



Assessment of Shelf life of Chrysanthemum (*Dendranthema x grandiflora* Tzelev.) var. Marigold Flowers as Influenced by Phenophase Based Irrigation and Nutrition Schedule

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was conducted in the Division of Flower and Medicinal Crops at the ICAR-Indian Institute of Horticultural Research, Bengaluru, to evaluate the influence of phenophase based irrigation and fertigation schedules on shelf life of chrysanthemum (*Dendranthema x grandiflora* Tzelev.) var. Marigold. The experiment comprised of three main plots (irrigation

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regimes) and five sub plots (nutrient regimes) and was laid out in split plot design with three replications. Irrigation regime at 0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively along with weekly fertigation of NPK @ 75:112.5:75 kg /ha (75% RDF) in three split doses of 40:20:20 % NPK during vegetative phase, 30:40:40 % NPK during bud phase and 30:40:40% NPK during flowering phase, recorded the maximum shelf life of flowers (12.15 days) whereas, the minimum shelf life (7.60 days) was observed in the irrigation regime at 0.6,0.8 and 1.0 ER at vegetative, bud and flowering phases, respectively along with conventional method soil application of recommended dose of fertilizer (100:150:100 Kg NPK/ha).The shelf life of flowers had significantly high positive association with the physiological parameters of the plant viz., relative water content (0.728), transpiration rate (0.201), single flower weight (0.559) and stomatal conductance rate (0.492). Whereas, the photosynthetic rate (0.214), diameter of the flower head (0.269) and estimated flower yield (0.047) were significantly and positively correlated with shelf life of flowers. However, the days taken for bud appearance (-0.250) was negatively associated with shelf life of flowers.

Keywords: *Chrysanthemum*; phenophase; irrigation; fertigation; shelf life.

1. INTRODUCTION

Chrysanthemum belonging to the family Asteraceae is very popular as loose flower, cut flower as well as potted plants. A final product of great quality is desirable in all economic activities, but when dealing with floriculture, this is vital. Nevertheless, this increase in quality must be accompanied by maximizing profits. According to Roude et al. [1] aggregated value in the case of the chrysanthemum is intimately related to the aspect and quality of flowers, fertilization and irrigation can be managed so as to achieve greater productivity, quality and shelf life of the flowers [2]. The use efficiency of water and nutrients is improved by drip fertigation [3-5]. Fertigation with 80 per cent level of the recommended dosage of fertilizers recorded maximum weight of marketable flowers, compared to control and shelf life of chrysanthemum was significantly influenced by 80 per cent of RDF (120: 150: 100 kg NPK/ha) through fertigation [6]. In chrysanthemum var. Wilson's white, the maximum flower diameter and dry weight of flower per plant was recorded with 75 % level of irrigation among different water regimes applied i.e. (25%, 50%, 75% and 100%) [7]. Most of the above-mentioned studies concentrated on only the effect of irrigation and fertigation irrespective of the phenological stages. The fertigation scheduling should be based on plant, soil-air, plant water relations and growth stage of plant [8]. Hence, this study aimed to assess the influence of phenophase based irrigation and fertigation and its effect on shelf life of chrysanthemum cv. Marigold. In view of above facts, the experiment was conducted with the objective to study the effect of phenophase based irrigation and fertigation on shelf life of chrysanthemum cv. Marigold.

2. MATERIALS AND METHODS

The experiment was conducted for two seasons during the year 2018-19 and 2019-20 to study the effect phenophase based irrigation and fertigation on shelf life of chrysanthemum cv. Marigold grown under open conditions at Division of Flower and Medicinal Crops, ICAR-IIHR, Bengaluru. The soil at the experiment site was red sandy loam soil with a pH of 7.13 and EC of 0.30 dS m⁻¹. The experiment was laid out in split plot design (SPD) comprising three main plot treatments i.e., irrigation regimes and five sub plot treatments i.e., nutrient regimes with three replications. The treatment consists of main plot treatments at three phenophases i.e. I₁ – (0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively), I₂ - (0.6, 0.8 and 1.0 ER at vegetative, bud and flowering phases, respectively) and I₃-(0.8 ER each at vegetative, bud and flowering phases) and five sub plot treatments (F₁: 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (bud phase) 33.3:33.3:33.3 % NPK (flowering phase) @ 100:150:100 Kg NPK/ha (RDF), F₂: 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 100:150:100 Kg NPK/ha (RDF), F₃: 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (bud phase) 33.3:33.3:33.3 % NPK (flowering phase @ 75:112.5:75 Kg NPK/ha (75% RDF), F₄: 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 75:112.5:75 Kg NPK/ha (75% RDF), F₅: soil application of recommended dose of fertilizer (100:150:100 Kg NPK/ha) and F₁-F₄: 25% of fertilizer dose i.e. 100:150:100 and 75:112.5:75 kg NPK/ha was applied as basal dose along with

farmyard manure at 20 t/ha along with basal doses were applied before transplanting according to the treatments. Thirty days old healthy and uniform rooted cuttings of chrysanthemum var. Marigold were transplanted in the main field at a spacing of 60×45 cm. The remaining dose of fertilizers was applied based on treatments through fertigation at weekly intervals with respect to phenophases of the crop from twenty-one days after transplanting up to 160 days. Drip irrigation was scheduled daily from transplanting till final harvest, as per the irrigation treatments based on the previous day open pan evaporation observations.

