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# Changes in post-harvest life of cut chrysanthemum as influenced by different holding solutions and two cultivars

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**ABSTRACT**

To determine the appropriate treatment suitable for improving the heads flowers keeping quality and detecting some physiological changes occurring during the vase life period of the cut *(Dendranthema grandiflorum*, Ramat) cvs White Reagan and Arctic Queen heads flowers so, this study was consummated at post-Harvest. Lab. of floriculture Dep., Hort. Res. Inst., Giza, Egypt during 2013 and 2014 seasons to study the effect of some holding solutions ,viz. distilled water, (control), Gibberellic acid at 0.001%, Sucrose at (2 and 4 %), Citric acid at (150 mg/l), and 8-Hydroxyqunoline citrate at (200 mg/l) on longevity of flower heads (vase life), water uptake, number of yellowing leaves and number of days from putting flowers in the different solutions to yellowing leaves (day). The obtained data exhibited that all holding solutions caused a marked increment in the studied characters compared to that registered from Sucrose (4%). In this respect, cut flowers treated with Sucrose at (2%) +8- Hydroxyqunoline citrate at (200 mg/l) + Gibberellic acid at (0.001 %) + Citric acid at (150 mg/l) decreased yellowing leaves and improved chlorophyll content and total carbohydrates in flower petals and leaves followed by the combined treatment of Sucrose at (4%) + 8-Hydroxyqunoline citrate at (200mg/l) + Gibberellic acid at (0.001%) + Citric acid at (150mg/l). Cut flowers *(Dendranthema grandiflorum,* Ramat.) cv. White Reagan gave the best results for studied characters compared to cv. Arctic Queen, results of interaction showed that all holding solutions had the highest effect on extending vase life, number of days taken for yellowing leaves and water uptake, while decreased number of yellowing leaves and improved chlorophyll content and total carbohydrates in flower petals and leaves .It could recommended to extend vase life of chrysantmemum cvs White Reagan and Arctic Queen holding cut flower in distilled water content sucrose ( 2%) + 8-Hydroxyqunoline citrate (8- HQC) (200 mg/l) + $GA_3$ (0.001 %)) + Citric acid (150mg/l).

***Keywords*:** Vase life, chrysanthemum cv. Whitr Reagan and Arctic Queen, Gibberellic acid, Sucrose, 8-Hydroxyquinoline citrate, Citric acid.

## Introduction

The original home of Chrysanthemum is China, the species are of wide spread occurrence in temperate regions and in many parts of the globe, mostly in the old world. Chrysanthemum flowers are herbaceous perennial plants or subshrubs. They have alternately arranged leaves divided into leaflets with toothed or occasionally smooth edges. The compound inflorescence is an array of several flower heads, or sometimes a solitary head. The head has a base covered in layers of phyllaries. The simple row of ray florets is white, yellow, red. Cut flowers are parts of plants, characteristically including the blooms or "inflorescences" and some attached plant materials, but not including roots and soil. Fresh cut flowers are used for decorative purposes such as vase arrangements and boquets at formal event (Bonarriva, 2003).

Chrysanthemum (*Dendranthema grandiflora*.) is one of the most popular ornamental crops in the world (Saxena, 2001). It is a member of Asteraceae family; today, it is the second most economically important flower in the world after roses. (Nabigol *et al*, 2007). Cut flowers of chrysanthemum come in a wide range of colors and forms including two types namely, standard (one flower on the stem such as cv. "Arctic Queen" and "White Reagan" and spray (multiple flowers on the

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stem such as cv. "White Zambla").The vase life is differing among various species and cultivars of chrysanthemum, which is one of the most valuable characteristics determining its quality, satisfying consumer preferences and the commercial value (Abou El-Ghait *et al*, 2012).

Vase life is an important parameter for evaluation of cut flower quality, for both domestic and export markets. The techniques of prolonging the vase life of flowers will be a great asset to the growers and users (Nair *et al,* 2003). The vase life is differing among various species and cultivars of chrysanthemum, which is one of the most valuable characteristics determining its quality, satisfying consumer preferences and the commercial value (Kumar, 2016).

The main postharvest problems in chrysanthemum is premature foliage yellowing, wilting and the failure of the flowers to fully open. The flowers of chrysanthemum have long vase life but its foliage often becomes yellow, brown and wilted during storage and transportation which reduces the postharvest quality of cut flowers. Foliage yellowing is cultivar specific and is caused by poor production, excessive or improper storage and preservative solutions used at higher than recommended concentrations. Leaves of cut chrysanthemum frequently become yellow spontaneously, sometimes prior to the onset of flower senescence, which makes the flowers unattractive, lowers their quality and shortens vase life (Doi *et al*, 2003, 2004).

Adding chemical preservatives to the holding solution is recommended to preserve the best quality of flower after harvest. All holding solutions must contain sugars (Sucrose), acids (Citric acid) growth regulators, such Gibberellic acid and antimicrobials such as 8-Hydroxyquinoline (Abou El-Ghait *et al*, 2012).

Sugar play important role in plants as substances for respiration, the addition of sugars such as sucrose to vase water is effective in improving the vase life of cut flowers (Halevy and Mayak, 1979).Sucrose has been found to be the most commonly used sugar in prolonging vase life of cut flowers. The exogenous application of the sucrose supplies the cut flowers with much needed substrates for respiration, and enables cut flowers harvested at the bud stage to open, which otherwise could not occur naturally (Pun and Ichimura, 2003).

Also, Citric acid (CA) improved water balance and reduced stem plugging of bird of paradise cut flowers (Halevy *et al*, 1978), in addition applying Citric acid (CA) at (0, 100, 200 ppm) increased vase life, petal water content (%), initial fresh weight (%), marketability and significantly of chrysanthemum cut flowers (Vahdati Mashhadian *et al*, 2012).

Gibberellic acid prevented leaf chlorosis, which was the major postharvest disorder in many cut flowers such as Santonia cv. Golden light flowers (Eason *et al*, 2001).
8-HQS delayed senescence and eliminated bacterial growth which was the principal reason for reducing water uptake and transport of gerbera flower, (Abdel Kader, 1987).

This study aims to determine the appropriate treatment suitable for improving the flowers keeping quality and detecting some physiological changes occurring during the vase life period of cut (*Dendranthema grandiflorum,* Ramat) cvs. White Reagan and Arctic Queen heads flowers.

## Material and Methods

The present study was conducted at the Ornamental Hort. Dep., Fac. Of Agric., Cairo Univ., Giza Egypt, during the period from 2012 to 2016.

This study had been carried out at Post-Harvest Lab. of Floriculture Dept., Hort. Res. Inst.; Agric. Res. Center, Ministry of Agric. and land reclamation, Giza, Egypt during 2013 and 2014 seasons. In order to determine the most suitable treatment for improving keeping quality and detecting some physiological changes taking place during the vase life period of cut chrysanthemum flowers.

