Effect of thidiazuron (TDZ) on delaying leaf yellowing during dry storage and postharvest quality of cut chrysanthemum (*Dendranthema grandiflora* Tzvelve) cultivars Solan Shringar and Yellow Star

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ABSTRACT

The investigations on postharvest handling of chrysanthemum (*Dendranthema grandiflora* Tzvelve) culivars Solan Shringar and Yellow Star were carried out at the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. Studies included the effect of TDZ on reduction of leaf yellowing in dry storage of selected cultivars. Experiments were conducted in a completely randomized design (factorial). Effect of foliar spray of thiadiazuron on cut foliage successfully retained the green colour and showed maximum vase life and appearance when treated with TDZ (150 µM) and dry stored at 4ºC for 5 days than those stored for longer durations. In general, better postharvest longevity was observed in cultivar Yellow Star than Solan Shringar.

Keywords: Chrysanthemum; thidiazuron; Solan Shringar; Yellow Star; leaf yellowing; dry storage

INTRODUCTION

Chrysanthemum (*Dendrenthama grandiflora* Tzvelve) is one of the most popular commercial flower crops being cultivated throughout the world. In India, chrysanthemum is being grown as cut flower, loose flower and potted plant besides being used as border plant in the gardens and landscaping. Owing to its easy cultivation practices and wider adaptability, it is grown extensively for natural season flowering during autumn and winter. However, by controlling the photoperiodic conditions and use of growth regulating chemicals, chrysanthemum can now be produced at any time during the year (Larson 1980).

Due to the lack of knowledge on postharvest management of cut flowers, estimated losses of more than 30-35 per cent have been pointed out by Joshi et al (2003). Postharvest losses in cut flowers of chrysanthemum result to a large extent from improper handling of flowers after harvesting or during transportation. Keeping quality is an important parameter for evaluation of cut flowers quality for both domestic and export markets. Addition of chemical preservatives is required to prolong the vase life of cut flowers.

Standard chrysanthemums are generally harvested when outer petals are fully elongated which often pose many problems as fully opened flowers are difficult to pack and transport. Harvesting flowers at appropriate stage maximize the vase life; however, harvesting at bud stage is often an advantage as buds are easier to handle and less susceptible to adverse environmental conditions. A quality cut flower must be able to withstand storage (cold or warm). Low temperature is recognized as most important factor in successful storage of cut flowers by reducing both plant metabolic processes and microbial growth rate (van Doorn and de Witte 1991). In cut stems of chrysanthemums, quality is not only assessed by the vase life of flower head but quality of foliage is equally important. Most of the varieties show initiation of leaf yellowing before the senescence of flower starts. The yellow foliage renders the cut stem unpresentable even when the flowers are still fresh thus reducing its vase

life. This problem becomes more severe during storage. Some treatments should, therefore, be formulated to delay the leaf yellowing in chrysanthemums during storage so that vase life could be improved.

MATERIAL and METHODS

The cut flower stems were harvested when outer petals were fully elongated. The foliage of the cut stems was sprayed with different concentrations of thidiazuron (TDZ). The treated cut flower stems were wrapped in cellophane sheets in bunches of five. The packed flowers were transferred to cold chamber and dry stored at 4°C for different durations (5, 10 and 15 days). They were observed regularly for any colour change of leaves during storage. For observation of colour change, Royal Horticultural Society Colour Chart (Anon 1966) was used. The effect of TDZ on leaf yellowing during dry storage was studied by putting stored cut stems in distilled water. In the experiment two cultivars namely Solan Shringar and Yellow Star, four different treatments of TDZ viz T_1: Control, T_2: TDZ 50 µM, T_3: TDZ 100 µM and T_4: TDZ 150 µM and different storage durations and conditions viz 5, 10 and 15 days and dry storage at 4ºC in cool chamber were used.

