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Morphological Responses and Vase Life of *Rosa hybrida* cv. Dolcvita to Polyamines Spray in Hydroponic System

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Abstract: Rose flower is one of the most important cut-flowers, with the highest world production rate. The main problem of rose flower is its short vase life. Polyamines are involved in a wide range of metabolic processes in plants. The aim of this study was to examine the effect of polyamines on vegetative and reproductive growth and vase life of rose plants (*Rosa hybrida* cv. Dolcvita) in soil-less cultures. The experiments were carried out in a randomized completely design with ten treatments and four replications. Treatments included: Putrescine at the rates of 0,1,2 and 3 mM, Spermidine at the rates of 0, 0.5,1 and 1.5 mM, Spermine at the rates of 0, 1,2 and 4 mM applied as foliar sprays on two months old of Rose plants cv Dolcvita. Data were analyzed using the MSTAT-C program by performing analysis of variance (ANOVA), followed by LSD Test at $P = 0.05$. Results showed that the effects of foliar application of polyamines on the length of flower stalks, flower stalks fresh weight; vase life, flower buds diameter and flower buds length were significant. The highest and lowest flower stalks length were obtained in nutrient solutions containing 1.5mM spermidine and in control with 100.66 and 71 cm respectively and the highest vase life was obtained in solutions containing 0.5mM spermidine and also in solutions containing 1mM spermine. The data obtained in this study suggested that polyamines have significant effects on rose properties and quality.

Abbreviations:
PAs-Polyamines.
Put-Putrescine.
Spd-Spd.
Spm-Spermine.
1-amino-cyclopropane-l-carboxylic acid-ACC.

Key words: Rosa hybrida · Vase life · Putrescine · Spermine · Spermidine · Flower stalks length

INTRODUCTION

Rose flowers are important cut flowers and many studies have therefore focused on their quality both in pre and post harvest periods. The vase life is often very short and is characterized by early wilting and bending of the pedicels. The development of such symptoms is considered to be caused by vascular occlusion, mainly located in the basal stem end [1].

Pas are low molecular weight polycations, organic, biogenic amines that are found in all eukaryotic and most prokaryotic cells [2, 3] and have profound effects on growth, development and senescence in eukaryotic cells [4]. In plants, di-amine putrescine (Put), triamine spermidine (Spd) and tetra-amine spermine (Spm) are frequently present in amounts varying from micromolars to more than millimolars [5].

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Polyamines (Put, Spm and Spd) are recognized as a new class of plant growth bio-regulators [6, 7]. They influence many biochemical and physiological processes such as cell division, cell elongation, flowering, fruit set and development, fruit ripening, senescence, storage life, [8, 9]. The various plant growth and developmental processes affected by PAs include stimulation of cell division, response to environmental stress and regulation of rhizogenesis, embryogenesis, fruit and flower development [10]. PAs mainly Spm, retarded the senescence of leaf discs of two diverse species of roses (*R. damascena and R. bourboniana*) whereas, PAs synthesis inhibitors such as difluoromethylarginine (DFMA) and methylglyoxal-bis-guanylhydrazone (MGBG) promoted senescence[11].

Tassoni, *et al.* [12] reported that, cut carnation flowers, treated with 10 mM Spd, exhibited a delay in senescence. The treated petals accumulated free and Perchloric Acid (PCA) soluble Spd, which resulted in stabilization and reduction of DNA degradation.

Sivaprakasam *et al.* [13] reported that Spm at 5 µM, delayed flower senescence in ethylene-insensitive gladiolus by three days, along with increased fresh weight which was retained for longer period and increased vase solution uptake as compared to control.

Pas significantly improved fresh weight, uptake of vase solution, flower opening and vase life of gladiolus. Spermidine at a concentration of 100 ppm+4% sucrose, 500 ppm Spm +4% sucrose, 100 ppm Put +4% sucrose, 100 ppm Spd +4% sucrose and 500 ppm Spd +4% sucrose significantly improved vase life over both control and 4%sucrose. PAs delayed senescence and improved vase life of cut spikes by improving membrane stability [14].

XiaoLing *et al.* [15] showed that combination of 2% sucrose+200 mg CA+100 mg penicillin+0.15% $Ca(NO_3)2$+0.1 mmol Spd/l could markedly extend the life of the cut roses and delay the process of senescence.