### Plant materials

*Dendranthema grandiflorum* (chrysanthemum) cvs. White Reagan and Arctic Queen cut flowers (standard: one flower on the stem). Cut flowers were obtained from a local commercial farm in Giza, Egypt in Jan. in both seasons. Chrysanthemum cut flowers were harvested in the early morning at their commercial stage which was full opening flowers Safa *et al*., (2012) and wrapped in Kraft paper and transported to postharvest lab of Floriculture. Dept., Hort. Res. Inst., Giza, Egypt. During two hour. Cut flowers were precooled by placing in ice cold water for 2 hours to remove the effect of high

field heat. Stem bases were recut to about 3cm in air before treatments and adjusted to 60 cm long. 99 cut flowers of *Dendranthema grandiflorum* cvs. White Reagan and Arctic Queen were placed in a vase (500 ml) containing 300 ml holding solution to end vase life. All treatments were kept under condition i.e. 15-20°c, 60-70 % RH and continues light (1000- 1500 lux) from white fluorescent.

**Holding solutions:**

1- Distilled water (D.W), as control = $T_1$.
2- Sucrose (Suc.) (2%) = $T_2$.
3- Sucrose (4%) =$T_3$.
4- Sucrose (2%) + 8-Hydroxyqunoline citrate (8-HQC) (200 mg/l) =$T_4$.
5- Sucrose (4%) + 8- Hydroxyqunoline citrate (200 mg/l)= $T_5$.
6- Sucrose (2%) + Gibberellic acid ($GA_3$) (0.001 %) =$T_6$.
7- Sucrose (4%) + Gibberellic acid (0.001 %) = $T_7$.
8- Sucrose (2%) + 8- Hydroxyqunoline citrate (200 mg/l) + Gibberellic acid (0.001%) + Citric acid (150 mg/l)= $T_8$.
9- Sucrose (2%) + Citric acid (150 mg/l)= $T_9$.
10- Sucrose (4%) + Citric acid (150 mg/l)= $T_{10}$.
11- Sucrose (4%) +8- Hydroxyqunoline citrate (200 mg/l) + Gibberellic Acid (0.001%) + Citric Acid (150 mg/l)= $T_{11}$.

## 1. Data record

- Vase life (day): day number till wilting.
- Water uptake (ml/3 flowers): (the solution volume at the beginning of the study- the solution volume of $1^{st,}$ $8^{th,}$ $15^{th,}$ $22^{th,}$, $30^{th}$ day in *Dendranthema grandiflorum cvs.* White Reagan and Arctic Queen cut flowers (ml/3 flowers).
- Number of yellowing leaves.
- Number of days from putting flowers in different solutions to yellowing leaves (day).

## 2. Chemical analysis:

- Total carbohydrates (%) in the flower petals were determined calorimetrically, according to the methods described by Dubois *et al,* (1956).
- Chlorophyll a,b and carotenoids content (mg/g) in flower petals was determined colorimetrically at the end of storage period according to Husia *et al,* (1965).

### 3. Layout of the experiment

The experimental layout was a complete randomized design in a factorial experiment (two factors). Holding solutions (factor A) was applied in 11 solutions and two cultivars on (factor B).

**Statistical analysis**

The data were statistically analyzed as a factorial experiment using MSTAT-C (1993) and means were compared by Duncan's Multiple Rang Test as described by Duncan (1955) to verify differences among means of various treatments.

**Results and Discussion**

**Effect of different cultivars, holding solutions and their interactions on quality of *(Dendranthema grandiflorum,* Ramat.) *cvs.* White Reagan and Arctic Queen cut flowers during 2013 and 2014:**

### 1. Flower vase life:

Data presented in Table (1) reveal that the significantly highest vase life was obtained with *Dendranthema grandiflorum* cv. White Reagan (22.36 and 25.63days) compared to the second cultivars Arctic Queen (19.36 and 20.88 days), in first and second seasons respectively.

**Table 1**: Effect of different cultivars on vase life (days) of (*Dendranthema grandiflorum*, Ramat) cvs White Reagan and Arctic Queen cut flowers during 2013 and 2014.

| Cultivars | 1st season 2013 | 2nd season 2014 |
|---|---|---|
| **White Reagan** | 22.36a | 25.63a |
| **Arctic Queen** | 19.36b | 20.88b |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

Regarding the effect of holding solutions treatments on vase life, data presented in Table (2) indicate that all treatments increased vase life of *Dendranthema grandiflorum*m cvs. White Reagan and Arctic Queen in the two seasons compared to ($T_1$) distilled water , ($T_2$ and $T_3$) Sucrose (2 and 4%). Data show that treating flowers with ($T_8$) Suc (2 %) + 8-HQC (200 mg/l) + $GA_3$ (0.001 %) + CA (150 mg/l) gave the highest significantly effect on longevity (31.07 and 33.43) followed by the last solution containing with ($T_{11}$)Suc (4%) + 8-HQC (200 mg/l) + $GA_3$ (0.001%) + CA (150mg/l) (28.75 and 31.60) in the both seasons respectively.

**Table 2:** Effect of holding solutions on vase life (days) of (*Dendranthema grandiflorum*, Ramat.) cvs White Reagan and Arctic Queen cut flowers during 2013 and 2014**.**

| Holding solutions treatments | 1st season 2013 | 2nd season 2014 |
|---|---|---|
| **$T_1$** | 15.23i | 17.22i |
| **$T_2$** | 12.33j | 15.05j |
| **$T_3$** | 9.983k | 13.07k |
| **$T_4$** | 26.72c | 29.32c |
| **$T_5$** | 25.45d | 27.10d |
| **$T_6$** | 19.28g | 21.43g |
| **$T_7$** | 17.38h | 19.52h |
| **$T_8$** | 31.07a | 33.43a |
| **$T_9$** | 23.38e | 25.03e |
| **$T_{10}$** | 20.87f | 23.05e |
| **$T_{11}$** | 28.75b | 31.60b |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

Data in Table (3) show that treatment with ($T_8$) Suc (2 %) + 8-HQC (200 mg/l) + $GA_3$(0.001 %) + CA (150 mg/l) was the most effective treatment for prolonging longevity with the two cultivars followed by cut flowers treated with ($T_{11}$) (Suc 4%) + 8-HQC (200 mg/l) + $GA_3$ (0.001%) + CA (150 mg/l) compared with other treatments in the first and second seasons respectively.

These results are in accordance with those reported by Sharma *et al,* (2005) who found that the highest vase life of *lilium grandiflorum* cut flowers was obtained with (2%) Sucrose + (50 ppm) $GA_3$+ (200 ppm) 8-HQC, also Li *et al*, (2012) mentioned that the vase life of cut carnations increased when holding (5%) Sucrose + (100 mg/l) 8-HQ + (200 mg/l) CA + (100mg/l) 6-BA. Abd El-Kafie *et al*, (2014) investigate that the chrysanthemum cut flowers were held in the vase solution containing Silver nitrate (75 ppm) + Citric acid (150 ppm) + Sucrose at (3%) was increased significant vase life (19.5 and 17.2 days, respectively). Preservative solutions containing (400 ppm) 8-HQC and (1.5%) Sucrose gave that maximum vase life of chrysanthemum (*Dendranthema grandiflora*, Ramat) cv. White Reagan cut flowers (Jain *et al*, 2014).

