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IMPROVEMENT IN POSTHARVEST ATTRIBUTES OF ZINNIA (*ZINNIA ELEGANS* CV. BENARY'S GIANT) CUT-FLOWERS BY THE APPLICATION OF VARIOUS GROWTH REGULATORS

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Abstract

Zinnias are timeless and classic cut flowers, holding prestigious position in the cut flower industry for their versatility, numerous colors and low maintenance. Indole-3-acetic acid (IAA) and 1-naphthylacetic acid (NAA) play fundamental function in coordination of many growth and behavioral processes in the plant life. Salicylic acid (SA) is a phenolic acid in nature and participates in the regulation of many physiological processes in plant body, maintains water homeostasis and triggers defense mechanism. The experiment was designed to evaluate these hormones for increase in quality and shelf life of zinnia cut flowers. Maximum water uptake 150.7 ml was observed at IAA @ 150 mg L^{-1} and maximum vase life of flower 11.33 days at SA @ 50 mg L^{-1}. The maximum percentage of flower color and physical appearance (67% excellent) was recorded at NAA@100 mg L^{-1}, however, maximum structural integrity (67% excellent) was recorded at SA@150 mg L^{-1}. These findings are recommended results in line with other studies will be further helpful for the commercial recommendations to obtain cultivation of zinnia with good quality and better vase life. in zinnia cut flowers.

Introduction

Zinnia is important and a diverse genus of family *Asteraceae* having *Zinnia elegans* and *Zinnia haagaena* the two most promising among 20-30 species (Javid *et al.,* 2005), having many types or groups and numerous cultivars, which are widely grown for their attractive flowers but the majority of ornamental cultivars are derived from *Zinnia elegans.* Zinnia can be easily grown in beds, pots, window boxes and rock gardens (Yassin & Ismail, 1994).

Zinnias are timeless and classic cut flowers, holding prestigious position in the cut flower industry for their versatility, numerous colors and low maintenance. Vase life of the cut flower is very important, which can be significantly increased by proper harvesting, handling and post harvest management. The production and utilization of cut flowers has also amplified over the decade and this rise is expected to continue due to number of unspecified factors in Pakistan (Riaz *et al*., 2007). One of the most important features in cut flower production is appropriate supply of nutrition during the growing period (Abbasi *et al.,* 2004). Many plant growth regulators have known effect to increase the vase life of flowers and they can be efficiently used to enhance the shelf life of flowering crops (Peng *et al*., 2007).

Indole-3-acetic acid (IAA) is a naturally occurring compound having a carboxyl group attached to another carbon-containing group (usually–CH_2-) that in turn is connected to an aromatic ring and playing diverse roles in plants such as rooting, cell elongation and flowering (Hartmann *et al.,* 2002). IAA plays fundamental function in coordination of many growth and behavioral processes in the plant life cycle such as rooting of cutting, flowering, aging, root growth, prevention or promotion of stem elongation, color enhancement of fruit and flower etc (Khan *et al*., 2007).

Synthetic auxins such as 1-naphthylacetic acid (NAA) influenced different crop physiology parameters e.g. alter plant archetype; promote photosynthesis; stimulate uptake of mineral ions; promote flowering; increase mobilization of assimilates to defined sinks and delay senescence (Verma *et al*., 2009).

The word salicylic acid (SA) was derived from Latin word "Salix", meaning willow tree (Raskin *et al.,* 1990). SA is assigned diverse regulatory roles in the metabolism of plants (Popova *et al.,* 1997) actually phenolic in nature, which participates in the regulation of physiological processes in plant (Shakirova *et al*., 2003), playing a role as a natural indicator of the thermogenesis to indicate flowering in a range of plants, to control ion uptake by roots, stomatal conductivity (Raskin, 1992) and signal regulation of genes expression in the course of leaf senescence (Morris *et al*., 2000). The main objective of the study was to investigate the effect of auxins (IAA, NAA) and SA foliar application on the vase life, to be used as specialty zinnia cut flower during harsh summer months.

Materials and Methods

To study the effect of plant growth regulators (NAA, IAA and SA) on vase life (Table 1), dahlia flowered *Zinnia elegans* cv. Benary's Giant (Golden Yellow) was grown in the Experimental Area, Department of Horticulture, PMAS-Arid Agriculture University Rawalpindi, on raised beds providing recommended conditions. Flowers were harvested at almost fully open stage with uppermost layer of florets in spoon form during the early morning hours and were brought to the Postharvest Laboratory for further studies. Complete Randomized Design (CRD) was used for experimental layout. Two flowers per treatment with three replications were used in the study.

