Post-Harvest Physiology of Cut Flowers of Sunflowers 'Sunrich Orange' (*Helianthus annuus*): First Experimental Results

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Abstract

Sunflower, as a cut flower species, has been holding for several years a growing economic importance on Italian markets and internationally. The data existing in the literature concerning the senescence physiology of cut sunflowers are still scanty. Vase life with commercial preservative products is estimated around 8 days with a variability within the different cultivars ranging between 5.3 and 14.7 days. From the experimentation here carried out, the importance of using preservative solutions based on surfactants (Irol) has arisen, entailing a life increase of cut flowers of about 30% compared with the use of only deionized water. Furthermore, a trial was made to verify the possibility of using 1-methylcyclopropene (Ethylbloc®) to prolong the vase life of cut flowers of sunflower. The first data collected show that 1-MCP seems to have a limited efficacy in the delay of senescence, however not to the same extent of what is already known for other flower species. Of a particular interest is the anticipated harvest of the flower stems of even 3-4 days, since it is possible to obtain a complete flower opening after about three days of vase life. Pulsing, even if on the one hand may give intermediate results in the improvement of qualitative parameters of cut flowers, on the other hand it carries on a considerably interesting action in increasing the fresh weight of the leaves.

INTRODUCTION

The senescence of cut flowers is a complex process entailing peculiar morpho-physiological modifications in each plant species, raising the need of carrying out aimed and thorough research, sometimes referring to single cultivars. In the flower sector, a growing importance is being given in the last years to sunflower both as a cut flower and in view of a flower pot use, with the aim of a more and more diversified productive offer. *Helianthus annuus* is a species belonging to the family *Asteraceae* and is characterized by a considerable decorativity, as production of heads varying in the different cultivars by size and colour of the flower, from cream to yellow as far as deep brown. Very recent selections differ for single or double flowers, besides for petals marked by the contemporaneous presence of two colours.

The stalk may bear one or more scentless flowers. The first employment of sunflower with an ornamental scope dates back to the XVIth century, anticipating by far the industrial use of this plant (oil, flour, fodder). Its large-scale cultivation, as a cut flower, began in the 90s, thanks above all to the creation of hybrids apt to glasshouse growth (Armitage, 1993). Sunflower holds presently a growing economic importance, so that on the market of Dutch flower auctions it passed, from 1994 to 2000, from the 35th to the 18th rank, respectively (43 million stalks sold). In Liguria (Italy) the yearly production is around 30-40,000 flower stalks (Gimelli, 2002).

Concerning the post-harvest physiology of cut sunflowers, in the literature there are still rather scanty data referring to cultivars not always of interest for cultivation in Italy. According to Han (2000), the harvest of sunflowers must be carried out when the flowers are almost completely open. The immediate rehydration of the flowers represents the key of the success of post-harvest life of this species, that is currently available the

whole year round (Holstead, 1993). Some authors do not consider necessary to use preservative solutions for sunflower, keeping as a must only a rapid rehydration (Pabst, 1993). The effects of using preservative solutions, including or not STS, were tested on different sunflower cultivars with results generally satisfying, with the only exception of the cv. 'Sunbright' (Gast, 1997). Adding water with HQC, together with STS, determines a vase life increase compared with the control in water (Redman and Dole, 1994). Vase life with commercial preservative substances was estimated averagely around 8.5 days (Stevens et al., 1993) with a variability between the different cultivars ranging from 5.3 to 14.7 days. In particular, for 'Sunrich Orange' a vase life length of 11.9 days was observed (Gast, 1995). It is known that a pulsing treatment of one hour with a non ionic detergent (Triton X-100) at 0.01% before storage or transporting, improves significantly water absorption and the following vase life. Pulsing increasing the uptake of the solution during the hour of treatment increasing significantly water uptake after dry storage (Jones et al., 1993).

As far as leaves are concerned, the senescence of basal leaves in sunflowers begins already before anthesis (Rousseaux et al., 2000). In the case of the cv. 'Golden glory' it was observed how the leaves become rapidly brownish, within two days, after keeping the stalks in commercial preservative solutions (Gast, 2002).