**2. Number yellowing leaves (%):**

Data in Table (4) clear that the number of yellowing leaves increased in cut flowers *Dendranthema grandiflorum* cv. Arctic Queen (3.04 and 2.82%) when compared with cv. White Reagan (2.69 and 2.33%) in both seasons respectively.

**Table 3:** Effect of interaction between different cultivars, holding solutions on vase life of (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen cut flowers during 2013 and 2014.

| Holding solutions treatments | Cultivars of *Dendranthema grandiflorum* 2013 | | 2014 | |
|---|---|---|---|---|
| | White Reagan | Arctic queen | White Reagan | Arctic queen |
| $T_1$ | 16.57l | 13.90m | 19.23l | 15.20n |
| $T_2$ | 13.00m | 11.67n | 17.10m | 13.00o |
| $T_3$ | 10.20o | 9.76o | 15.23n | 10.90p |
| $T_4$ | 28.00cd | 25.43f | 32.00c | 26.63g |
| $T_5$ | 27.00de | 23.90g | 29.43e | 24.77hi |
| $T_6$ | 20.70i | 17.87k | 23.77i | 19.10l |
| $T_7$ | 19.00j | 15.77l | 21.13jk | 17.90m |
| $T_8$ | 33.77a | 28.37c | 36.10a | 30.77d |
| $T_9$ | 24.87fg | 21.90h | 27.87f | 22.20j |
| $T_{10}$ | 22.10h | 19.63ij | 25.67gh | 20.43k |
| $T_{11}$ | 30.80b | 26.70e | 34.43b | 28.77ef |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

**Table 4:** Effect of the different cultivars on number of yellowing leaves (%) of *(Dendranthema grandiflorum,* Ramat.) cvs. White Reagan and Arctic Queen cut flowers during seasons 2013 and 2014.

| Cultivars | 1st season 2013 | 2nd season 2014 |
|---|---|---|
| **White Reagan** | 2.69b | 2.33b |
| **Arctic Queen** | 3.04a | 2.82a |

Means within column having the same letters are not significantly different according to Ducan's multiple range test.

Data in Table (5) indicate that all holding solutions significantly decreased the number of yellowing leaves of dendranthema cut flowers meanwhile treating cut flowers with ($T_1$) distilled water, ($T_2$) sucrose 2% , ($T_3$) sucrose 4% and ($T_{10}$) Suc 4% + CA 150mg/l increased number of yellowing leaves in both seasons.

Concerning the data of interaction (holding solutions x different cultivars) the obtained data in Table (6) mentioned that treating cut flowers in 2 cultivars with different holding solutions decreased the number of yellowing leaves, compared with ( $T_1$) distilled water, ( $T_3$ and $T_2$ ) Sucrose (4% and 2%) in the two seasons.

This agreed with the results found by Han (2001) who stated that the yellowing leaves decreased in cut lilies when used high concentrations of growth regulators like $GA_3$.Using Gibberellic acid treatment (20, 50, and 100 mg/l) in combination with Sucrose (4%) and Citric acid (200 mg/l) prevented the yellowing of lily leaves of the cut flowers of *Lilium longiflorum*. (Dias-Tagliacozzo *et al* (2005), Also Jain *et al* (2014) showed that reduce the foliage discoloration of chrysanthemum (*Dendranthema grandiflora*, Ramat.) cv. White Reagan when held flowers in preservative solutions containing (400ppm) 8-HQC and (1.5%) sucrose.

**3- Number of days from putting flowers in different solutions to yellowing leaves (day).**

Data presented in Table (7) evident that the *Dendranthema grandiflorum* cv. White Reagan cut flowers gave highest number of days for yellowing leaves (15.94 and 19.11days) than cv. Arctic Queen cut flowers (13.38 and 15.28 days), in both seasons respectively .

**Table 5:** Effect of holding solutions on number of yellowing leaves (%)on (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen during seasons 2013 and 2014.

| Holding solutions treatments | 1st season 2013 | 2nd season 2014 |
|---|---|---|
| **$T_1$** | 4.21c | 3.81c |
| **$T_2$** | 4.93b | 4.60b |
| **$T_3$** | 5.68a | 5.33a |
| **$T_4$** | 2.58e | 2.21e |
| **$T_5$** | 2.83e | 2.50e |
| **$T_6$** | 1.23fg | 1.00f |
| **$T_7$** | 1.45f | 1.21f |
| **$T_8$** | 0.50h | 0.35g |
| **$T_9$** | 3.56d | 3.16d |
| **$T_{10}$** | 8.78cd | 3.50cd |
| **$T_{11}$** | 0.78gh | 0.66fg |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

**Table 6:** Effect of interaction between different cultivars, holding solutions on number of yellowing leaves (%) on (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen during seasons 2013 and 2014.

| Holding solutions treatments | Cultivars of *Dendranthema grandiflorum* | | | |
|---|---|---|---|---|
| | 2013 | | 2014 | |
| | White Reagan | Arctic queen | White Reagan | Arctic queen |
| **T1** | 3.90cd | 4.53bc | 3.43cde | 4.20bc |
| **T2** | 4.76b | 5.10ab | 4.33bc | 4.86ab |
| **T3** | 5.56a | 5.80a | 5.00ab | 5.66a |
| **T4** | 2.36f | 2.80ef | 2.00gh | 2.43fg |
| **T5** | 2.53f | 3.13def | 2.20gh | 2.80efg |
| **T6** | 1.00ghi | 1.47gh | 0.90ij | 1.10ij |
| **T7** | 1.33gh | 1.57g | 1.00ij | 1.43hi |
| **T8** | 0.33i | 0.67hi | 0.23j | 0.47j |
| **T9** | 3.46de | 3.67d | 2.80efg | 3.53cde |
| **T10** | 3.66d | 3.90cd | 3.23ef | 3.77cd |
| **T11** | 0.67hi | 0.90ghi | 0.53ij | 0.80ij |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

**Table7:** Effect of the different cultivars on number of days from putting flowers in different solutions to yellowing leaves of *(Dendranthema grandiflorum, Ramat.)* cvs. White Reagan and Arctic Queen cut flowers during seasons 2013 and 2014.

| Cultivars | 1st season 2013 | 2nd season 2014 |
|---|---|---|
| **White Reagan** | 15.94a | **19.11a** |
| **Arctic Queen** | 13.38b | **15.28b** |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

Data in Table (8) show that treating dendranthema cut flowers with different holding solutions increased the number of days for yellowing leaves, while treating them with ($T_8$) Suc (2 %) + 8-HQC (200 mg/l) + $GA_3$ (0.001 %) + CA (150 mg/l) was increased the number of days for yellowing leaves, followed by treating with ($T_{11}$) Sucrose (4 %) +8-HQC (200 mg/l) + GA3( 0.001 %) + CA (150 mg/l) compared with the other treatments in both seasons.