For studies on shelf life of flowers, fully opened flowers were harvested from each of the treatment combinations when all ray florets had expanded, precooled and kept in 150-gauge polyethylene package under room condition (Temperature 24-28°C & RH 65-70%). Ten flowers per replication and in treatment were used to record the shelf life and it was expressed in days. Observations on the vegetative, floral and physiological parameters were recorded and correlated with the shelf life of the flowers to determine the level of influence of each of these parameters on the post-harvest keeping quality of the flowers. The statistical analysis in split-plot design as per the standard statistical procedures, SAS (SAS V 9.3, 2012) was done. The results have been presented and discussed at the probability level of five percent.

3. RESULTS AND DISCUSSION

The data pertaining to the shelf life of chrysanthemum cv. Marigold have been analysed and presented below.

3.1 Influence of Irrigation Regimes

Irrigation regimes significantly influenced the shelf life of chrysanthemum var. Marigold. The irrigation regime I₁ – (0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively) recorded the maximum shelf life of flowers (9.60 days) followed by I₃-(0.8 ER each at vegetative, bud and flowering phases) (9.50 days) and the minimum (9.14 days) was recorded in I₂ - (0.6, 0.8 and 1.0 ER at vegetative, bud and flowering phases, respectively) during the first year. During the second year, the maximum shelf life of flowers (9.92 days) was recorded in I₃ followed by I₁ (9.59 days) and the minimum was recorded in I₂ (9.46 days). The maximum shelf life of flowers (9.72

days) was recorded in I₃ followed by I₁ (9.61 days) and the minimum was recorded in I₂ (9.30 days) of pooled analysis of irrigation treatments (Table 1). The increase in shelf life might be due to constant evaporation replenishment at optimum levels during all the growth phases resulting in higher water availability to the plant. Availability of water in adequate amount leads to growth and development of plant, continued cell division and enlargement, progressive initiation of tissue and primordia. Daily irrigation through drip might create favourable soil water environment condition for crop growth and resulted in higher yield and improved quality. Yield and quality were enhanced as a result of keeping the soil water content at required level as was also reported by Vijayaselvaraj [9] in *J. grandiflorum*, Tsirogiannis et al. [10] in gerbera, Aydinsakir et al. [11] in carnation and Babu et al. [12] in marigold. Superior quality of citrus was recorded in the irrigation regime with 80 % evaporation replenishment at different crop phenophases according to Shirgure et al. [13] which is also in line with the present findings.

3.2 Influence of Nutrient Doses

Among the fertigation treatments, weekly fertigation of 75% of recommended dose of fertilizers i.e. 75:112.5:75 kg NPK/ha @ 40:20:20 % NPK during vegetative phase, 30:40:40 % NPK during bud phase and 30:40:40% NPK during flowering phase recorded maximum shelf life of flowers (11.83 and 12.03 days respectively, during the first and second year) and the minimum shelf life (7.73, 7.51 days respectively, during the first and second year) was recorded in F₅ – soil application of recommended dose of fertilizer (100:150:100 kg NPK/ha). In pooled analysis the maximum shelf life of flowers (11.95 days) was recorded in the treatment F₄ followed by F₃ (10.05 days) and minimum shelf life of flowers (7.63 days) was recorded in F₅ (Table 1). The increased shelf life might be attributed to the increased vegetative growth of plants supplemented with nitrogen fertilizers which might have enhanced turgidity of flowers by increasing the rate of photosynthesis and other metabolic activities. The vase life of chrysanthemum was increased by the application of 75 % of RDF as fertigation according to Ganesh et al. [14] which might be attributed to continuous supply of nutrients would have helped in maintenance of turgor in the leaf and flower and in turn favoured the higher vase life of chrysanthemum. These results are also in