MATERIAL AND METHODS

Two experiments were carried out on cut flowers of *Helianthus annuus* 'Sunrich Orange' in the months of September-October 2002 and July 2003 in the laboratories of the Department of Agronomy, Forest and Land Management of the University of Turin to evaluate the efficacy on vase life and on leaf senescence of different preservative solutions and pulsing treatments. Furthermore, it was evaluated the possibility to harvest the flowers 3-4 days before of the optimal commercial moment, maintaining post-harvest flower quality (bud opening). Cut stalks of the sunflower cv. 'Sunrich Orange', grown continuously throughout the whole year in a greenhouse at San Lorenzo al mare (Imperia - Italy) were harvested in the morning, kept dry, packed in cellophane and immediately transported to the laboratories to start the experimentation. At their arrival the stalks were selected according to disc size and total weight and one basal centimetre was cut off in water before starting the vase life phase. For each treatment ten repetitions were made.

On the grounds of data collected in previous tests, in both trials the preservative solutions listed in table 1 were used with the addition in the formulation of a wetting agent "Irol®" (*Aromatic Polyglycolether*) at different concentrations, besides pulsing treatments for 24 hours, then the flowers were put in vases with deionized water. Treatments were compared with a control, represented by deionized water. Moreover, it was carried out another trial in order to harvest beforehand the flower stalks, about 3-4 days in advance of the optimal commercial moment, represented by the almost complete opening of the disc. The buds, hardly showing the colour of the outer ligulate flowers, were submitted to the same treatments foreseen for flowers collected in the normal opening stage. Furthermore, 6 leaves cut off the stalk and placed singly inside test-tubes were submitted to the same experimental treatments as the flower stalks for an evaluation of desiccation and decorativity loss.

During the vase life, parameters such as fresh weight, flower diameter and longevity were taken into consideration. Of the leaves cut off and kept singularly in test-tubes the fresh weight and the decorativity loss was considered adopting an evaluation scale of the damage divided into 6 classes (0 = integral and healthy leaf; 1 = slight alterations/desiccations; 2 = medium alterations/desiccations; 3 = pronounced desiccations; 4 = vast desiccations; 5 = completely compromised/desiccated leaf).

Finally, a second trial was made to verify the possibility of using 1- Methylcyclopropene (Ethylbloc®) on cut flowers of sunflower, together with the different preservative solutions and with Pulsing technique (Table 1). Ten repetitions were carried out for each treatment. The flowers were submitted to the treatment with 1-MCP (0,98 µg/l) for 12 hours, inside about 50 litre volume plastic bags at room

temperature. Also in this case we proceeded to evaluate the parameters such as fresh weight of the flowers, flower diameter and longevity.

The data concerning the longevity of flowers were submitted to the analysis of variance and to Duncan's Test.

RESULTS AND DISCUSSION

In Table 1 the results are shown regarding longevity of the flower, using different preservative solutions and pulsing treatment. In the first experiment vase life was 10.8 days for treatments no. 1 and 5 and 11.0 days for treatment no. 2, that were significantly higher than all pulsing treatments and the control. Longevity values resulted comparable or slightly higher than those reported in the literature for trials conducted with commercial products (Gast, 1995).

Concerning fresh weight increase of the flowers was recorded (Fig. 1) that, in terms of percentage change from the beginning of the test, was of over 20% towards the seventh day of vase life in treatments n° 2, 4, 5 and 1. This datum appears particularly meaningful if compared with the control that after 7 days of vase life showed an initial weight decrease, with negative values of over 10% from the ninth day onwards. In the same way, unsatisfying results, as far as flower weight is concerned, and their hydration as a consequence, were obtained from the treatments n° 8 and 9 (pulsing) at the highest doses of wetting agent (Fig. 1). The highest concentration of Irol did not carry on in sunflowers a favourable action on the water absorption. The pulsing treatment n° 7, characterized by a lower dose of wetting agent (0.5 ml/l) showed a favourable effect on water uptake until the fifth day and then manifesting a sudden decrease of fresh weight.