**Table 8:** Effect of holding solutions on number of days from putting flowers in different solutions to yellowing leaves of *(Dendranthema grandiflorum,* Ramat.) cvs. White Reagan and Arctic Queen cut flowers during seasons 2013 and 2014.

| Holding solutions treatments | 1st season 2013 | 2nd season 2014 |
|---|---|---|
| **T1** | 8.73i | 11.18i |
| **T2** | 6.67j | 9.27j |
| **T3** | 5.67k | 7.45k |
| **T4** | 13.95e | 17.17e |
| **T5** | 13.02f | 15.77f |
| **T6** | 17.95c | 20.72c |
| **T7** | 15.62d | 18.00d |
| **T8** | 30.38a | 33.00a |
| **T9** | 11.38g | 13.78a |
| **T10** | 9.93h | 12.38h |
| **T11** | 27.95b | 30.43b |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1=** Distilled water
**T2 =** Sucrose (2%)
**T3=** Sucrose (4%)
**T4 =** Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5 =** Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6 =** Sucrose (2%) + Gibbrillic acid (0.001%)
**T7 =** Sucrose (4%) + Gibbrillic acid (0.001%)
**T8=** Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9 =** Sucrose (2%) + Citric acid (150mg/l)
**T10 =** Sucrose (4%) + Citric acid (150mg/l)
**T11=** Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

The effect of the interaction between holding solutions treatments and different cultivars from dendranthema cut flowers is shown in Table (9). Data indicate that the highest number of days for yellowing leaves was obtained by supplemented with ( $T_8$) Suc (2%) + 8-HQC (200 mg/l) + $GA_3$ (0.001%) + CA (150 mg/l) in cv. White Reagan compared with other treatments, in the first and second seasons. The present results are also in accordance with those reported by Jain *et al*, (2014) who mentioned that the maximum number of days taken for yellowing leaves of *Chrysanthemum grandiflora* cv. White Reagan cut flower was recorded in the treatment containing 8-HQC (400ppm) and sucrose (1.5 %) as the holding solution.

**4- Water uptake:**

The effect of the difference between dendranthema cultivars is shown in Table (10) it is clear that *Dendranthema grandiflorum* cv. White Reagan raised the amount of water uptake till the 22th day (492.58 , 601.52) and also, cv. Arctic Queen raised the amount of water uptake till the 22th day (425.45, 478.33) in the first and second season respectively.

Data presented in Table (11) clearly indicate that holding solutions containing of ($T_8$) Suc (2%) + 8-HQC (200 mg/l) + $GA_3$ (0.001 %) + CA (150 mg/l) was the best treatment for increasing water uptake of dendranthema cut flowers till the 30th day in the first and the second season. Meanwhile dendranthema cut flowers with ($T_1$) distilled water increased water uptake till the 15th day in the both season while ($T_3$ and $T_2$) sucrose (4 and 2%) was increased water uptake till the 8th day in the first season and 15th day in the second one.

According to data presented in Table (12) it is obvious that treating *Dendranthema grandiflorum* cv. White Reagan cut flowers with ($T_8$) Suc at (2 %) + 8-HQC (200 mg/l) + $GA_3$ (0.001 %) + CA (150 mg/l) was increased water uptake till the 30th day in the first season and the second season, compared with other treatments. This matches with Kumar (2016) who mentioned that treating chrysanthemum cut flowers with different solutions content of sucrose, citric acid and 8-HQC increasing the flowers water uptake, also Zamani *et al* (2011) showed that sucrose at 3 % , citric acid , malic acid and salicylic acid increasing water uptake in chrysanthemum cut flowers.

**Table 9:** Effect of interaction between different cultivars and holding solutions on number of days from putting flowers in different solutions to yellowing leaves of (*Dendranthema grandiflorum,* Ramat.) cvs. White Reagan and Arctic Queen cut flowers during Seasons 2013 and 2014.

| Holding solutions treatments | Cultivars of *Dendranthema grandiflorum* | | | |
|---|---|---|---|---|
| | 2013 | | 2014 | |
| | White Reagan | Arctic queen | White Reagan | Arctic queen |
| **T1** | 9.80jk | 7.67l | 12.80k | 9.57mn |
| **T2** | 7.43l | 5.90m | 10.87l | 7.67o |
| **T3** | 6.90lm | 4.43n | 8.90n | 6.00p |
| **T4** | 15.00g | 12.90h | 19.00fg | 15.33ij |
| **T5** | 14.23g | 11.80hi | 17.20h | 14.33j |
| **T6** | 18.90e | 17.00f | 23.20e | 18.23gh |
| **T7** | 16.33f | 14.90g | 20.00f | 16.00i |
| **T8** | 33.10a | 27.67c | 35.77a | 30.23c |
| **T9** | 12.77h | 10.00jk | 15.00ij | 12.57k |
| **T10** | 10.90ij | 8.97k | 14.23j | 10.53lm |
| **T11** | 30.00b | 25.90d | 33.20b | 27.67d |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

**Table 10:** Effect of the different cultivars on water uptake (ml/3 flowers) of (*Dendranthema grandiflorum,* Ramat.) cvs. White Reagan and Arctic Queen cut flowers during seasons 2013 and 2014.

| | 1st season 2013 | | | | |
|---|---|---|---|---|---|
| **Cultivars** | **1st** | **8th** | **15th** | **22th** | **30th** |
| **White Reagan** | 38.99a | 267.73a | 449.09a | 492.58a | 356.67a |
| **Arctic queen** | 36.364b | 219.09b | 404.55b | 425.45b | 252.58b |
| | **2nd season 2014** | | | | |
| **Cultivars** | **1st** | **8th** | **15th** | **22th** | **30th** |
| **White Reagan** | 48.333a | 287.88a | 508.33a | 601.52a | 484.24a |
| **Arctic queen** | 42.121b | 234.39b | 441.36b | 478.33b | 263.33b |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**Table 11.** Effect of holding solutions on water uptake (ml / 3flowers) of chrysanthemum (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen cut flowers during seasons 2013 and 2014.