Singh *et al.*, [16] showed that PAs (Spm, Spd and Put) at 100 ppm concentration in combination with sucrose were effective in extending vase life of gladiolus. Of these three treatments, 100 ppm Spm along with sucrose in vase solution was also able to keep fresh weight of gladiolus spikes higher for longer duration in comparison to other treatments due to higher uptake of holding solution. In carnation, the greatest delay of senescence was evidenced with 10 mM Spd in the irrigation solution (10 mM Spd-V), while no significant effect was obtained by spraying this substance on flowers [17].

The results showed that all flower characters and chemical composition of *Chrysanthemum indicum* L were significantly increased by foliar application of Put at different concentrations. The highest values were found when plants were treated with 200 ppm Put [18].

Nada, *et al.* [19]reported that, rose flowers kept in Put-supplemented sucrose + HQS solution, showed a much slower rate of petal unfolding and significantly lower content of fructose in petals than those maintained in sucrose + HQS solution. The results suggested that Put induced the alteration of sucrose metabolism in petals, resulting in the retardation of petal cell growth and unfolding of petals, thereby extending the vase life of cut rose flowers. Mahgoub *et al.* [6] showed that spraying plants with PAs such as Put and thiamine significantly increased plant height, number of branches, number of leaves, fresh and dry weight and stem diameter of *Dahila pinnata* L.

There is a limited research on the effects of different concentration and pre-harvest application of polyamines spray on rose cultivars; therefore the aim of this study was to investigate the effects of application of exogenous PAs on quality characteristics and vase life of rose (*Rosa hybrida* cv. Dolsvita) in hydroponics system.

MATERIALS AND METHODS

Plant Materials and Growth Conditions: Experiments were conducted in the green-houses of Dena Rose Company in Yasooj Iran equipped with hydroponic systems. Two months old rooted roses (*Rosa hybrida* var. Dolcvita) were purchased from a local commercial producer. Plants were grown in Cocopeat:Perlite(1:1 v/v) media with an open system of irrigation and nutrition. Plants were irrigated 6 times every day for 15 min. Four weeks after planting plants were treated with different levels of PAs. Plants were sprayed with putrescine at the rates of 1, 2 and 3 mM, spermidin at the rates of 1, 2 and 4 mM and spermine at the rates of 0.5,1 and 1.5 mM.

Experiments began in Feb 2010 and continued until July 2011. To facilitate PAs absorption, a few drops of twin 20(Merk) were added to spray solutions. Cultural practices such as nutrition, bending, pruning, disease and pest control and thinning were performed according to the common practices. Two weeks after PAs spray, flowers were harvested at stage two (completely opened buds) and immediately placed in tap water and transferred to laboratory. The flowers were re-cut and placed horizontally on the jar pots in a room set at 20°C and

30-40% relative humidity (RH). Traits such as leaf chlorophyll content, stems lengths and diameters, fresh weight of flowers stems, flower diameters and vase lives were recorded. Vase life of cut flowers was considered to be completed when petals or stems (below the flower head) lost their turgidity. Leaves chlorophyll content was determined with a chlorophyll meter (SPAD 502-Minolta-Japan). Flowers stem fresh weights were determined with digital scale. Flower bud diameters, flower stem diameters, flower bud heights and stem lengths were measured with a digital caliper

Experimental Design and Statistical Analyses: The experiments were performed with a Complete Randomized Block Design (CRBD) with 10 treatments, four replications and two observations per replication. Data were subjected to analysis of variance (ANOVA) using the MSTAT-C program (Michigan State University, MI, USA). In case of significant treatment effects, comparison of means were separated using LSD test (P= 0.05).

RESULTS AND DISCUSSION

Morphological Traits: Results of analysis variance showed that the effects of PAs on flower stalk height was significant at 1% level (Table 1). Data in Table 2 revealed that foliar application of rose plants with PAs promoted all morphological traits as compared to control. The highest and lowest flowers stalk length obtained by 1.5mM Spd1.5mM solution and in control with 100.66 and 71 cm, respectively. These result confirm that applications of Pas improve the stem length of cut roses cv Dolcvita in soil-less culture. These results are in agreement with those reported by others (Mahgoub *et al.* [6] on *Dahila pinnata* L., Yousef *et al.* [20] on *Matthiola incanna*, Talaat *et al*, [21] on periwinkle, Mahgoub *et al.* [7] on *Dianthus caryophyllus*), who reported that polyamines significantly promoted the flower stalks length, fresh and dry weight. Abdel Aziz Nahed *et al.* [22] reported that foliar application of Put significantly increased plant length, number of leaves, leaves fresh and dry of gladiolus plants compared with untreated ones.