Solution n° 5, as well as the solutions n° 4 and 6, (all three of them made of 50 mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose), carried out an efficient action in keeping flower opening during the vase life, permitting the discs to reach a diameter of 15% greater than that of the beginning on the eighth day of vase life. Referring to the anticipated harvest of sunflower stalks *(*bud opening), it was possible to verify that the flower buds reached after three - to four days of vase life a diameter similar to that of the flowers harvested at the traditional opening stage. The employment of the preservative solutions n° 2 and 5 was favourable also for buds helping flower opening (Fig. 2). Concerning fresh weight changes, the solutions n^{o} 2, 5 and 4, also in the case of bud opening, permitted to reach remarkable weight percentage increases of over 30% with respect to the beginning in all three solutions after the 9th day of vase life (Fig. 3).

With reference to the fresh weight of single leaves kept in test-tubes, it was possible to verify that the best results were gained using only deionized water or pulsing treatments (Fig. 4). The worst results were obtained with the solution n^{o} 3 made of Irol at 5 ml/l that determined an immediate weight loss already since the first day of vase life, reaching a negative value of over 30% eight days later.

Analogously, examining the desiccation of the 5 leaves beneath the disc, it was possible to check a very negative action of treatments n° 3 and 6, both characterized by a higher dose of Irol (5 ml/l), that determined the withering and necrosis of all leaves after only 5 days of vase life. In the other treatments, a certain favourable action on the preservation of leaves was seen in water and in the pulsing treatment n° 7, at least in the first 5–6 days of vase life (Fig. 5).

As far as 1-MCP is concerned, the best results in terms of flower fresh weight increase (Fig. 6) were obtained by using the solutions n° 2 and 1 that kept the weight stationary, after an initial increase of about 50% of the starting weight, until the eleventh day. Meaningful increases, close to 50% have been recorded also in the case of using the solutions n° 3 and 4, that did not permit, as in the case of the above mentioned solution, a stabilization of the fresh weight, with decreases occurring already since the fifth day. In this case the use of MCP did not lead to point out particular differences. The use of the pulsing technique did not show to be particularly efficacious to improve vase life parameters. In the case of the control there was a swift decrease of the flower fresh weight, already starting from the fourth day. Concerning flower longevity (Table 1), we

had a value significantly higher of 10.8 days in the case of the treatment n° 4 (+MCP), compared with the control without MCP (7.9 days) and with deionized water added with MCP (8.3 days).

From these preliminary results one sees the importance of using preservative solutions, that permit an increase of cut flower life of about 30% compared with only deionized water. The use of preservative solutions made of 25 mg $AgNO_3$ + 50 mg/l $Al_2(SO_4)_3$ + 30 g/l sucrose and 50 mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose with the addition of a wetting agent at the lower doses of 0.5–1 ml/l can assure longevity values and an overall flower quality comparable with what is reported in the literature referring to commercial preservative products.

Of a particular interest is the anticipated harvest of the flower stalk of even 3-4 days, since it is possible to reach a complete opening of the flower after about three days of vase life. Such a harvest strategy shows advantages connected to a reduction of cultivation times, a quicker harvest, a greater ease of handling and preservation in warehouses, besides an easier packing and transportation. The employment of pulsing, referring to the solution n° 7, made of 70 g/l sucrose + 100 mg/l citric acid added with 0.5 ml/l Irol, if on the one hand it gives intermediate results in the improvement of qualitative parameters of cut flowers, on the other hand it can carry on an action of a certain interest in limiting leaf alterations and desiccations.

The first data collected show that using 1-MCP seems to have a limited efficacy with the same preservative solution in the delay of senescence and not to the same extent of what is already known for other flower species. Further tests are necessary to outline more precisely the actual possibility of using MCP on sunflower.

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Tables

Table 1. Average longevity of cut sunflowers during the first and second experiment. *The numbers followed by the same letter do not show differences statistically significant according to Duncan's test (P< 0.05).