| Holding solutions treatments | 1st season 2013 | | | | | 2nd season 2014 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1st** | **8th** | **15th** | **22th** | **30th** | **1st** | **8th** | **15th** | **22th** | **30th** |
| **T1** | 31.94d | 188.33h | 343.33e | —— | —— | 41.66d | 195.00g | 353.33f | 258.33g | —— |
| **T2** | 28.33e | 166.67i | 103.33f | —— | —— | 38.33e | 182.50g | 277.50g | —— | —— |
| **T3** | 25.83e | 145.00j | —— | —— | —— | 36.67e | 160.0h | 157.50h | —— | —— |
| **T4** | 44.17a | 295.00c | 556.67b | 769.17a-c | 807.50a | 50.83b | 315.83c | 592.50b | 789.17a-c | 875.00a |
| **T5** | 40.00b | 276.67d | 525.83bc | 723.33b-d | 520.00b | 46.67c | 295.83d | 544.17c | 758.33b-d | 575.0b |
| **T6** | 35.83c | 222.50f | 441.67d | 414.17e | —— | 42.50d | 231.67f | 476.67de | 628.33e | 128.33de |
| **T7** | 35.00c | 202.50g | 428.33d | 154.17f | —— | 42.50d | 222.50f | 442.50e | 409.17f | —— |
| **T8** | 46.66a | 363.33a | 645.83a | 841.67a | 924.17a | 54.17a | 358.00a | 684.17a | 863.33a | 970.83a |
| **T9** | 40.83b | 252.50e | 518.33bc | 686.67cd | 224.17c | 45.83c | 282.50d | 531.67c | 711.67cd | 406.67bc |
| **T10** | 40.00b | 232.50f | 503.33c | 651.67d | —— | 45.83c | 258.33e | 518.33cd | 686.67de | 255.00cd |
| **T11** | 45.83a | 327.50b | 628.33a | 808.33a-b | 875.00a | 52.50ab | 343.3b | 645.00a | 834.17ab | 900.83a |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/**l**)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/**l**)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

**Table 12:** Effect of interaction between different cultivars, holding solutions on water uptake (ml / 3 flowers) of (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen cut flowers during Seasons 2013 and 2014.

| Holding solutions treatments | Cultivars of *Dendranthema grandiflorum* 1st season 2013 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | | 8th | | 15th | | 22th | | 30th | |
| | White reagan | Arctic queen | White reagan | Arctic queen | White reagan | Arctic queen | White reagan | Arctic queen | White reagan | Arctic queen |
| T1 | 33.89f | 30.00g | 223.33ij | 153.33m | 366.67ij | 320.00j | —— | —— | —— | —— |
| T2 | 30.00g | 26.67g | 205.00k | 128.33n | 206.67k | —— | —— | —— | —— | —— |
| T3 | 30.00g | 21.67h | 180.00l | 110.00o | —— | —— | —— | —— | —— | —— |
| T4 | 45.00bc | 43.33b-d | 316.67c | 273.33e | 573.33bc | 540.00cd | 785.00a-c | 753.33a-d | 823.33a | 791.67a |
| T5 | 40.00de | 40.00de | 296.67d | 256.67fg | 541.67cd | 510.00c-e | 743.33a-d | 703.33b-d | 783.33a | 256.67b |
| T6 | 36.67ef | 35.00f | 246.67gh | 198.33k | 456.67e-h | 426.67g-i | 518.33e | 310.00f | —— | —— |
| T7 | 35.00f | 35.00f | 231.67hi | 173.33l | 440.00f-h | 416.67hi | 308.33f | —— | —— | —— |
| T8 | 50.00a | 43.33b-d | 383.33a | 353.33b | 661.67a | 630.00ab | 853.33a | 830.00ab | 948.33a | 900.00a |
| T9 | 41.67cd | 40.00de | 270.00ef | 235.00hi | 533.33cd | 503.33d-f | 706.67b-d | 666.67cd | 448.33b | —— |
| T10 | 40.00de | 40.00de | 253.33g | 211.67jk | 516.67c-e | 490.00d-g | 683.33cd | 620.00de | —— | —— |
| T11 | 43.37ab | 45.00bc | 338.33b | 316.67c | 643.33a | 613.33ab | 820.00ab | 796.67a-c | 920.00a | 830.00a |
| | 2nd season 2014 | | | | | | | | | |
| T1 | 43.33c-e | 40.00ef | 228.33hi | 161.67l | 375.00kl | 331.67l | 516.67i | —— | —— | —— |
| T2 | 40.00ef | 36.67fg | 221.67h-j | 143.33lm | 348.33l | 206.67m | —— | —— | —— | —— |
| T3 | 40.00ef | 33.33g | 195.00k | 125.00m | 315.00l | —— | —— | —— | —— | —— |
| T4 | 55.00a | 46.67bc | 348.33b | 283.33de | 606.67b-d | 578.33c-e | 818.33a-d | 760.00b-f | 913.33a | 836.67a |
| T5 | 50.00b | 43.33c-e | 321.67c | 270.00ef | 565.00d-f | 523.33e-h | 783.33a-e | 733.33c-g | 890.00a | 260.00bc |
| T6 | 45.00cd | 40.00ef | 251.67fg | 211.67i-k | 495.00g-j | 458.33h-j | 666.67f-h | 590.00hi | 256.67bc | —— |
| T7 | 45.00cd | 40.00ef | 243.33gh | 201.67jk | 448.33ij | 436.67jk | 635.00gh | 183.33j | —— | —— |
| T8 | 58.33a | 50.00b | 406.67a | 363.33b | 705.00a | 663.33ab | 886.67a | 840.00a-c | 995.00a | 946.67a |
| T9 | 50.00b | 41.67de | 296.67d | 268.33ef | 550.00d-g | 513.33e-i | 733.33c-g | 690.00e-H | 813.33a | —— |
| T10 | 50.00b | 41.67de | 286.67de | 230.00g-i | 528.33e-g | 508.33f-i | 710.00d-G | 663.33f-H | 510.00b | —— |
| T11 | 55.00a | 50.00b | 366.67b | 320.00c | 655.00ab | 635.00bc | 866.67ab | 801.67a-e | 948.33a | 853.33a |

Means within column having the same letters are not significantly different according to Ducan's multiple range test

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

## Total carbohydrates %:

Data presented in Fig.(1) illustrated that the carbohydrates % increased in *Dendranthema grandiflorum* cv White Reagan , compared to cv Arctic Queen (in leaves and petals) in both seasons.

