.76 |
| 1.5% | 92.84 | 92.43 | 42.34 | 44.03 | 5.74 | 5.81 | 8.11 | 8.99 | 10.97 | 10.68 | 10.53 | 10.61 |
| LSD 0.05 | 3.32 | 3. 25 | 2.91 | 3.03 | 0.92 | 1.02 | 0.99 | 0.96 | 1.21 | 1.42 | 1.34 | 1.02 |

were achieved with increasing level of fertilizer through fertigation in the two seasons. On the contrary, increasing the addition of fertilizer up to the highest rate (1.5%) delayed the initiation of flowering, increasing flowering period and vas-live in the three types studies. The promoting effect of addition the complete fertilizers at high rates on the flowering characters may be explained that the macro and microelements are essential to develop more vegetative growth on the account of formation and development of flowering character. These results are in agreement with the findings of Kandeel *et al.* (2002) on *Chrysanthemum parthenium* who mentioned that the highest number of inflorescences per plant, inflorescence diameter and fresh and dry weights of inflorescences per plant were obtained by high fertilizer rate. Munikrishnappa *et al.* (2002) indicated that fertigation without micronutrient have no effect while, fertigation with 80% NPK supplementation with 0.1% B or 0.5% Zn can be effectively adopted for proper growth of tuberose. Treder (2003) using fertilizer through fertigation improved lily plant quality expressed as higher stem weight, better sturdiness, higher leaf area better leaf coloration and accelerated flowering of plant.

**Effect of interaction between irrigation water quantity and fertilizer rates:** Table 11 indicated that high quantity of irrigation water (800 $m^3$/fed.) and fertigated with high rates of complete fertilizer (0.1 and 1.5%) had a great influence on flowering characters comparing with irrigation without fertilizer. The interaction between complete fertilizer and all water quantity caused an increase in flowering characters compared to that control treatment. These results are in line with those stated by Asadi *et al.* (2002) showed that a fertigation system can be an efficient practice and an advanced way to give water and plant nutrients together to the crop. Dufour and

Table 11: Interaction effect of irrigation water quantity on some flowering characters of of *Xerochrysum bracteatum, Statice sinuate* and *Acroclinium roseum* plants during 2010/2011 and 2011/2012 seasons