N°	First experiment		Vase life (days)
1	Preservative solution	0.5 ml/l IROL + 25 mg/l $AgNO_3$ + 50 mg/l $Al_2(SO_4)_3$ + 30 g/l sucrose	10.8 a*
2	Preservative solution	1 ml/l IROL + 25 mg/l $AgNO_3$ + 50 mg/l $Al_2(SO_4)_3$ + 30 g/l sucrose	11.0 a
3	Preservative solution	5 ml/l IROL + 25 mg/l $AgNO_3$ + 50 mg/l $Al_2(SO_4)_3$ + 30 g/l sucrose	9.8 ab
4	Preservative solution	0.5 ml/l IROL + 50mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose	9.8 ab
5	Preservative solution	1 ml/l IROL + 50 mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose	10.8 a
6	Preservative solution	5 ml/l IROL + 50 mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose	10.0 ab
7	Pulsing 24 h	0.5 ml/l IROL + 70 g/l sucrose + 100 mg/l citric acid	9.0 bc
8	Pulsing 24 h	1 ml/l IROL + 70 g/l sucrose + 100 mg/l citric acid	8.3 c
9	Pulsing 24 h	5 ml/l IROL + 70 g/l sucrose + 100 mg/l citric acid	8.8 bc
10	Control	Deionized water	7.8 c

N°	Second experiment		Vase life (days)
1	Preservative solution	0.5 ml/l IROL + 25 mg/l $AgNO_3$ + 50 mg/l $Al_2(SO_4)_3$ + 30 g/l sucrose	8.7 ab*
2	Preservative solution + MCP 12 h	0.5 ml/l IROL + 25 mg/l $AgNO_3$ + 50 mg/l $Al_2(SO_4)_3$ + 30 g/l sucrose	9.9 ab
3	Preservative solution	0.5 ml/l IROL + 50 mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose	8.9 ab
4	Preservative solution + MCP 12 h	0.5 ml/l IROL + 50 mg/l $AgNO_3$ + 8-HQS 300 mg/l + 20 g/l sucrose	10.8 a
5	Pulsing 12 h	0.5 ml/l IROL + 70 g/l sucrose+ 100 mg/l citric acid	8.7 ab
6	Pulsing 12 h + MCP 12 h	0.5 ml/l IROL + 70 g/l sucrose+ 100 mg/l citric acid	8.8 ab
7	Control	Deionized water	7.9 b
8	Control + MCP 12 h	Deionized water	8.3 b

Figures

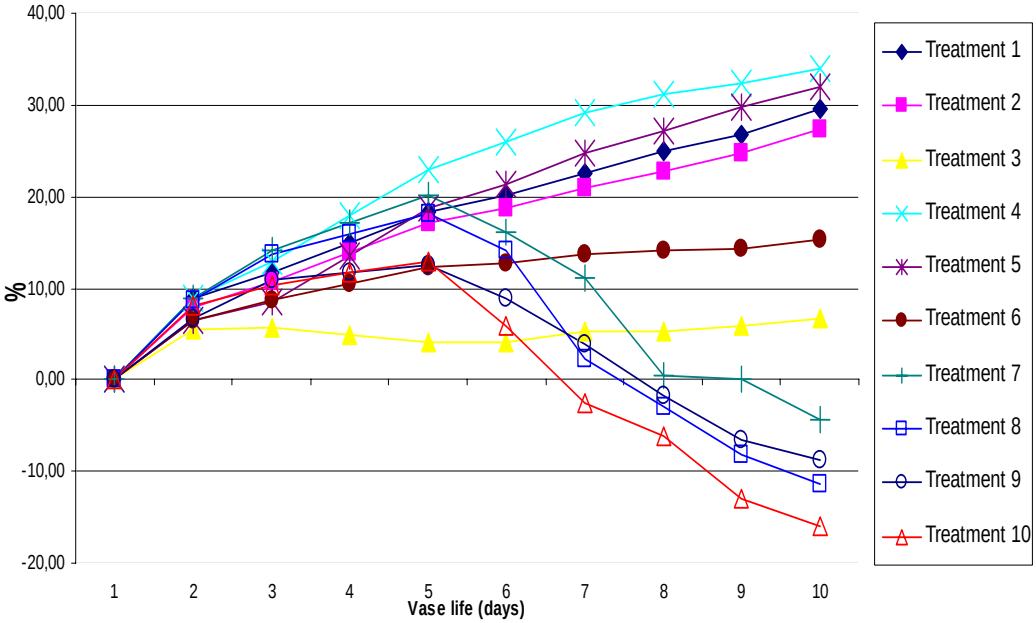

Fig. 1. Variation of increment weight change percentage during vase life of cut flowers of *Helianthus annuus* (First experiment).

