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Improvement of the vase life of cut gladiolus flowers by salicylic acid and Putrescine

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ABSTRACT

The effects of salicylic acid (SA) and Putrescine (Put), on cut Gladiolus was studied. SA (0, 150, 300 and 450 mg l^{-1}) and Put (0, 100, 200 and 300 mg l^{-1}), their combinations were tested as preservative mixture. This study was conducted in a factorial experiment with complete randomized design on 192 Gladiolus cut flowers in horticulture laboratory of agriculture faculty of Islamic Azad University, jiroft branch. The recorded traits included Vase life, Flower Diameter, SPAD, flower diameter, flower petal wilting, percent of floret blossoming, total soluble solids (TSS) and Solution uptake. the results shown effect of different levels of PUT ($p<0.01$) and interaction of PUT×SA ($p<0.05$) on flower diameter. Mean comparison indicated that increased level of PUT and the concentration of 300 mg l^{-1} of this polyamine result in increase of flower diameter. Increasing salicylic acid concentration up to 300 mg/l^{-1} had positive and significant effect on soluble solids but application of concentrations above 450 mg/l^{-1} reduced soluble solids level. Water uptake in the absence and presence of 100 mg/l^{-1} PUT was 168.4 ml and 170.2 ml respectively which is not significant but was elevated to 184.4 ml when PUT concentration was increased to 300 mg l^{-1}.

Abbreviations: SA, Salicylic acid; Put, Putrescine.

Key words: Cut flowers, Fresh weight changes, Narcissus, Vase life.

INTRODUCTION

Cut flowers are precious products of horticulture. Maintaining good quality of cut flowers and extending the vase life, is considered important and practical for having acceptable products for the markets. In general, many studies have been under taken for this purpose. (Redman, et al., 2002; Macnish et al., 2008 and Solgi et al., 2009, Zencirkiran, 2005; Zencirkiran, 2010). Vase life of cut flowers is mainly affected by two main factors, namely ethylene which accelerates the

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senescence of many flowers and by microorganisms which cause vascular blockage and thus reduces the vase life of cut flowers (Van Doorn, 1994; Zencirkiran, 2005; Zencirkiran, 2010).

Gladiolus is a popular cut flower in the world, but flowers longevity is very short. The vase life of individual florets is 4 to 6 days (Mayak et al., 1973). The life of the flower is a function both of the life of individual florets, the postharvest expansion and opening of the buds remaining on the spike (Serek et al., 1994). Short postharvest vase life is one of the most important problems of the cut flowers. However, longevity of vase life is an important factor in consumer preference (Da Silva, 2003; Kader, 2003).

SA is considered to be a potent plant hormone because of its diverse regulatory roles in plant metabolism (Popova et al., 1997). It was first extracted from willow trees, and named after the Latin word "Salix" by Rafacle Piria in 1938. SA has been found to play a key role in the regulation of plant growth, development and in responses to environmental stresses (Hayat et., al, 2009). Further, its role is evident in ion uptake and transport (Harper and Balke, 1981), photosynthetic rate, stomatal conductance and transpiration (Khan et al., 2003). SA is considered to be an important signaling molecule which is involved in local and endemic disease resistance in plants in response to various pathogenic attacks (Enyedi et al., 1992; Alverez, 2000). Besides providing disease resistance to the plants, SA can modulate plant responses to a wide range of oxidative stresses (Shirasu et al., 1997). SA also suppressed ACC synthase and ACC oxidase activities and biosynthesis of ethylene, and hence retarded the climacteric rise in ethylene production, in kiwi fruit (Zheng, 2002). SA has been shown to interfere with the biosynthesis and/ or action of ethylene, abscisic acid and cytokinins in plants (Hayat et., al, 2009). SA and its derivative, acetyl salicylic acid (ASA) have been reported to inhibit ethylene production in pear (Leslie and Romani, 1988), banana (Srivastava, 2000) and carrot cell suspension cultures, suggesting the role of SA as an antagonist to ethylene action. Also, the upward gravitropic bending of snapdragon was inhibited using SA (Friedman et al., 2003).

PAs are low molecular weight polycations, organic, biogenic amines that are found in all eukaryotic and most prokaryotic cells (Kumar et al., 1997; Mahgoub et al., 2006) and have profound effects on growth, development and senescence in eukaryotic cells (Casiro and Marton, 2007). 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 (Kakkar and Sawhney, 2002). Polyamines (Put, Spm and Spd) are (Bouchereau et al., 1999). 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 (Iman Talaat et al., 2005). 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 and4%sucrose. PAs delayed senescence and improved vase life of cut spikes by improving membrane stability (Mahgoub et al., 2011).