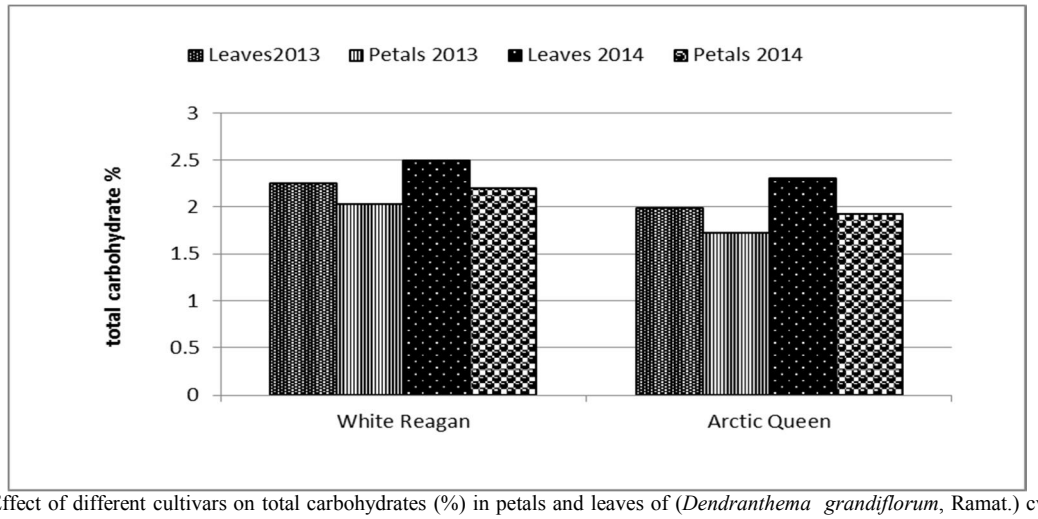



**Fig. 1:** Effect of different cultivars on total carbohydrates (%) in petals and leaves of (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen during seasons 2013 and 2014

Regarding the effect of holding solutions, it was concluded from data in Fig. (2) That, the dendranthema cut flowers treated with ( $T_3$ and $T_2$ ) Suc (4 and 2%) and($T_1$) distilled water had the least values of the carbohydrates % compared to all the other treatments used in the first and second

seasons. The highest values of the carbohydrates % were found in the dendranthema cut flowers treated with ( $T_8$) Suc (2%) + 8-HQC (200mg/l) + $GA_3$ (0.001%) + CA (150 mg/l) followed by cut flowers treated with ($T_{11}$) Suc at (4%) + 8-HQC (200mg/l) + $GA_3$ (0.001%) + CA (150mg/l) as compared to other treatments used in the first and second seasons.

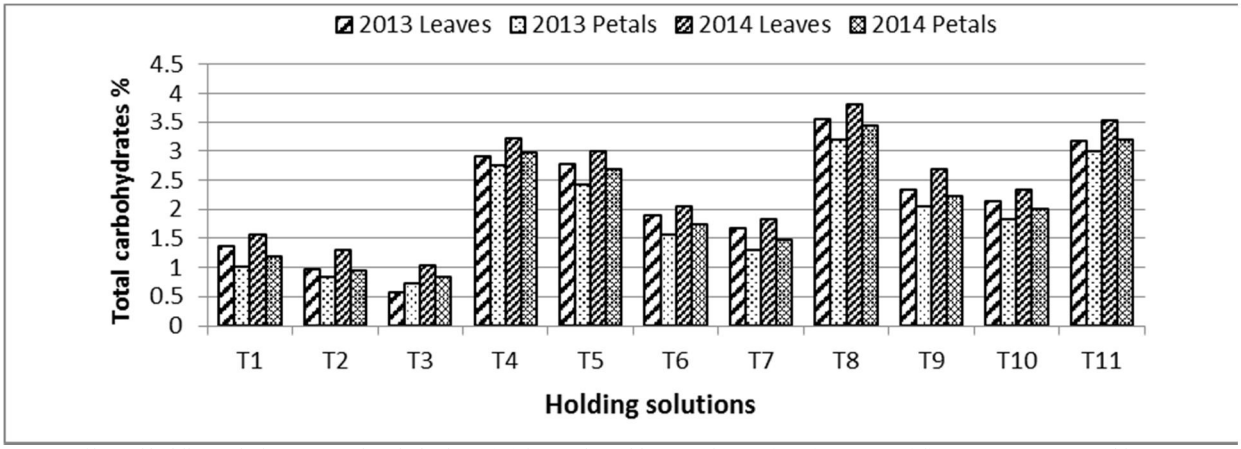



**Fig. 2:** Effect of holding solutions on total carbohydrate (%) in petals and leaves of (*Dendranthema grandiflorum*, Ramat) cvs. White Reagan and Arctic Queen during seasons 2013 and 2014.

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l)
**T6** = Sucrose (2%) + Gibbrillic acid (0.001%)
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10** = Sucrose (4%) + Citric acid (150mg/l)
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

The interaction between holding solutions treatments and different cultivars from dendranthema cut flowers as shown in fig (3) and fig (4), which indicate that *Dendranthema grandiflorum* cv White Reagan held in solution containing ($T_8$) Suc (2%) + 8-HQC (200mg/l) + $GA_3$ (0.001%) + CA (150mg/l) were the best for obtaining the highest carbohydrates % as compared to the other treatments. The previous results are in agreement with Hwang *et al*, (2009) on *Lilium oriental* hybride "Casa Blanca" he found that the holding solution containing (3%) Sucrose + (200mg/l) HQC +(25 mg/l) $GA_3$ maintained high levels of total sugar for a long time as compared with the control.

Amin (2017) mentioned that the maximum content in total soluble sugar for chrysanthemum cut flowers cv. Arctic Queen when treated with combination of (Sucrose + Citric acid), also Su *et al,* (1991) reported in chrysanthemum cut flowers treated with (5%) Sucrose + (150ppm) Citric acid + (50 ppm) $AgNo_3$ increased the soluble sugar content in the petal.

**Chlorophyll content (mg/g):**

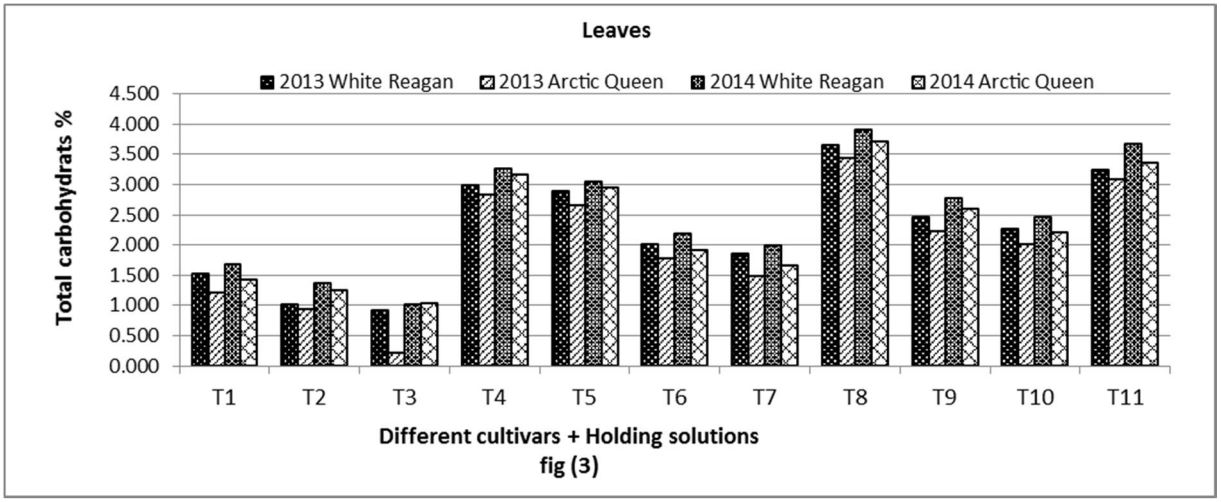
Data presented in Fig. (5) Indicate that *Dendranthema grandiflorum* cv White Reagan gave higher values of chlorophyll content than *Chrysanthemum grandiflorum* cv Arctic queen.