Data regarding water uptake, vase life, structural integrity, physical appearance and color was recorded at two days interval to check the influence of foliar applications on zinnia cut flowers. Analysis of variance was used and means were compared using least significant difference test (Steel *et al*., 1997).

Table1. Exogenous application of NAA, IAA and SA on zinnia flowers.

Treatments	Chemicals	Concentration (mg L^{-1})
T_o	Control	Distilled water
T_1	NAA	100
T_2	NAA	200
T_3	NAA	300
T_4	IAA	50
T_5	IAA	100
T_6	IAA	150
T_7	SA	50
T_8	SA	100
T_9	SA	150

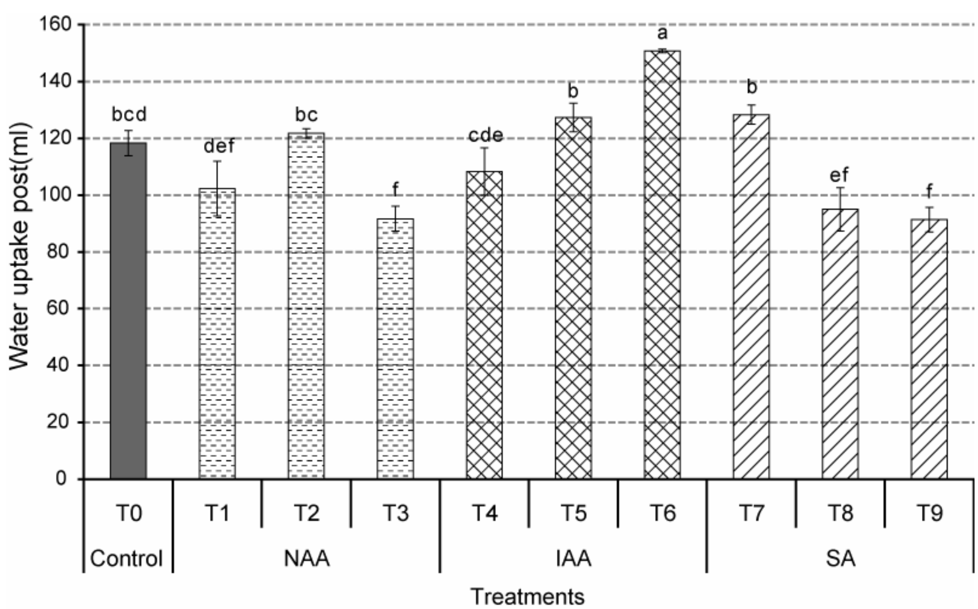
Result and Discussion

The studies were carried out to observe the visual quality and vase life of zinnia (*Zinnia elegans* L.) as influenced by the post-harvest foliar application of NAA, IAA and salicylic acid (SA). Different concentrations of NAA, IAA and SA (Fig. 1) showed maximum water uptake (150.7 ml) with T_6 (IAA @ 150 mg L^{-1}) followed by 128 ml with n T_7 (SA @ 50 mg L^{-1}) and 121 ml with T_2 (NAA @ 200 mg L^{-1}). Minimum water uptake (91.33 ml) was recorded with T_9 (SA @ 150 mg L^{-1}).

With the application of IAA, production of ethylene increased in petals of carnation cut-flowers (Yakimova & Woltering, 1997) and the ethylene production emanated from the physical stress which deteriorated the post-harvest quality and accelerated the senescence process in cut-flowers (Yang & Hoffman, 1984). Auxin enhances the production of ethylene in leaves (Yu & Yang, 1979; Yang & Hoffman, 1984). This might be the reason for maximum uptake of water in zinnia flower since IAA accelerates production of ethylene resulting in increased respiration and uptake of water.

The minimum vase life (6.33 days) was recorded with T_0 (Control) treatment, whereas, the maximum vase life (11.33 days) was observed with T_7 (SA @ 50 mg L^{-1}) at normal room temperature followed by T_8 (SA @ 100 mg L^{-1}) and IAA @ 100 mg L^{-1} with vase life of 9.67 days, and the flower remain fresh for 8.33 days with NAA @ 200 mg L^{-1} (Table 2).