| Treatments | | Days to first flower open | | Flowering period (days) | | Inflorescence diameter (cm) | | Flowering shoots number/plant | | No. of Inflorescence/plant | | Vase-life (days) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation water Quantity ($m^3$/fed.) | Fertilization | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| ***Xerochrysum bracteatum* plants** | | | | | | | | | | | | | |
| 400 | Control | 90.94 | 89.52 | 42.33 | 44.26 | 3.31 | 3.56 | 6.45 | 6.41 | 11.20 | 11.42 | 9.04 | 9.30 |
| | 0.5% | 90.32 | 90.13 | 45.26 | 46.25 | 3.91 | 4.11 | 8.78 | 8.81 | 15.41 | 14.24 | 9.58 | 9.64 |
| | 1.0% | 91.85 | 91.87 | 48.94 | 49.21 | 4.01 | 4.21 | 10.21 | 10.14 | 18.65 | 18.11 | 10.25 | 10.11 |
| | 1.5% | 91.92 | 91.90 | 51.97 | 56.02 | 5.89 | 5.59 | 10.97 | 11.44 | 19.22 | 19.93 | 10.63 | 10.23 |
| 600 | Control | 91.62 | 90.13 | 47.54 | 51.01 | 4.37 | 4.95 | 8.45 | 9.47 | 11.44 | 11.35 | 9.06 | 9.32 |
| | 0.5% | 92.21 | 92.22 | 49.25 | 50.15 | 5.06 | 5.11 | 10.70 | 10.89 | 18.22 | 18.12 | 10.25 | 10.32 |
| | 1.0% | 92.85 | 93.25 | 50.46 | 51.26 | 5.54 | 5.60 | 11.27 | 12.14 | 19.65 | 19.36 | 10.48 | 10.69 |
| | 1.5% | 93.52 | 93.81 | 52.36 | 53.26 | 6.10 | 6.57 | 11.97 | 12.48 | 21.38 | 22.90 | 10.69 | 10.95 |
| 800 | Control | 91.60 | 90.10 | 50.70 | 52.40 | 5.32 | 4.92 | 9.45 | 9.42 | 12.62 | 12.34 | 11.63 | 11.23 |
| | 0.5% | 92.36 | 92.51 | 53.46 | 53.06 | 5.34 | 5.41 | 10.74 | 10.83 | 18.68 | 18.35 | 11.78 | 12.64 |
| | 1.0% | 93.02 | 93.51 | 55.97 | 56.31 | 5.81 | 5.89 | 13.27 | 14.14 | 20.66 | 20.35 | 12.36 | 13.25 |
| | 1.5% | 94.24 | 94.93 | 62.76 | 65.24 | 6.42 | 6.54 | 14.97 | 15.43 | 22.34 | 21.95 | 13.74 | 14.12 |
| LSD 0.05 | 1.45 | 1.63 | 20.027 | 2.00 | 0.36 | 0.25 | 1.15 | 1.100 | 2.69 | 2.86 | 0.90 | 1.00 | |
| ***Statice sinuate* plants** | | | | | | | | | | | | | |
| 400 | Control | 107.21 | 105.42 | 74.7 | 77.36 | 5.02 | 5.25 | 9.41 | 10.14 | 22.43 | 25.32 | 8.75 | 8.72 |
| | 0.5% | 107.94 | 107.59 | 76.26 | 77.25 | 6.12 | 6.24 | 11.74 | 11.44 | 30.00 | 30.62 | 9.12 | 9.88 |
| | 1.0% | 108.21 | 108.65 | 82.16 | 83.02 | 7.15 | 7.25 | 15.17 | 15.52 | 34.47 | 35.08 | 10.45 | 10.32 |
| | 1.5% | 109.50 | 109.20 | 84.30 | 87.58 | 8.58 | 8.49 | 16.74 | 19.31 | 35.33 | 39.31 | 11.44 | 12.08 |
| 600 | Control | 107.80 | 108.43 | 75.70 | 78.35 | 6.52 | 6.85 | 10.11 | 10.18 | 24.42 | 25.11 | 8.83 | 8.85 |
| | 0.5% | 108.46 | 108.56 | 77.99 | 78.25 | 7.52 | 7.59 | 12.99 | 11.12 | 30.36 | 31.69 | 10.25 | 10.55 |
| | 1.0% | 109.02 | 109.21 | 85.36 | 86.21 | 8.02 | 8.12 | 14.11 | 15.18 | 34.48 | 35.29 | 12.45 | 11.58 |
| | 1.5% | 109.54 | 109.24 | 86.30 | 89.56 | 8.62 | 8.91 | 18.22 | 19.14 | 36.15 | 41.42 | 13.15 | 13.75 |
| 800 | Control | 107.92 | 108.14 | 84.30 | 87.54 | 6.52 | 6.85 | 10.44 | 11.14 | 25.00 | 26.66 | 8.86 | 9.12 |
| | 0.5% | 108.69 | 109.42 | 88.26 | 89.65 | 7.59 | 7.61 | 12.71 | 12.41 | 30.36 | 31.69 | 10.52 | 11.25 |