Data illustrated in Fig.(6) show that the treatment with ($T_3$ and $T_2$) Suc (4 , 2%) and ($T_1$) distilled water gave the least values of chlorophyll content (mg/g) in the leaves of dendranthema cut flowers compared to other treatments in both seasons. However, treated flowers with ($T_8$) Suc (2%) + 8-HQC (200mg/l) + $GA_3$ (0.001%) + CA (150 mg/l) recorded the highest values of chlorophyll content (mg/g) followed by treating with ($T_{11}$) Suc (4%) + 8-HQC (200mg/l) + $GA_3$ (0.001%) + CA (150mg/l) in both seasons.

Data in Fig. (7,8 and 9) showed that the *Dendranthema grandiflorum* cv White Reagan cut floweres treated with ($T_8$) Suc (2%) + 8-HQC (200mg/l) + GA3 (0.001%) + CA (150mg/l) gaves the highest value of chlorophyll content (mg/g) in leaves compared with all other treatments, in the two seasons.

These results are in accordance with those of Gendy (2000) who indicate that Gladiolus cut flowers treated with holding solutions containing Sucrose (10%) + 8-HQ (200ppm)+ Citric acid (150ppm) was most effective for increasing chlorophyll content when compared to the other treatment. Emami *et al*, (2011) mentioned that the highest chlorophyll a content was related to

Gibberllic acid at (75 ppm) in (*Lilium longiflorum*) cut flowers. Also, Osman and Sewedan (2014) showed that application of (200) $GA_3$ induced a significantly increased in the total chlorophyll of *Solidago Canadensis*" Tara".



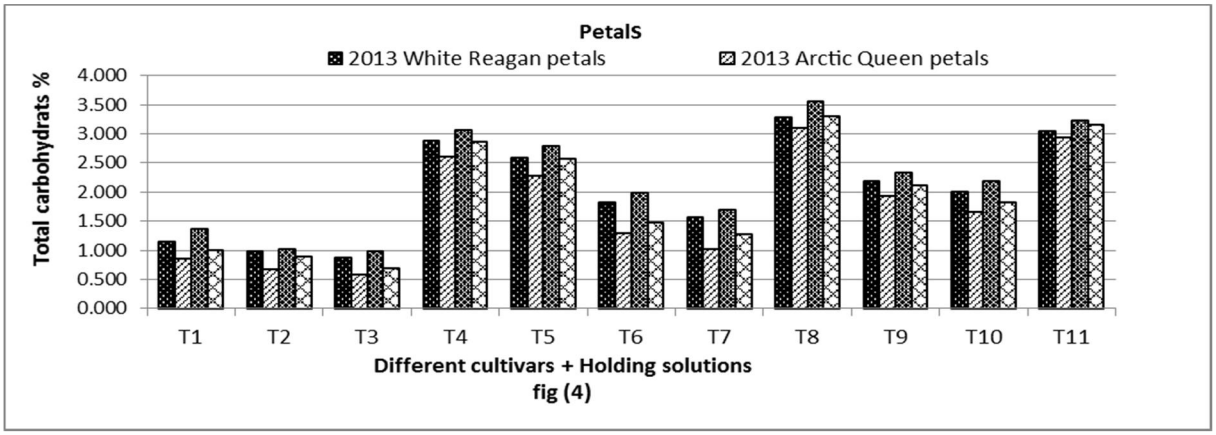




**Fig. 3, 4:** Effect of interaction between different cultivars, holding solution on carbohydrate (%)in petals and leaves on *(Dendesranthema grandiflorum*, Ramat.)cvs. White Reagan and Arctic Queen during seasons 2013 and 2014.

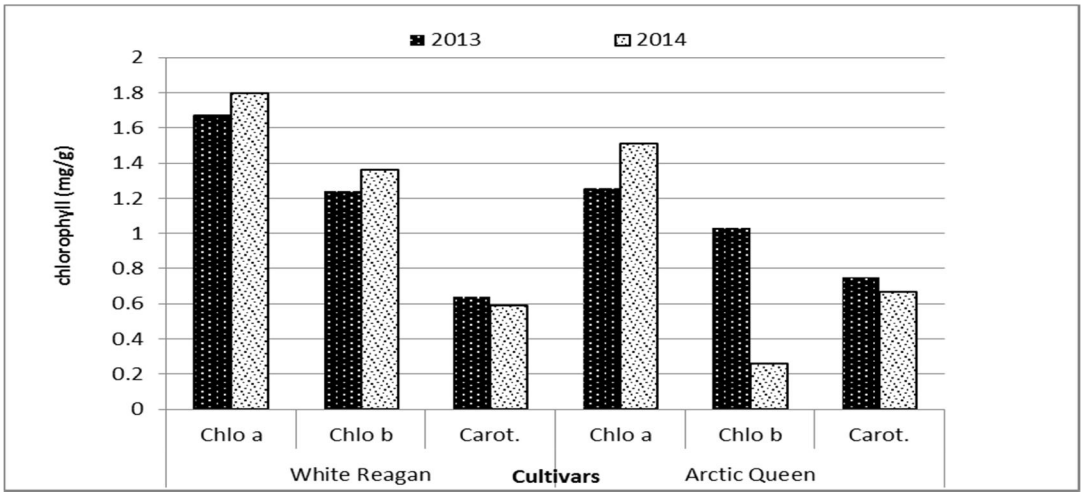



**Fig. 5:** Effect of different cultivarse on chlorophyll content (mg/g) in leaves of (*Dendranthema grandiflorum*, Ramat.) cvs. White Reagan and Arctic Queen during seasons 2013 and 2014.