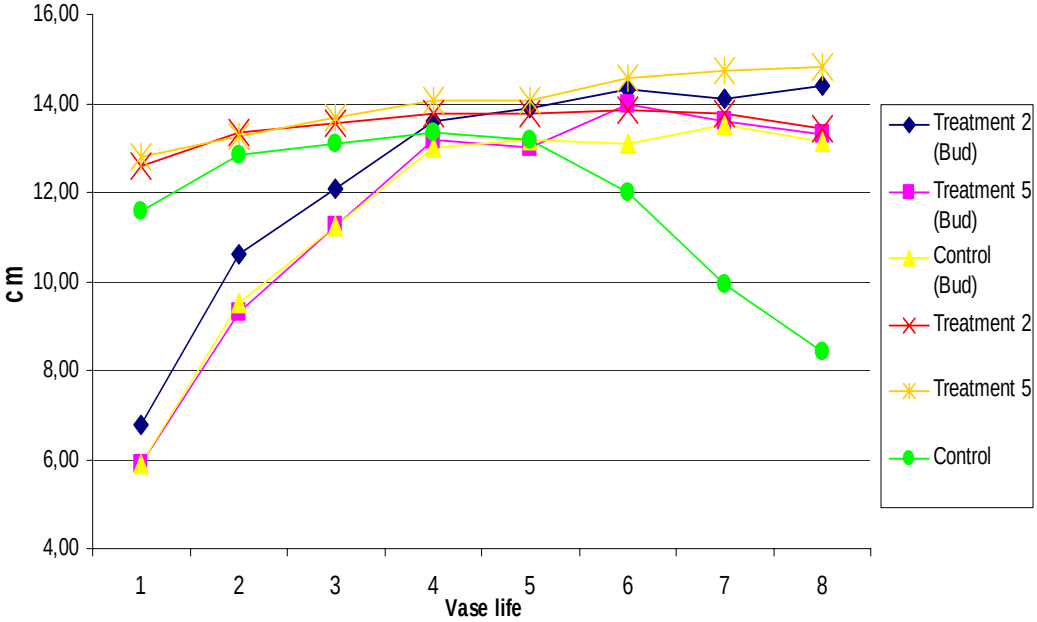

Fig. 2. Diameter change of the flowers harvested in standard opening and in bud stage, using during the vase life preservative solution n° 2 and 5 and deionised water (control).