| | 1.0% | 108.93 | 109.75 | 92.36 | 93.15 | 8.56 | 8.61 | 15.12 | 16.55 | 35.86 | 36.00 | 13.25 | 13.29 |
| | 1.5% | 112.82 | 112.31 | 97.7 | 96.74 | 9.83 | 9.57 | 18.78 | 20.33 | 37.36 | 40.36 | 14.37 | 14.51 |
| LSD 0.05 | 1.45 | 1.56 | 1.54 | 1.63 | 0.29 | 0.29 | 1.02 | 1.08 | 2.14 | 2.37 | 0.8 | 0.8 | |
| ***Acroclinium roseum* plants** | | | | | | | | | | | | | |
| 400 | Control | 90.21 | 90.24 | 32.35 | 34.05 | 3.21 | 3.34 | 5.26 | 5.01 | 6.02 | 6.04 | 6.41 | 6.23 |
| | 0.5% | 90.46 | 90.27 | 36.25 | 40.24 | 3.95 | 40.11 | 7.44 | 7.05 | 7.61 | 7.46 | 6.89 | 7.05 |
| | 1.0% | 90.77 | 91.24 | 40.28 | 42.96 | 4.26 | 4.32 | 7.78 | 7.81 | 9.34 | 9.11 | 7.88 | 8.01 |
| | 1.5% | 91.16 | 92.14 | 42.33 | 44.05 | 5.12 | 5.45 | 7.11 | 7.92 | 9.97 | 9.64 | 9.92 | 9.04 |
| 600 | Control | 90.92 | 90.24 | 36.87 | 38.01 | 4.41 | 4.44 | 5.92 | 5.75 | 6.58 | 6.21 | 7.27 | 7.57 |
| | 0.5% | 91.21 | 91.57 | 40.15 | 42.51 | 4.97 | 5.02 | 6.41 | 7.01 | 8.65 | 8.46 | 8.52 | 9.18 |
| | 1.0% | 91.35 | 91.59 | 43.28 | 44.18 | 5.22 | 5.23 | 6.88 | 7.01 | 9.38 | 9.38 | 9.41 | 9.56 |
| | 1.5% | 91.64 | 92.15 | 46.86 | 48.07 | 5.40 | 5.43 | 7.99 | 8.09 | 9.94 | 10.68 | 10.02 | 9.76 |
| 800 | Control | 90.06 | 90.10 | 42.31 | 44.02 | 4.72 | 4.73 | 6.90 | 6.34 | 7.68 | 7.94 | 7.30 | 8.00 |
| | 0.5% | 91.26 | 91.68 | 48.19 | 50.34 | 5.04 | 5.12 | 7.12 | 7.95 | 9.61 | 9.42 | 9.09 | 9.18 |
| | 1.0% | 91.65 | 91.79 | 50.16 | 50.12 | 5.46 | 5.52 | 7.74 | 8.15 | 10.35 | 10.34 | 10.5 | 10.0 |
| | 1.5% | 92.08 | 93.03 | 52.30 | 52.94 | 5.74 | 5.81 | 8.19 | 8.12 | 11.15 | 11.25 | 10.71 | 10.63 |
| LSD 0.05 | | 2.32 | 2.33 | 1.55 | 1.58 | 0.29 | 0.30 | 1.02 | 1.05 | 3.45 | 4.15 | 0.91 | 0.89 |

Guerin (2005) found that suitable nutrient solutions are proposed in order to match anthurium plant absorption at different growth stages and adjusting the nutrient solution volume and composition to match plant requirements is the first step for flower yield improvement.

Finally, from the forgoing results and discussion, it could be noticed that the growth rate and flowering behavior of *Xerochrysum bracteatum*, *Acroclinium roseum* and *Statice sinuate* plants varied according to the irrigation water quantity and the used rates of complete fertilizer.

## CONCLUSION

Finally, from the forgoing results and discussion, it could be noticed that the growth rate and flowering behavior of *Xerochrysum bracteatum* Vent., *Acroclinium roseum* Hook. and *Statice sinuate* Mix. plants varied according to the irrigation water quantity and the used rates of complete fertilizer. Moreover, previous studies reported that increasing soil moisture content and choosing the suitable method of fertilizer application (as fertegation) in sand soil greatly promoted the growth rate and the productivity of the three various ornamental plants.

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