The aim of this work was to study the responses Gladiolus to the interactive effects of salicylic acid and Putrescine.

MATERIALS AND METHODS

Cut Gladiolus flowers were obtained from a local commercial greenhouse, and transported with proper covers immediately to Laboratory. Solutions were freshly prepared at the start of experiments. Stems were recut to 60 cm length. The study was arranged in a factorial test with complete randomized design with four replications. Each replication consisted of three cut flowers. Three levels of SA (0, 150, 300 and 450 mg L^{-1}), Three levels of and Three levels of PUT (0, 100, 200 and 300 mg L^{-1}) were applied (total of 16 treatments). After recording the fresh weight, each flower was placed in a bottle containing 400 ml preservative solutions. The flowers were held at ambient temperature (22±2°C). Except vase life all measurements including flower diameter and stem curvature were made at the 10 th day of the experiment.

Vase life was the period from the time of harvest to the time when 50% of the petals lost turgor and wilted. Leaves chlorophyll content was determined with a chlorophyll meter (SPAD 502-Minolta Japan). Flower bud diameters were measured with a digital caliper. The volume of water uptake was calculated by subtracting the volume of water evaporated from a control bottle without cut flowers from the amount of water decreased in bottles containing flowers.

Experimental Design and Statistical Analysis: Experiment was arranged in a factorial test with complete randomized design with four replications. Analysis of variance was performed on the data collected using the MSTAT-C software. The mean separation was conducted by duncan analysis in the same software (p= 0.05).

RESULTS AND DISCUSSION

ANOVA results of different traits are presented in table 1. As can be seen, all the traits except life days and floret opening were at least affected by one of the tested factors or their interaction. All the traits are discussed below.

Soluble solids

ANOVA results (table1) indicate that soluble solids are influenced by two factors. Different levels of PUT ($p<0.01$) and various concentrations of SA and interaction of the factors ($p<0.05$) had significant effect on soluble solids. Mean comparison results showed that elevated PUT levels resulted in increased level of soluble solids but this increase was not significantly different from control. Increasing salicylic acid concentration up to 300 mg/l^{-1} had positive and significant effect on soluble solids but application of concentrations above 450 mg/l^{-1} reduced soluble solids level. Mean comparison of interactions indicated that the lowest percentage of soluble solids is achieved when 450 mg/l^{-1} SA was applied alone or in combination with 100 mg/l^{-1} PUT. It seems that high concentrations of salicylic acid have negative effect on soluble solids and presence of enough PUT can alleviate this negative effect (fig 1).

Water uptake

ANOVA results (table1) indicated that different levels of PUT had significant effect on water uptake ($p<0.05$), that is increased PUT level enhanced water uptake. Water uptake in the absence and presence of 100 mg/l^{-1} PUT was 168.4 ml and 170.2 ml respectively which is not significant but was elevated to 184.4 ml when PUT concentration was increased to 300 mg l^{-1}. interaction of PUT×SA had significant effect on water uptake ($p<0.01$). mean comparison showed that the lowest water uptake rate was obtained by applying 450 mg/l^{-1} SA alone, 300mg/l SA combined by 100 mg l^{-1} PUT or single application of 200 mg l^{-1} PUT. The result suggests that application of high or low concentrations of SA alone or in presence of low concentration of PUT has negative effect of water uptake. Despite the lack of significant differences among many of the treatments, application of 300 mg l^{-1} PUT either in presence or absence of SA resulted in the highest water uptake (fig 2). The effectiveness of this compound can be due to water relations enhancement, prevent vascular occlusion due to antimicrobial effect, anti-ethylene effect which reduces respiration rate of cut flowers and increased dry matter percent (Edrisi, 2009; Gast Karen, 1997).