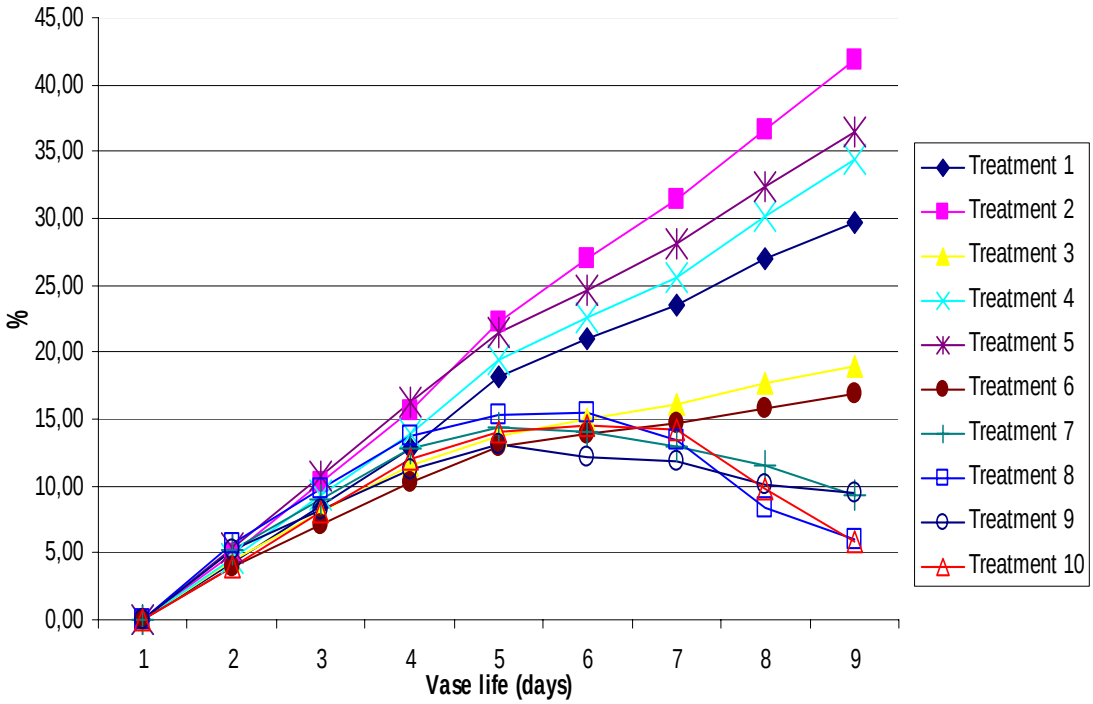

Fig. 3. Variation of increment weight change percentage during vase life of sunflower stems harvested in flower bud stage.

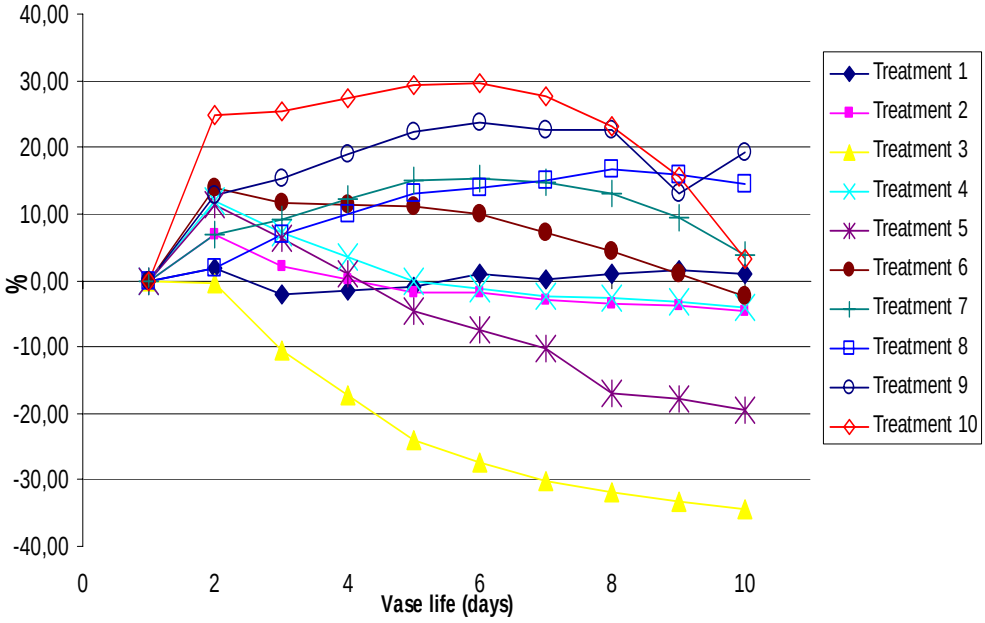

Fig. 4. Variation of increment weight change percentage during vase life of detached sunflower leaves.