Results in Table 1 indicate that spraying rose plants with PAs has significantly increased flower stalks diameter, flower buds diameter and flower buds length. Data in Table 2 reveals that highest flower stalks diameters were obtained by 1.5mM Spd, 1mM Spm and by 2 and 3 mM Put treatments and the lowest obtained by control plants. The highest flower bud diameters were obtained by 2 and 3 mM Put, 1 and 1.5 mM Spd and by 1mM Spm treatments and the lowest were in control plants. Data presented in Table 1 shows that plants treated with 2mM put and 2mM spm, significantly increased their flower buds length as compared with control.

Table 1: Analysis of Variance (ANOVA) effect of polyamines on morphological traits of Rose (*Rosa hybrid* cv Dolcvita) in soilless culture

Source of Variation	df	Flower Height Stalk (cm)	Flower Stalk Diameter (cm)	Flower Bud Diameter (mm)	Flower Bud Height (mm)	Fresh Weight of Flower Stalk (gr)	SPAD	Vase Life (Day)
Treatment	9	271.39 **	0.957 n.s	24.005 *	74.752 **	1517.230**	6.471 n.s	2.477 *
Error	20	38.64	0.635	9.10	15.779	301.720	13.216	0.883
CV (%)	7.21	11.26	8.90	8.39	24.7	8.37	6.32	

Ns=Non Significant *= Significant at 0.5 % **= Significant at 0.1%

Table 2: Effect of polyamines on vegetative growth of rose (*Rosa hybrid* cv Dolcvita) in soilless culture

Treatments	Flower Height Stalk (cm)	Flower Stalk Diameter (cm)	Flower Bud Diameter (mm)	Flower Bud Height (mm)	SPAD
Control	71e	5.84b	30.27b	36.19c	42a
Put 1 mM	82.5cd	6.86ab	30.84ab	43.92ab	41a
Put 2 mM	96.5ab	7.8a	35.45a	49.84ab	43.5a
Put 3 mM	73de	7.46a	33.79a	44.11ab	44.5a
Spd 0.5 mM	92abc	6.9ab	31.5ab	36.57c	33.5a
Spd 1 mM	84.33c	6.72ab	40.07a	43.95ab	42.5a
Spd 1.5mM	100.66a	7.72a	34.48ab	48.84ab	46a
Spm 1 mM	86.16bc	7.32a	33.38ab	47.15ab	43a
Spm 2 mM	92.16abc	7.05ab	35.47ab	50.55a	44a
Spm 4 mM	83.53cd	7.06ab	33.51 ab	43.68a	44.5a