Floret wilting

Results of ANOVA (table1) showed that though interaction of PUT×SA had significant effect on floret wilting ($p<0.01$), single effect of PUT or salicylic acid was not significant on this trait. As can be seen in (graph 3), despite the lack of significant difference among many of the treatments, the highest rate of wilting was observed when 200 mg l^{-1} PUT was applied alone. Moreover, the lowest wilting rate was obtained by applying 300 mg l^{-1} PUT alone (fig 3). These results are in accordance with those obtained for water uptake rate. In this experiment, SA and PUT had no significant on life days, floret wilting day and floret opening day. Investigating effects of polyamines on senescence of clove, upfold and staden studied the influence of spermidine and putrescine and reported that the two polyamines had no significant effect on clove senescence in any concentration (upfold & staden, 1991). Through affecting glucose metabolism of petals, putrescine postpones cell expansion of petals and opening of rose (Nowak & Rudnicki, 1990). It has been reported that simultaneous application of sucrose and salicylic acid has no influence on rose flower opening rate (Dezhkam & Dezham, 2010).

Flower diameter

ANOVA results (table 1) showed significant effect of different levels of PUT ($p<0.01$) and interaction of PUT×SA ($p<0.05$) on flower diameter. Mean comparison indicated that increased level of PUT and the concentration of 300 mg l^{-1} of this polyamine result in increase of flower diameter. There was no significant difference between 0, 100 and 200 mg l^{-1} of PUT regarding their effect on flower diameter. Mean comparison of the interaction of the two polyamines indicates that in all concentrations of SA, increasing PUT level to 300 mg l^{-1} was accompanied by increased diameter of the flowers. Results showed that when treated by 300 mg l^{-1} of PUT plus 450 mg l^{-1} of SA, flower diameter was increased from 34.35 to 42.28 mm (fig 4). investigating effect of salicylic acid on shelf life of rose cut flowers, Dezhkam and dezham (2010) reported that the polyamine had no significant effect on flower diameter (Dezhkam & Dezham, 2010).

Leaf chlorophyll content

According to the results of ANOVA presented in table 1, leaf chlorophyll content was affected by different concentrations of PUT ($p<0.01$), salicylic acid ($p<0.05$) and their interaction ($p<0.01$). Mean comparison results indicated that increased level of PUT resulted in elevation of leaf chlorophyll content so that the lowest chlorophyll content 7.37 was observed in the lack of PUT application. By increasing PUT concentrations to 100, 200 and 300 mg/l^{-1}, chlorophyll content was elevated by 9.28, 9 and 9. respectively. There was no significant difference between various concentrations. It has been reported that polyamines have an anti-senescence effect and postpone chlorophyll losses and membrane degradation and increase protease and RNAse activity. All of these events help alleviate senescence process. As mentioned before, PUT application reduces chlorophyll content which indirectly alleviates senescence. Chlorophyll content was also affected by different concentrations of salicylic acid. Unlike the pattern observed in PUT application, increase in SA concentration resulted in reduction of chlorophyll content. Increasing SA concentration from 150 to 300 mg/l^{-1} caused chlorophyll content to be reduced from 9.9 to 8.07. interaction of the two polyamines led to different results. Based on the results (fig 5), the highest chlorophyll content was achieved when a combination of 200 mg/l^{-1} PUT and 450 mg/l^{-1} SA was applied, though it was not significantly different from most of the treatment. The lowest chlorophyll content was observed in 0 mg/l^{-1} PUT plus 300 mg/l^{-1} SA.

As mentioned before for water uptake rate, high concentrations of salicylic acid with or without low concentration of other substances had negative effect on chlorophyll content. Salicylic acid contained in preservative solution reduces respiration rate and ethylene production and postpone chlorophyll degradation, thereby increases vase life of the flower (Capdeville et al., 2003).

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Tab1- Mean square for traits of coriander as affected by different levels of PUT and SA

SOV	df	Vase life (day)	Flower diameters (mm)	water uptake (cc)	SPAD	Floret wilting	floret blossoming	total soluble solids (%)
PUT	3	0/01^{ns}	175/81**	881/24*	16/84**	0/02^{ns}	0/21^{ns}	1/89**
SA	3	0/07^{ns}	9/94^{ns}	61/62^{ns}	9/37*	0/35^{ns}	0/68^{ns}	0/86*
PUT × SA	9	0/3^{ns}	13/47*	1125/57**	10/67**	0/96**	1/57^{ns}	0/67*
Error	45	0/38	5/48	343/75	2/86	0/45	0/87	0/27
C.V %	..	7/18	6/16	10/57	19/08	10/94	9/37	22/9

^{ns} Non Significant at 0.05 probability level and *, ** Significant at 0.05 and 0.01 probability levels, respectively.