RESULTS and DISCUSSION

Data pertaining to parameter days taken to initiation and complete leaf yellowing show that foliar spray of TDZ at all the concentrations was effective in preventing leaf yellowing during storage irrespective of cultivar and storage duration. Initiation of leaf yellowing was, however, observed after 9 days in Solan Shringar and 12 days in Yellow Star in control, when the foliage was sprayed with distilled water only. The cut stems stored for 10 and 15 days showed shriveling and wilting of petals which were not suitable to carry out vase life studies. Therefore vase life studies were carried out only on cut stems stored for 5 days.

Data presented in Table 1 reveal that vase life of Yellow Star (8.88 days) was more in comparison to Solan Shringar (4.85 days) when foliage of cut stems was treated with TDZ before dry storage for 5 days. It was also observed that the vase life increased with increasing concentration of thiadiazuron. Maximum vase life of 10.47 days was observed when foliage of cut stems was sprayed with T_4 (TDZ 150 µM) and was dry stored for 5 days. In contrast, minimum vase life (3.40 days) was observed when cut stems were treated with distilled water (control) only before storage. The interaction between cultivars and treatments showed that maximum vase life was attained by Yellow Star (13.07 days) when cut stems were treated with T_4 (TDZ 150 µM). In contrast, vase life (2.13 days) was observed minimum in cv Solan Shringar when cut stems were treated with distilled water (control) before storage.

In both the cultivars, maximum vase life was observed in cut stems when foliage was sprayed with T_4 (TDZ 150 µM) before dry storing them for 5 days at 4ºC. It may be attributed to the cytokinin like effect of thidiazuron which might have delayed the senescence of leaves and reserved the cut stems photosynthetically active ultimately resulting in availability of ample food source for the cut flowers. These results are in conformity with those of Ferrante et al (2009) in stock flowers which when treated with TDZ 5 and 10 µM successfully increased the vase life and inhibited leaf yellowing.

In case of *Lupinus densiflorus*, treatment combination of TDZ and sucrose as holding solution delayed the flower senescence and retained flowers quite fresh and healthy for 8-10 days (Sankhla et al 2005). In another study, TDZ application significantly increased the vase life of cut carnation flowers (*Dianthus caryophyllus*) as compared to control (Chamani et al 2007).

Amount of water consumed (ml/stem) in vase: Data in Table 2 depict that amount of water consumed in vases differed significantly due to cultivars, treatments and their interaction. Cut stems of cultivar Yellow Star (23.80 ml) consumed more amount of water as compared to Solan Shringar (11.48 ml). Among different foliar spray applications, maximum amount of water (26.73 ml) was consumed by the cut flower stems treated with T_4 (TDZ 150 µM) before storage. However, minimum amount of water was absorbed by cut stems treated with distilled water (6.40 ml). In general, cut stems treated with different solutions consumed more water as compared to control (distilled water).

Data pertaining to interaction between cultivars and treatments reveal that maximum amount (38.33 ml) of water was consumed by Yellow Star when cut stems were treated with T_4 (TDZ 150 µM) followed by T_3 (TDZ 100 µM) (29.13 ml) before storage. In contrast, minimum amount (4.00 ml) of vase solution

Table 1. Effect of thiadiazuron on vase life of cut stems of chrysanthemum cvs Solan Shringar and Yellow Star dry stored at 4ºC for 5 days

Treatment	Vase life (days)		
	Cultivar		Mean
	Solan Shringar	Yellow Star	
T_1 (Control)	2.13	4.67	3.40
T_2 (TDZ 50 µM)	2.93	6.87	4.90
T_3 (TDZ 100 µM)	6.47	10.93	8.70
T_4 (TDZ 150 µM)	7.87	13.07	10.47
Mean	4.85	8.88	-

$CD_{0.05}$

Cultivars: 0.34
Treatments: 0.48
Cultivars x Treatments: 0.68

Table 2. Effect of thiadiazuron on quantity of distilled water consumed by cut stems of chrysanthemum cvs Solan Shringar and Yellow Star dry stored at 4ºC for 5 days