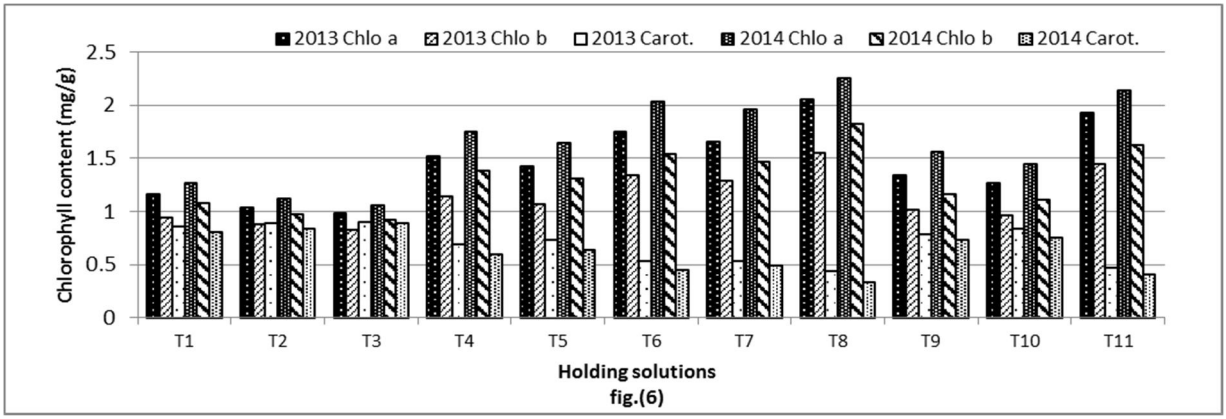
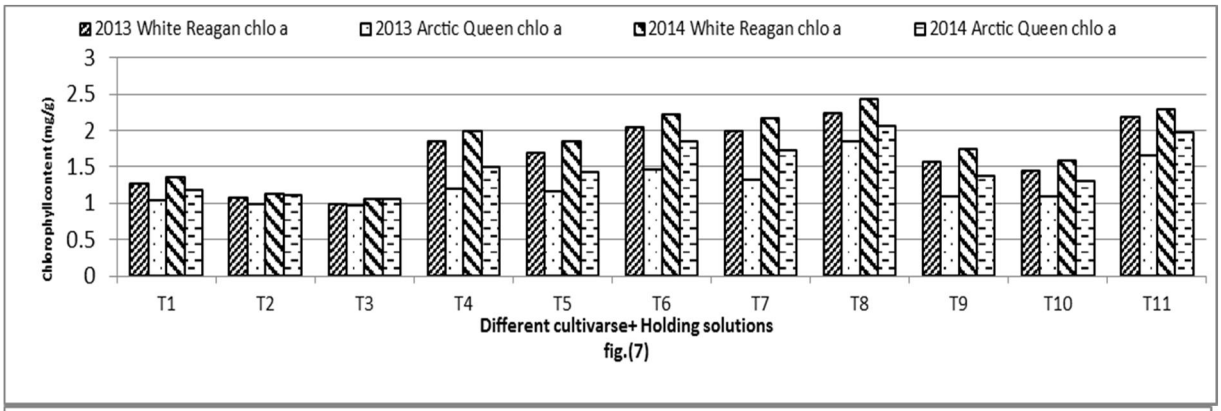
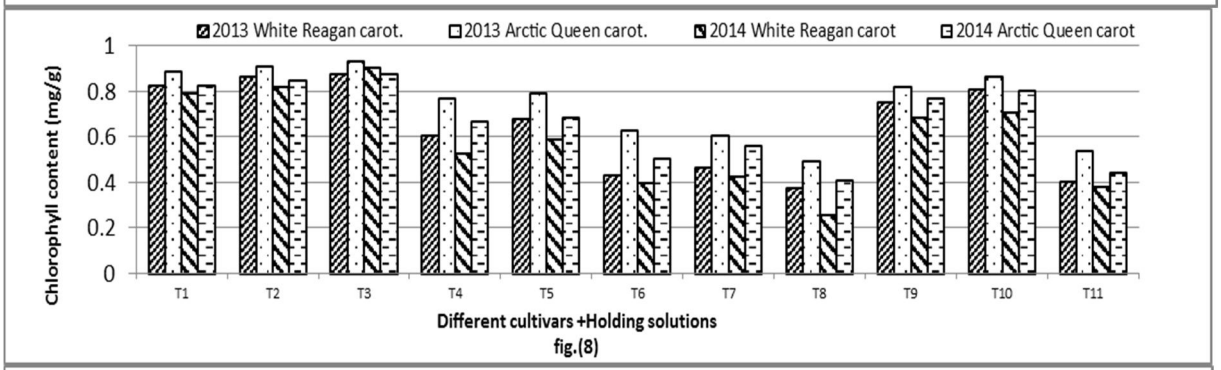



**Fig. 6:** Effect of holding solutions on chlorophyll content (mg/g) in leaves of (*Dendranthema grandiflorum,* Ramat) cvs White Reagan and Arctic Queen during seasons 2013 and 2014.



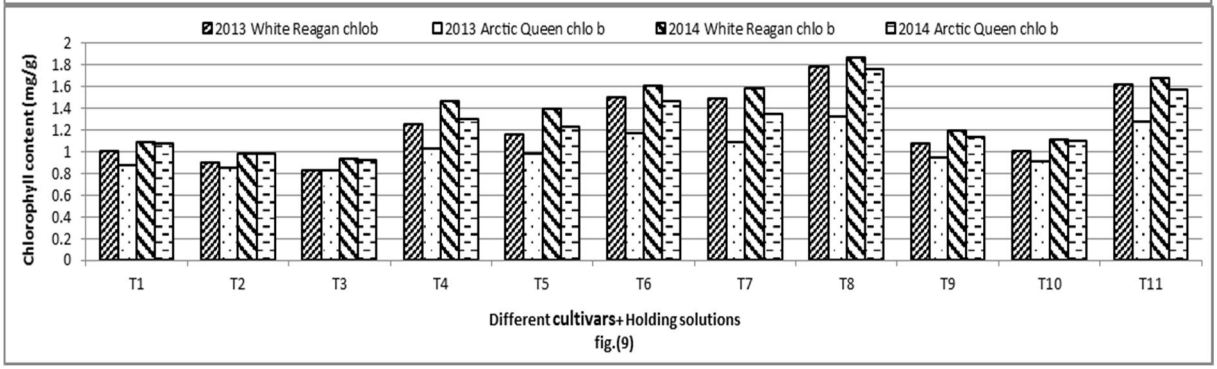




**Fig.7, 8 and 9:** Effect of interaction between different cultivars, holding solutions on chlorophyll content (mg/g) in leaves on *(Dendesranthema grandiflorum*, Ramat.)cvs. White Reagan and Arctic Queen during seasons 2013 and 2014

**T1**= Distilled water
**T2** = Sucrose (2%)
**T3**= Sucrose (4%)
**T4** = Sucrose (2%) + 8-Hydroxyqunoline citrate (200mg/l)
**T5** = Sucrose (4%) + 8-Hydroxyqunoline citrate (200 mg/l**)**
**T6** = Sucrose (2%) + Gibbrillic acid (0.001**%)**
**T7** = Sucrose (4%) + Gibbrillic acid (0.001%)
**T8**= Sucrose (2%) + 8-Hydroxyqunoline citrate( 200mg/l) + Gibbrillic acid( 0.001%) + Citric acid (150mg/l)
**T9** = Sucrose (2%) + Citric acid (150mg/l)
**T10 = Sucrose (4%) + Citric acid (150mg/l)**
**T11**= Sucrose (4% )+ 8-Hydroxyqunoline citrate (200mg/l) + Gibbrillic acid (0.001%) + Citric acid (150mg/l)

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