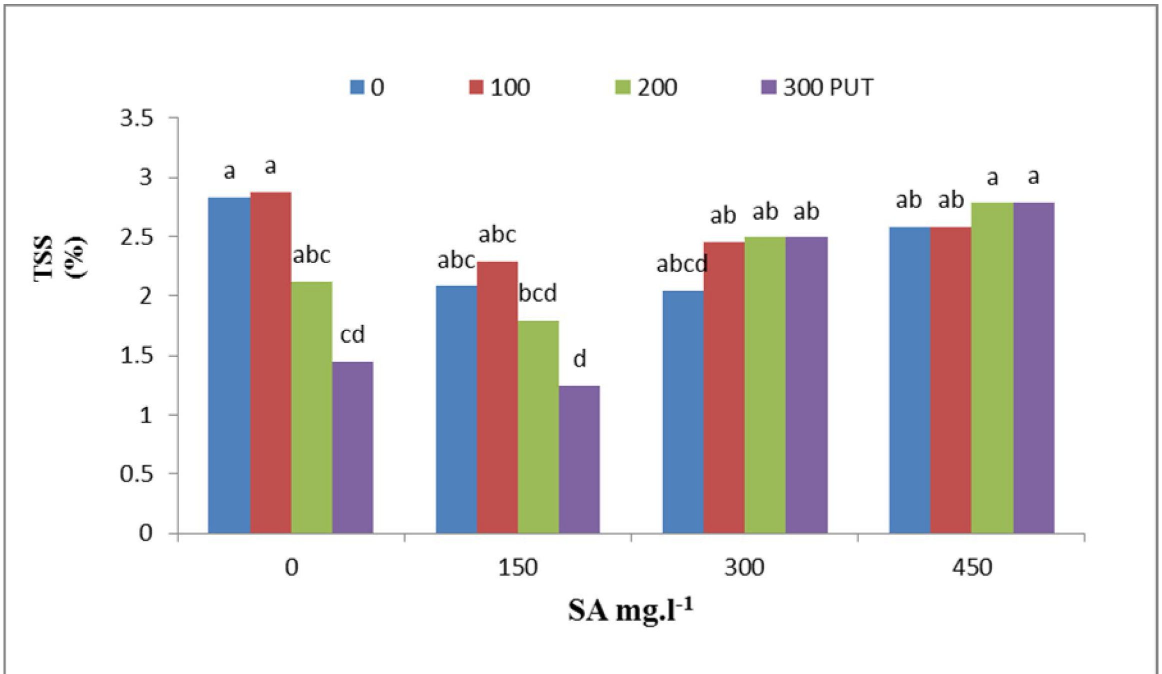

Fig 1. Comparison of PUT treatments in four compactness levels SA for TSS. Means followed by the same letter (s) are not significantly different ($p \leq 0.05$).

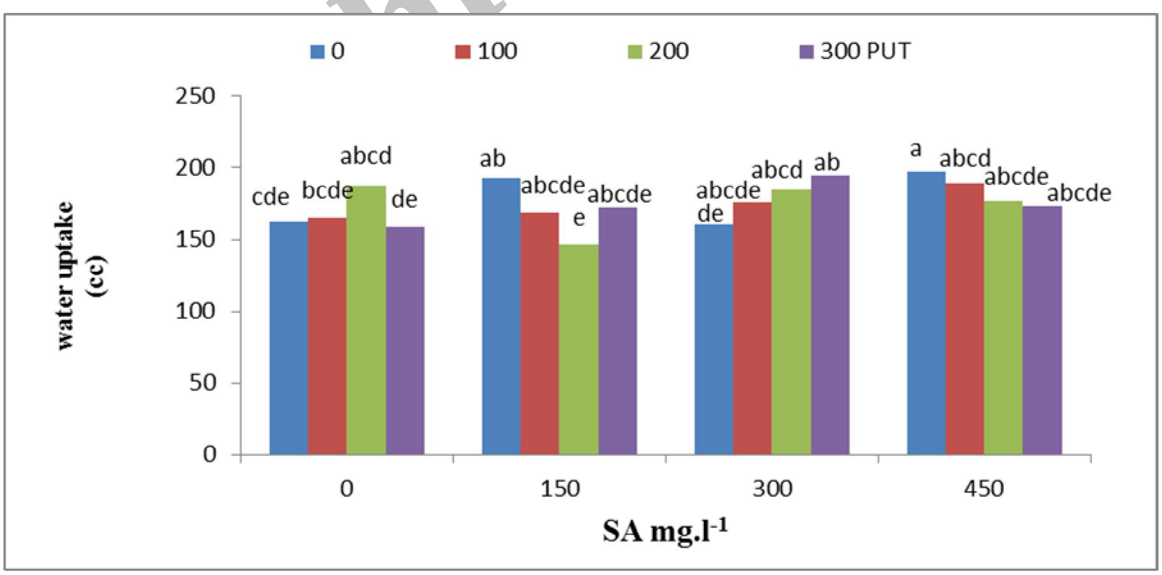

Fig 2. Comparison of PUT treatments in four compactness levels SA for water uptake. Means followed by the same letter (s) are not significantly different ($p \leq 0.05$).