Treatment	Water consumed (ml)		
	Cultivar		Mean
	Solan Shringar	Yellow Star	
T_1 (Control)	4.00	8.80	6.40
T_2 (TDZ 50 µM)	11.93	18.93	15.43
T_3 (TDZ 100 µM)	14.87	29.13	22.00
T_4 (TDZ 150 µM)	15.13	38.33	26.73
Mean	11.48	23.80	-

$CD_{0.05}$

Cultivars: 1.83
Treatments: 2.59
Cultivars x Treatments: 3.67

was consumed when cut stems were sprayed with distilled water (control) before dry storage in case of Solan Shringar. Lesser amount of distilled water consumed by cut stems of Solan Shrinagr can be attributed to corresponding less vase life as compared to Yellow Star.

More absorption of distilled water was noted in cut stems treated with foliar spray of TDZ (150 µM) before storage in cultivars Solan Shringar and Yellow Star. It can be directly correlated to longer vase life of cut stems in this experiment. Minimum amount of distilled water consumption was, however, noted in untreated cut stems which may be due to their lesser vase life.

Increase in weight of cut flower stems: Increase in the weight of cut flower stems was noted more in Yellow Star (13.66%) as compared to Solan Shringar (7.53%) (Table 3) after storage. Data also reveal that maximum increase in weight (20.89%) was observed when foliage of cut flower stems was treated with T_4 (TDZ 150 µM) before storage. In contrast, minimum increase in weight (4.58 and 6.77%) was observed when cut stems were treated with distilled control and T_2 (TDZ 50 µM) respectively which were at par.

The interaction between cultivars and treatments show that maximum increase in weight after storage was observed in Yellow Star (13.97%) when cut stems were treated with T_4 (TDZ 150 µM), T_3

(TDZ 100 µM) (12.19%) and in case of Solan Shringar, T_4 (TDZ 150 µM) (9.81%), the three being at par. In contrast, minimum increase in weight of cut stems was recorded in T_1 (Control) (4.57%), T_2 (TDZ 50 µM) (7.57%), and T_3 (TDZ 100 µM) (8.18%) in case of Solan Shringar and T_1 (control) (4.60%) and T_2 (TDZ 50 µM) (5.88%) in case of Yellow Star, all the five being at par.

Foliar spray of TDZ (150 µM) before storage resulted in maximum gain in weight in both the cultivars. Thidiazuron is used as a potential postharvest treatment for preventing chlorophyll losses during storage and for extending the vase life. Ad per Genkov and Iordanka (1995), TDZ is around 50-100 times more active in inducing cytokinine like effects than common cytokinin. The retention of chlorophyll in leaves can directly be correlated to the optimum level of photosynthesis in stems during storage leading to expansion of ray florets and finally enhancing stem weight.

Decrease in weight of cut flower stems: Decrease in weight of cut flower stems was calculated at the time of termination of vase life. Flowers of cultivar Yellow Star (21.77%) showed more loss in weight than Solan Shringar (9.86%) (Table 4) after termination of vase life. Among different treatments, minimum weight loss (10.79%) was observed when foliage of cut flower stems was treated with T_4 (TDZ 150 µM) solution. It is also evident from the data that maximum weight loss of cut flower stems was observed when foliage of cut flower stems was treated with distilled water (18.89%), T_2 (TDZ 50 µM) (17.71%)and T_3 (TDZ 100 µM) (15.87%) before storage, the three treatments being at par.