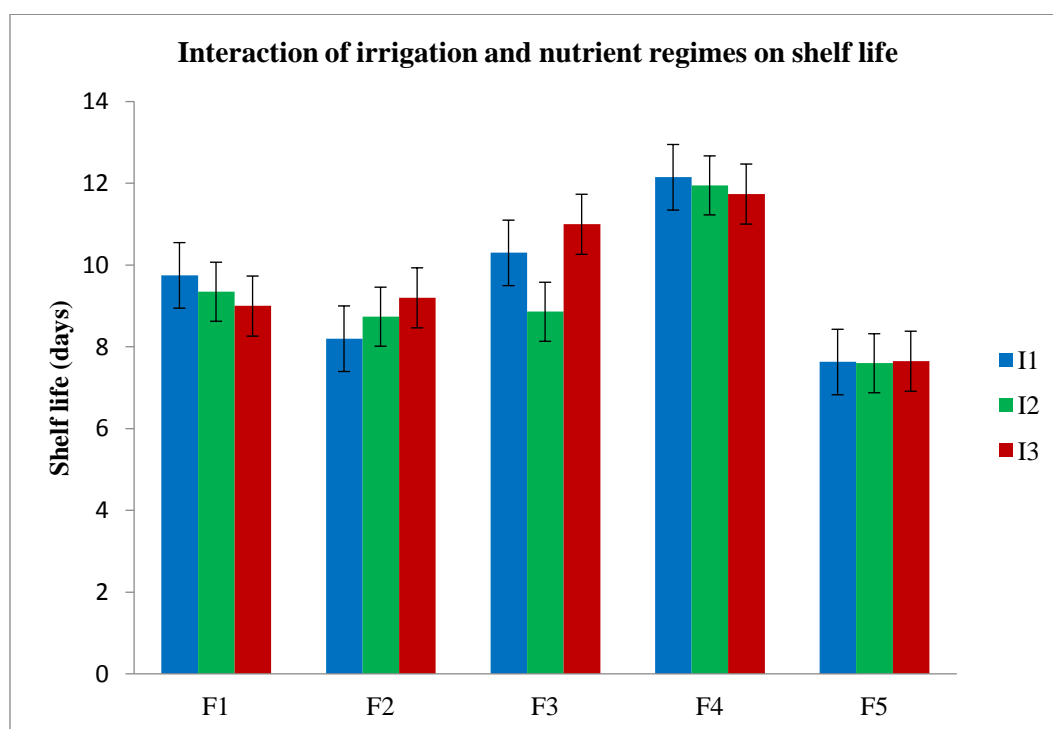


Fig. 1. Interaction of irrigation and nutrient regimes on shelf life of chrysanthemum var. Marigold flowers (days)

conformation with the findings of Naik [15] in marigold.

3.3 Interaction Effect of Irrigation and Nutrient Doses

Among the interaction effects of irrigation and fertigation treatments (Fig. 1), the treatment combination I_1F_4 recorded the maximum shelf life of flowers (12.20 days) followed by I_2F_4 (11.80 days) whereas, the minimum shelf life of flowers (7.40 days) was recorded in I_1F_5 during the first year. During the second year the maximum shelf life (12.10 days) was observed in the treatment I_2F_4 followed by I_1F_4 (12.00 days) and minimum shelf life of flowers was recorded in I_2F_5 (7.00 days). In pooled interaction the maximum shelf life of flowers (12.15 days) was recorded in the treatment I_1F_4 followed by I_2F_4 (11.95 days) and minimum shelf life of flowers was recorded in I_2F_5 (7.60 days). Increase in shelf life was observed at lower levels of fertilizers in combination with higher water regimes at the flowering phase. Translocation of water-soluble nutrients through increased quantity of irrigation water would have improved the quality of flowers which ultimately increased the shelf life of chrysanthemum flowers. This is also in line with the findings of Kabariel [16] in marigold.

4. CORRELATION OF PHYSIOLOGICAL, FLOWERING AND YIELD COMPONENTS WITH SHELF LIFE OF FLOWERS

The shelf life of flowers recorded a highly significant positive association (0.728) with relative water content, transpiration rate (0.201), single flower weight (0.559) and stomatal conductance rate (0.492); whereas, photosynthetic rate (0.214) and diameter of the flower head (0.269) had positive significant correlation with shelf life of flowers. The days taken for bud appearance (-0.250) however, was negatively associated with shelf life of flowers. With respect to the inter-correlations, the relative water content had significant positive correlation with total dry matter distribution (0.123), single flower weight (0.561) and diameter of the flower head (0.024). The photosynthetic rate registered highly significant positive correlation with total dry matter distribution (0.355) and single flower weight (0.035) The transpiration rate recorded positive significant correlation with days taken for bud appearance (0.594) and it was negatively correlated with stomatal conductance (-0.321), total dry matter distribution (-0.285), diameter of the flower head (-0.203) and days taken for bud appearance (-0.184). Stomatal conductance was

Table 1. Interaction effect of phenophase based irrigation and fertigation scheduling on shelf life (days) of chrysanthemum var. Marigold