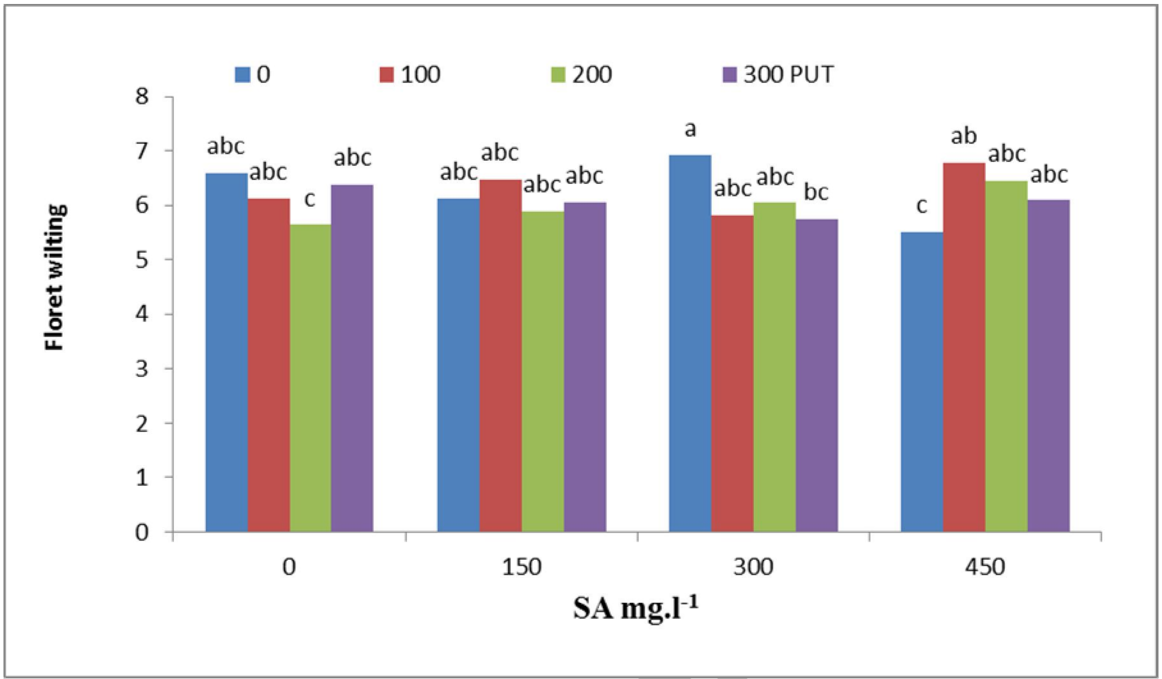

Fig 3. Comparison of PUT treatments in four compactness levels SA for Floret wilting . Means followed by the same letter (s) are not significantly different ($p \leq 0.05$).