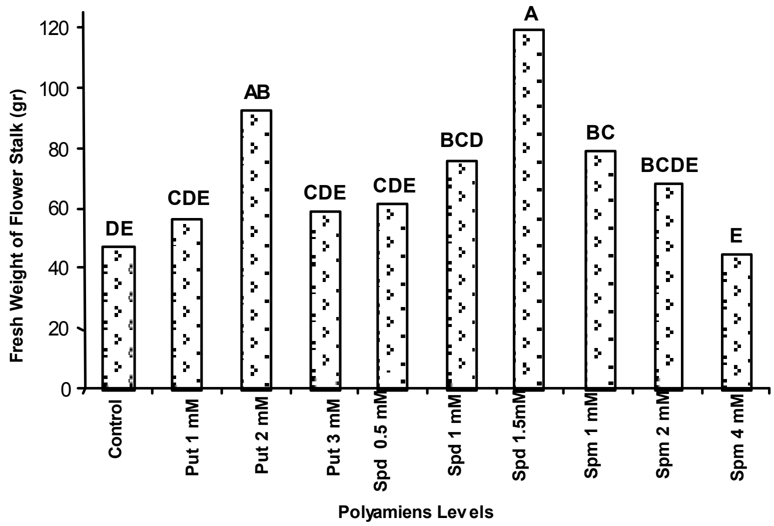

Fig. 1: Effect of polyamiens on fresh weight of flower stalk of rose cv Dolcvita

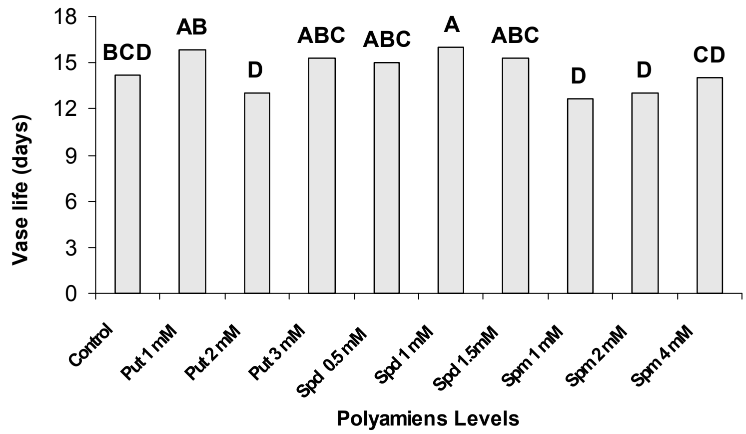

Fig. 2: Effect of polyamiens on vase life of rose cv Dolcvita

The positive effects of PAs on growth through enhancing cell division and cell expansion has been reported by Cohen [3]. Also, Iman *et al.*, [23] studying the periwinkle plants, pointed out that application of Put at 10^{-3} M significantly promoted growth at successive developmental stages. Mahgoub *et al.,* [7] found that foliar application of Put at 200 ppm to *Dianthus caryophllus* plants significantly increased growth parameters.

Clearly, PAs are involved in many plant developmental processes, including cell division, embryogenesis, reproductive organ development, root growth, tuberization, floral initiation, fruit development and ripening as well as leaf senescence and abiotic stresses [10, 11].

Pas play important roles in regulating sugar and carbohydrate biosynthesis. They act as plant growth regulators and may be involved in many biological activities and have been shown to be closely associated with carbohydrate biosynthesis [6].

Mahros *et al.* [18] reported that all flower characters and chemical composition of *Chrysanthemum indicum* L were significantly increased by foliar application of Put at three concentration levels. The highest values were found when plants treated with 200 ppm Put. PAs sprayed on rose plants significantly increased fresh weight of flower stalks. The highest fresh weight of flower stalks was obtained by 1.5 mM Spd and the lowest was in control plants (Fig. 1).

Dantuluri *et al.* [14] reported that PAs significantly increased fresh weight, vase solution uptake, flower opening and vase life of gladiolus flowers and also delayed senescence and improved vase life of cut spikes by improving membrane stability.

Singh [24] showed that Spd increased fresh weight of carnation (*Dianthus caryophyllus* L.) petals. IAA, ACC and ethylene on the other hand, tended to shorten petal longevity. Pretreatment with Spd slightly improved longevity of ACC and ethylene-treated petals but completely antagonised the effect of IAA. PAs have significantly increased vase life of rose cv Dolcvita when compared with untreated ones. The longest vase life was obtained by 0.5 mM Spd and 1mM Spm (Fig. 2). The increase in flowers vase life by using growth regulators may be due to increase in protein content of both petals and ovaries or due to increase in cytokinins, which have shown to reduce and delay the production of endogenous ethylene [18]. Also, PAs may retard senescence by inhibiting ethylene production. The increase in PAs was accompanied by inhibition of lipid peroxidation and the inhibition of lipid peroxidation may be one of the mechanisms responsible for the anti-senescence effects of PAs.

Upfold and Staden [25] reported that Put and Spm were effective in delaying the senescence of carnation buds, but were ineffective when applied to flowers in which the petals had already been opened. Higher levels of endogenous Put were detected in the open flowers than in the buds and this may explain the negative effects obtained when PAs were applied to open flowers that had been picked for commercial distribution.

Leea *et al.* [26] reported that Spm delayed the senescence of cut carnation flowers and reduced ethylene production, endogenous ACC content, the activities and transcript content of ACC synthase and ACC oxidase in petals. They suggested that endogenous Pas possibly suppress ethylene production. Singh *et al.* [16] reported that PAs such as Spm, Spd and Put at 100 ppm concentration in combination with sucrose were effective in extending vase life of gladiolus. Of these three PAs, 100 ppm Spm along with sucrose in vase solution was also able to cause higher fresh weight of gladiolus spikes for longer duration in comparison to other treatments due to higher uptake of holding solution. Aesthetic look of cut spikes in terms of floret diameter, turgidity and freshness was also better in these treatments. These results are in agreement with those obtained by others researchers [6, 7, 18, 24, 27]. Chlorophyll content was not affected by PAs treatments (Table 2).

CONCLUSIONS

The data presented in this paper suggest that PAs application has affected and improved the morphological traits such as stem lengths and diameters, fresh weight of flower stems, flower diameters and vase life of rose plants, cv Dolcvita grown in hydroponic system.

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