Addition of low level of SA delayed senescence, while, higher level promoted abscission and also enhanced senescence in lupin cut flower (Mackay *et al*., 2000). Similar results were found in present study at lower concentration T_7 (SA @ 50 mg L^{-1}) which gave maximum vase life i.e., 11.33 days. The inhibitory actions of SA most closely resembled to that of dinitrophenol, a known inhibitor of ethylene forming enzyme (Lesile & Romani, 1988). SA and Acetyl-SA inhibited ethylene production by about 90% when applied with vase solution (Romani *et al*., 1989). The application of SA increased the vase life of cut-roses and delayed senescence (Li *et al*., 1999; Mackay *et al*., 2000). It also agreed with Dumitras *et al*., (2002) who stated that SA increased vase life of Gerbera and Gladiolus.



T_0 (Control), T_1 (NAA@100 mg L^{-1}), T_2 (NAA@200 mg L^{-1}), T_3 (NAA@300 mg L^{-1}), T_4 (IAA@50 mg L^{-1}), T_5 (IAA@100 mg L^{-1}), T_6 (IAA@150 mg L^{-1}), T_7 (SA@50 mg L^{-1}), T_8 (SA@100 mg L^{-1}), T_9 (SA@150 mg L^{-1})
Bars carrying different letters are significantly different at 5% probability level

Fig. 1.Water uptake of zinnia cut flower as influenced by different levels of NAA, IAA and SA.

Table 2. Effect of NAA, IAA and SA exogenous application on vase life (days).

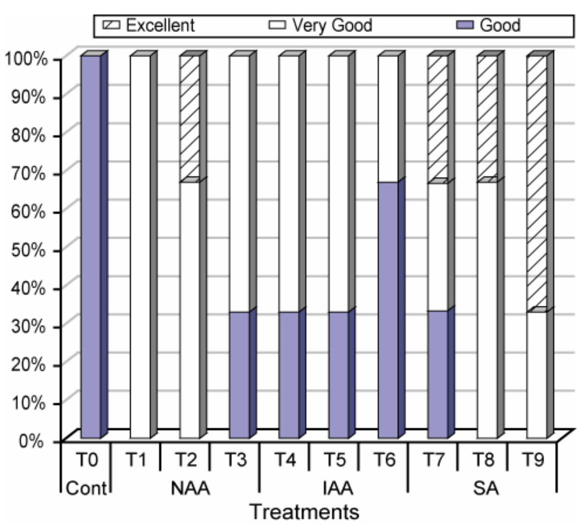
Treatments	Chemical and concentration	Vase life post
T_0	Control	6.333 ± 0.33e
T_1	NAA @ 100 mg L^{-1}	8.000 ± 0.31d
T_2	NAA @ 200 mg L^{-1}	8.333 ± 0.33cd
T_3	NAA @ 300 mg L^{-1}	8.000 ± 0.32d
T_4	IAA @ 50 mg L^{-1}	7.667 ± 0.33d
T_5	IAA @ 100 mg L^{-1}	9.667 ± 0.33b
T_6	IAA @ 150 mg L^{-1}	9.333 ± 0.66bc
T_7	SA @ 50 mg L^{-1}	11.33 ± 0.33a
T_8	SA @ 100 mg L^{-1}	10.00 ± 0.57b
T_9	SA @ 150 mg L^{-1}	8.333 ± 0.33cd

Means not sharing a common letter differ significantly at 5% level of probability, ± = Standard error

Minimum flower structural integrity was showed (Fig. 2) by T_0 (Control), whereas, the maximum structural integrity was observed with T_9 (SA @ 150 mg L^{-1}) and followed by T_8 (SA @ 100 mg L^{-1}), T_7 (SA @ 50 mg L^{-1}) and T_2 (NAA @ 200 mg L^{-1}) with 33 percent excellent structural integrity. Photosynthesis and carbohydrates play an important role in flowering and development of flower with respect to size and solidity. In this context, SA has positive effect on photosynthesis and carbohydrates accumulation in plants which might be the cause compactness of flower (Khodary, 2004).