Treatments	I year						II year						Pooled Mean					
	F ₁	F ₂	F ₃	F ₄	F ₅	Mean	F ₁	F ₂	F ₃	F ₄	F ₅	Mean	F ₁	F ₂	F ₃	F ₄	F ₅	Mean
I ₁	10.50	8.40	9.50	12.20	7.40	9.60	9.00	8.00	11.10	12.00	7.87	9.59	9.75	8.20	10.30	12.15	7.63	9.61
I ₂	9.60	8.50	7.60	11.80	8.19	9.14	9.09	8.98	10.12	12.10	7.00	9.46	9.35	8.74	8.86	11.95	7.60	9.30
I ₃	9.20	8.30	10.90	11.50	7.60	9.50	8.79	10.10	11.10	11.98	7.65	9.92	9.00	9.20	11.00	11.74	7.65	9.72
Mean	9.77	8.40	9.33	11.83	7.73		8.96	9.03	10.77	12.03	7.51		9.37	8.71	10.05	11.95	7.63	
	SE. d					CD (P=0.05)	SE. d					CD (P=0.05)	SE. d					CD (P=0.05)
I	0.02					0.03	0.10					0.28	0.05					0.09
F	0.09					0.18	0.10					0.20	0.12					0.30
I at F	0.16					0.36	0.04					0.07	0.08					0.15
F at I	0.15					0.32	0.03					0.06	0.07					0.14

Table 2. Correlation of physiological flowering and yield components with shelf life (days) of chrysanthemum var. Marigold

Parameters	RWC	PSR	TR	SC	TDD	SFW	DIA	DTBA	DTBSC	SLF
RWC: Relative water content (%)	1									
PSR: Photosynthetic rate (μ mol (CO ₂) m ⁻² s ⁻¹)	-0.407	1								
TR: Transpiration rate (m mol (H ₂ O) m ⁻² s ⁻¹)	0.126	0.103	1							
SC: Stomatal conductance (mol (H ₂ O) m ⁻² s ⁻¹)	0.462	-0.176	-0.321	1						
TDD: Total dry matter distribution (g)	0.123*	0.355**	-0.285	-0.072	1					
SFW: Single flower weight (g)	0.561*	0.035**	0.326	-0.426	0.073*	1				
DIA: Diameter of the flower head (cm)	0.024*	-0.464	-0.203	0.394**	0.411*	0.036	1			
DTBA: Days taken for flower bud appearance (Days)	-0.180	0.119	0.594*	0.159*	-0.237	0.325	-0.129	1		
DTBSC: Days taken for flower bud showing colour (Days)	0.165	0.145	-0.184	-0.547	0.268	0.083	0.093*	0.605	1	
SLF: Shelf life (Days)	0.728**	0.214*	0.201**	0.492**	0.068*	0.559**	0.269*	-0.250	0.195*	1

**Significant, CD @ 5%; *Significant, CD @ 1%

significantly and highly positively correlated with diameter of the flower head (0.394) and recorded positively significant correlation with days taken for bud appearance (0.159). The total dry matter distribution was significantly positively correlated with single flower weight (0.073) and diameter of the flower head (0.411) and negatively correlated with days taken for bud appearance (-0.237). The diameter of the flower head had significant positive correlation with days taken for bud showing colour (0.093).

Higher relative water content during the different crop growth phases might have resulted in better turgidity and therefore resulting in lesser weight loss during storage, thereby enhancing the shelf life. Better stomatal conductance and photosynthetic rates, which is related to higher dry matter distribution, flower weight and flower diameter might have also contributed to increased shelf life of flowers. Abbaszadeh et al. [17] also reported that the shelf life of flowers had a positive correlation with the relative water content. The highest positive direct effect towards shelf life of flowers was exerted via plant height followed by harvest index, flower weight, number of flowers per plant and photosynthetic rate as reported by Patel et al. [18]. The flowering trait, days taken for flower bud appearance (0.250) had negative association with shelf life of flowers [19].

5. CONCLUSION

In chrysanthemum var. Marigold irrigation regime at 0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively along with weekly fertigation of NPK @ 75:112.5:75 kg /ha (75% RDF) in three split doses of 40:20:20 % NPK during vegetative phase, 30:40:40 % NPK during bud phase and 30:40:40% NPK during flowering phase, recorded the maximum shelf life of flowers (12.15 days) whereas, the minimum shelf life (7.60 days) was observed in the irrigation regime at 0.6,0.8 and 1.0 ER at vegetative, bud and flowering phases, respectively along with conventional method soil application of recommended dose of fertilizer (100:150:100 Kg NPK/ha). Relative water content (0.728), transpiration rate (0.201), single flower weight (0.559) and stomatal conductance rate (0.492) recorded a highly significant positive association; whereas, photosynthetic rate (0.214) and diameter of the flower head (0.269) had positive significant correlation with shelf life of flowers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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