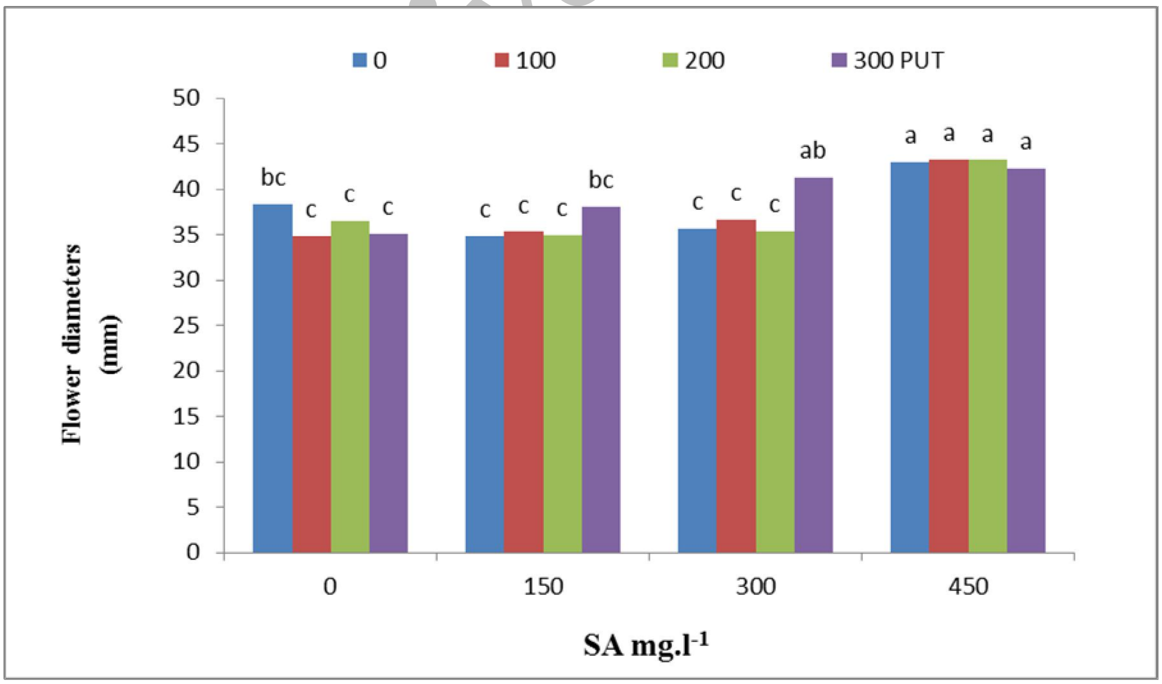

Fig 4. Comparison of PUT treatments in four compactness levels SA for Flower diameters. Means followed by the same letter (s) are not significantly different ($p \leq 0.05$).

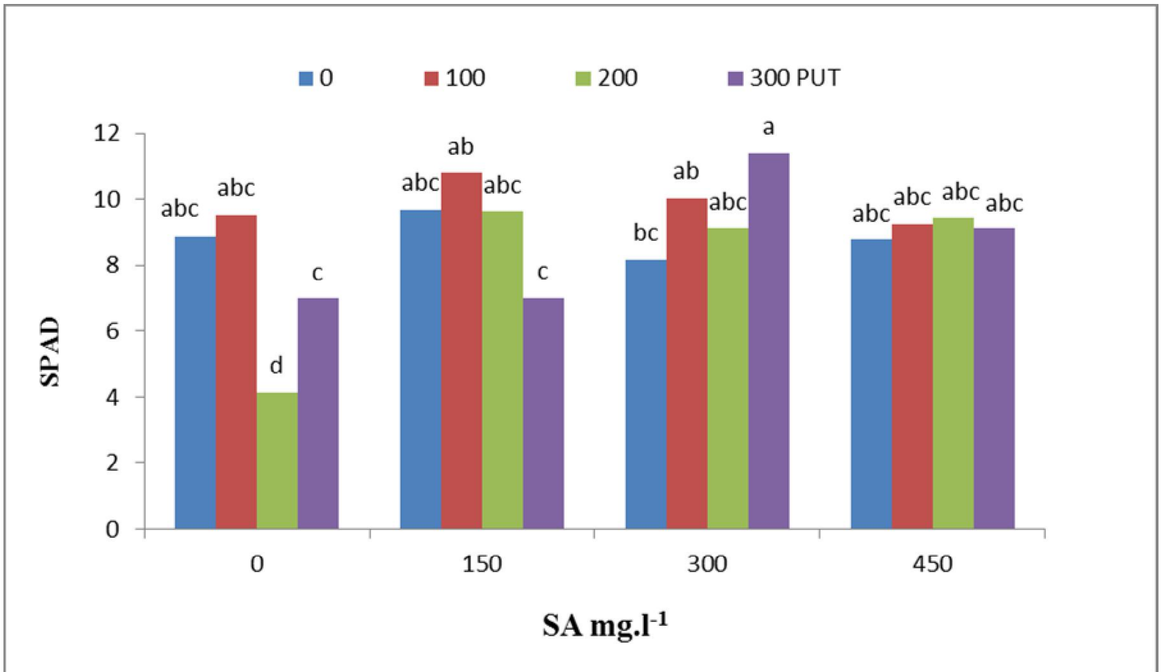

Fig 5. Comparison of PUT treatments in four compactness levels SA for SPAD. Means followed by the same letter (s) are not significantly different ($p \leq 0.05$).