Table 3. Effect of thiadiazuron (TDZ) on increase in weight of cut stems of chrysanthemum cvs Solan Shringar and Yellow Star dry stored at 4ºC for 5 days

Treatment	Increase in weight (%)		
	Cultivar		Mean
	Solan Shringar	Yellow Star	
T_1 (Control)	4.57	4.60	4.58
T_2 (TDZ 50 µM)	7.57	5.88	6.77
T_3 (TDZ 100 µM)	8.18	12.19	10.18
T_4 (TDZ 150 µM)	9.81	13.97	20.89
Mean	7.53	13.66	-

$CD_{0.05}$

Cultivars: 2.23
Treatments: 3.15
Cultivars x Treatments: 4.45

Table 4. Effect of thiadiazuron (TDZ) on decrease in weight of cut stems of chrysanthemum cvs Solan Shringar and Yellow Star dry stored at 4ºC for 5 days

Treatment	Decrease in weight (%)		
	Cultivar		Mean
	Solan Shringar	Yellow Star	
T_1 (Control)	10.35	27.43	18.89
T_2 (TDZ 50 µM)	10.62	24.81	17.71
T_3 (TDZ 100 µM)	10.12	21.62	15.87
T_4 (TDZ 150 µM)	8.37	13.21	10.79
Mean	9.86	21.77	-

$CD_{0.05}$

Cultivars: 3.29
Treatments: 4.66
Cultivars x Treatments: NS

Interaction between cultivars and treatments was found to be non-significant.

Minimum decrease in weight at the termination of vase life was observed when foliar spray of T_4 (TDZ 150 µM) was given to cut stems in both the cultivars before storage. It might be due to the fact that thidiazuron which induced cytokinin like effect (Genkov and Iordanka 1995) resulted in delayed senescence and increased photosynthesis (Wingler et al 1998), hence least weight loss.

Appearance of cut flower stems (colour and freshness): The appearance of cut flower stems in vases containing distilled water differed significantly due to cultivars and treatments. Data presented in Table 5 show that cut flower stems of cultivar Yellow Star (3.39) achieved more score than Solan Shringar (2.97) showing their better appearance.

Data also show that cut flower stems scored maximum score (3.49) giving better appearance when cut foliage was treated with T_4 (TDZ 150 µM) before storage. In contrast, minimum score (2.86) was noted when these were treated with distilled water (control) before storage. The interaction between cultivars and treatments showed that the cultivar Yellow Star achieved maximum score (3.73) when treated with T_4 (TDZ 150 µM) and T_3 (TDZ 100 µM) (3.60), the two being at par. In contrast, minimum score (2.82, 2.85 and 2.97) was noted in cv Solan Shringar when treated with T_1 (Control), T_2 (TDZ 50 µM), T_3 (TDZ 100 µM) respectively and in cv Yellow Star when treated with distilled water (control) (2.90) before storage, all four treatments being at par. Yellow Star scored higher score for appearance than Solan Shringar. When cut stems were treated with TDZ (150 µM), however, showed the best appearance in both the cultivars in vases. All the treatments of TDZ showed maximum effect on appearance.

In the presence of TDZ, flower abscission in chrysanthemum cultivars was prevented considerably and senescence of leaves was delayed. It is likely that in chrysanthemum cultivars, Solan Shringar and Yellow Star, TDZ, like other cytokinins, is also able to reduce the sensitivity of tissues to ethylene. This result is in conformity with the work of Sankhla et al (2003) who reported that leaf senescence retarding effect of TDZ in phlox appears to be more like that of purine cytokinin1a.

Table 5. Effect of thiadiazuron (TDZ) on appearance (colour and freshness) of cut stems of chrysanthemum cvs Solan Shringar and Yellow Star dry stored at 4ºC for 5 days

Treatment	Appearance score (colour and freshness)		
	Cultivar		Mean
	Solan Shringar	Yellow Star	
T_1 (Control)	2.82	2.90	2.86
T_2 (TDZ 50 µM)	2.85	3.34	3.10
T_3 (TDZ 100 µM)	2.97	3.60	3.28
T_4 (TDZ 150 µM)	3.24	3.73	3.49
Mean	2.97	3.39	-

$CD_{0.05}$

Cultivars: 0.09
Treatments: 0.12
Cultivars x Treatments: 0.17

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