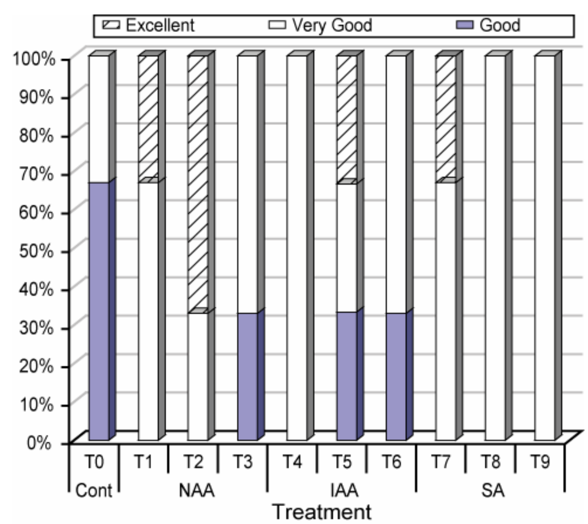
Excellent color was exhibited (Fig. 3) with T_2 (NAA @ 200 mg L^{-1}) followed by T_7 (SA @ 50 mg L^{-1}), T_1 (NAA @ 100 mg L^{-1}) and T_5 (IAA @ 100 mg L^{-1}), whereas, lowest flower quality with respect to color was shown by T_0 (Control). In this regard 67 percent flowers fell in the excellent category with T_2 (NAA @ 200 mg L^{-1}) ultimately placed at the first position in the rank order. T_7 (SA @ 50 mg L^{-1}) and T_1 (NAA @ 100 mg L^{-1}) got 33 percent excellent flowers regarding color and occupied second position, however T_0 (Control) got the end position in rank order with 67 percent flowers fell in good color. Salicylic acid enhanced color in the current study, similar to the results obtained by Xueping *et al.,* (1999) who found that the SA treatment made cut roses more colorful and attractive.

Different concentrations of NAA, SA and IAA postharvest treatments exhibited excellent physical appearance (Fig. 4) with NAA @ 200 mg L^{-1} followed by SA @ 150 mg L^{-1}., whereas the minimum flower quality regarding physical appearance shown by untreated flowers. Salicylic acid also enhanced appearance of the flower in the current study, similar to the results established by Xueping *et al.,* (1999) who stated that the decorative appearance of rose flower treated with SA solution was increased.



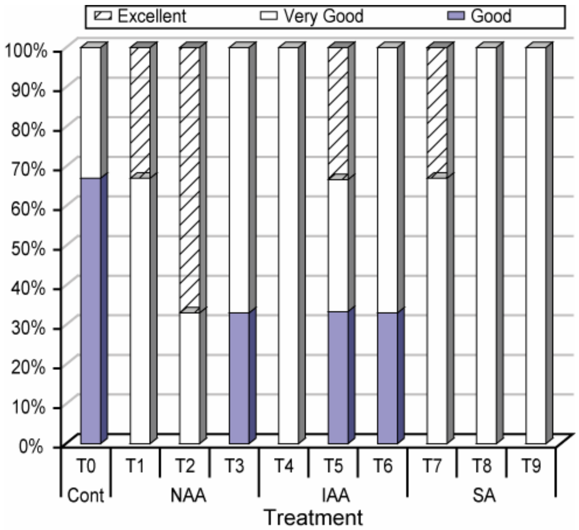
T_0 (Control), T_1 (NAA@100 mg L-1), T_2 (NAA@200 mg L-1), T_3 (NAA@300 mg L-1), T_4 (IAA@50 mg L-1), T_5 (IAA@100 mg L-1), T_6 (IAA@150 mg L-1), T_7 (SA@50 mg L-1), T_8 (SA@100 mg L-1), T_9 (SA@150 mg L-1)

Fig. 2. Effect of NAA, IAA and SA on flower structural integrity in post harvest.



T_0 (Control), T_1 (NAA@100 mg L^{-1}), T_2 (NAA@200 mg L^{-1}), T_3 (NAA@300 mg L^{-1}), T_4 (IAA@50 mg L^{-1}), T_5 (IAA@100 mg L^{-1}), T_6 (IAA@150 mg L^{-1}), T_7 (SA@50 mg L^{-1}), T_8 (SA@ mg L^{-1}), T_9 (SA@150 mg L^{-1})

Fig. 3. Color response of zinnia cut flower to different concentrations of NAA, IAA and SA.



T_0 (Control), T_1 (NAA@100 mg L^{-1}), T_2 (NAA@200 mg L^{-1}), T_3 (NAA@300 mg L^{-1}), T_4 (IAA@50 mg L^{-1}), T_5 (IAA@100 mg L^{-1}), T_6 (IAA@150 mg L^{-1}), T_7 (SA@50 mg L^{-1}), T_8 (SA@100 mg L^{-1}), T_9 (SA@150 mg L^{-1})

Fig. 4. Effect of NAA, IAA and SA on physical appearance of Zinnia cut flower.

Conclusion

These results showed that growth regulators effected vase life and visual parameters. SA showed best result at50 mgl^{-1}. If SA used in less than 50 mg L^{-1} may produce better results.

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