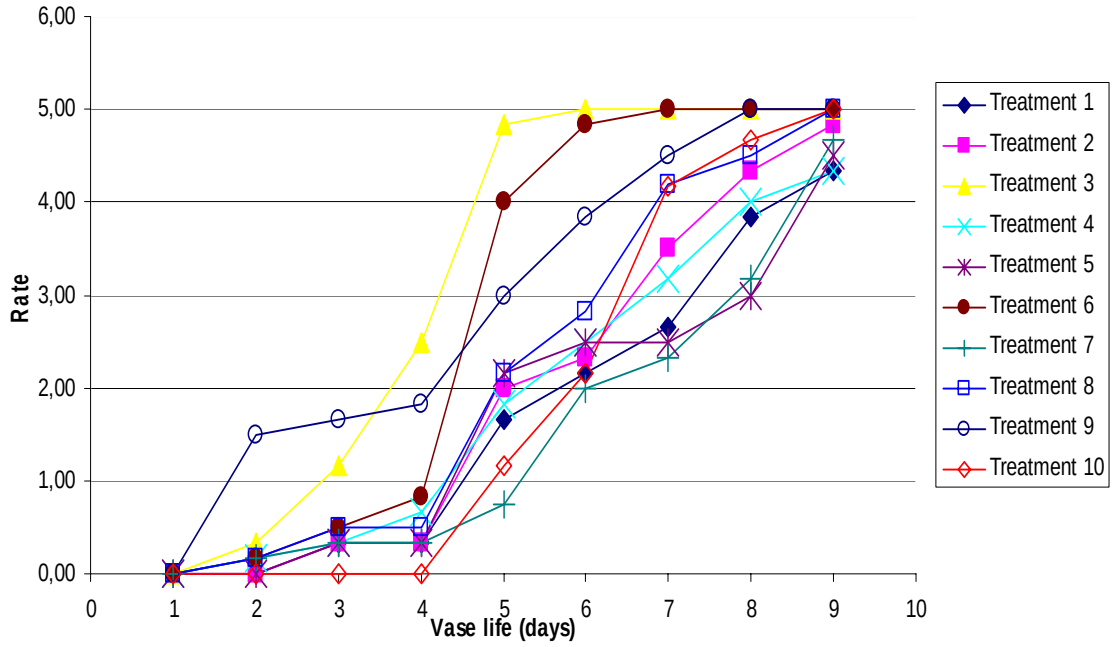

Fig. 5. Progression in foliar desiccation during vase life (Scale of the damage: 0 = integral and healthy leaf; 1 = slight alterations/desiccations; 2 = medium alterations/desiccations; 3=pronounced desiccations; 4= vast desiccations; 5 = completely compromised/desiccated leaf).

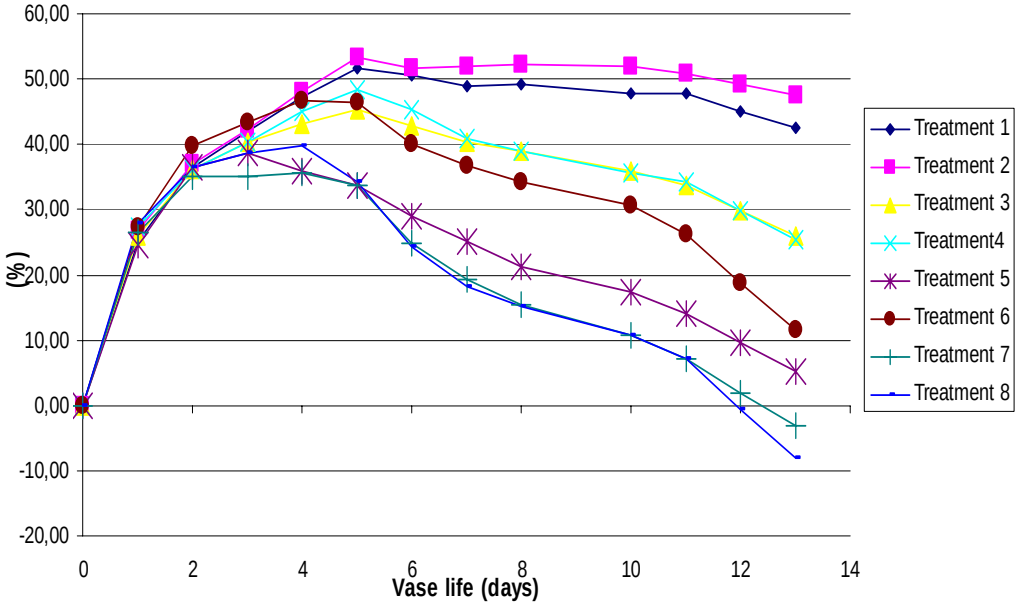

Fig. 6. Variation of increment weight change percentage during vase life of cut flowers of *Helianthus annuus* (Second experiment).