Madras Agric. J., 105 (7-9): 317-323, September 2018

Influence of Post Harvest Chemical Treatments on Delaying of Petal Senescence with Improvement of longevity in *Jasminum nitidum* Flower Buds

Mohanasundari. P[1] , T. Sivakumar*[1], K. Krishna Surendar[2] and M. Ganga[3]
[1]Department of Crop Physiology, TNAU, Coimbatore, 641 003.
[2]Department of Rice, TNAU, Coimbatore – 641 003. [3] TNAU-HRS, Ooty, 643 001

Senescence is a highly coordinated complex and genetically programmed natural process that mainly regulated by phytohormones. Factorial completely randomized design with three replications has been followed in this experiment with an objective to study the physiological and biochemical role of anti-senescence treatment on flower senescence of *Jasminum nitidum.* The harvested jasmine flowers were treated with different anti-senescence chemicals *viz*., Silver nanoparticle (20ppm), Boric acid (4%), Sucrose (4%), NAA (100 ppm), BA (500 ppm), α-AIB (20µM) and packed in 200 gauge without ventilation then stored in two storage conditions of cold storage and ambient storage. Different physiological and biochemical parameters were recorded at three different stages *viz*., bud stage, open stage and senescence stage. Among the treatments sucrose (4%) showed positive significant differences in moisture content, membrane stability index, protein content, phenol content and maintained higher shelf life compared to the control.

Key words: *Jasminum nitidum*, Senescence, Post harvest physiology, Storage, Shelf life.

Peculiar fragrance and good medicinal and aromatic value of the jasmine flower gets attraction by the peoples from ancient period to till the date. The demand for the jasmine flowers increased in India as well as some of neighbouring countries like Singapore, Malaysia, Sri Lanka and the Middle East countries and also to distant nations including the United States. *J.nitidum* belongs to the family "Oleaceae" and it is derived from an Arabic word "Jessamine" (Bailey, 1947). It commonly referred to as 'Angelwing jasmine', *Jasminum nitidum* is an evergreen or semi-evergreen vine or shrub with sweetly fragrant, snow-white, pinwheel shaped flowers to almost 2 inch (5.1 cm) across. The white flowers are multi-petaled and fragrant.They appear in clusters on the ends of new growth. Leaves are dark green and glossy, making the plant attractive even when not in bloom. Individual flowers are two inches across. Flower buds are pinkish in color before opening. This species has moderate salt tolerance and it is adaptable to most of the soil.

Though flower senescence is a complex process, it acts as excellent model system for studying the senescence due to its rapid process in flower in comparison with other parts of plant organs. Senescence is an end phase of developmental process which include flower wilting, shedding of flower parts and fading of blooms. It is highly regulated by genetically or genetically programmed process that involves structural, biochemical and molecular changes to programmed cell death (Yamada *et al*., 2009, Shahri and Tahir, 2011a).

*Corresponding author's email: sivashreedurga@gmail.com

Many conditions accelerate the senescence such as biotic and abiotic stress like light, temperature, nutrients, ethylene, pathogen attack and pollination etc. (Shahri and Tahir, 2011b). Senescence cause shut down of several biosynthetic pathway and the expression of different hydrolases that hydrolyses polymers such as carbohydrates , proteins, lipids and nucleic acids in addition with complex interplay role of different hormones, for example during senescence ethylene and ABA concentration will get increased while the application of cytokinins decrease these two hormone activity. The mechanism of these hormones or their precursors are rapidly transmitted and sensed to bring about the changes in different tissues such as petal, stamens and ovary which are not yet well known (Rogers, 2006). All these changes hastened the senescence process in jasmine flowers.

Even though jasmine is most sought after in traditional usage, the needs of flower fulfillment to the local market as well as export are yet to be fulfilled. The cultivated areas are also getting increased year by year but the meeting out the increasing demand for these flowers due to shorten shelf life is causing great difficulties. Hence, the study of post harvest physiology of jasmine has become very important. Keeping in view of these constraint; present studies entitled on "Delaying of petal senescence with post harvest treatments of anti senescence chemicals and improving shelf life of *Jasminum nitidum* flower buds*"* was undertaken at the Department of Crop Physiology of the AC & RI of TNAU, Coimbatore, with the objective, to study the physiological and biochemical role of anti-senescence treatment in flower senescence of *Jasminum nitidum.*

Material and Methods

The experiment was carried out at the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore. The experiment design followed for this study is FCRD and each treatment replicated thrice. The treatments comprised of six anti-senescence chemicals *viz*., Silver Nano Particle (20 ppm), Boric acid (4%), Sucrose (4%), NAA (100 ppm), BA (500 ppm), α-AIB (20µM) and control. The flowers were harvested at morning hours between 6.30 to 7.30am. These flower buds are then immersed in chemical solution by quick dipping method and surface drying was done. After that it was packed in 200 gauge polyethylene bag without ventilation then stored in two storage conditions of cold storage and ambient storage. Different physiological and biochemical parameters were taken up at three different stages *viz*., bud stage, open stage and senescence stage. The observations recorded *viz*., Moisture content, Membrane stability index, protein content and phenol content in flower petals.

The moisture content of the whole flower was estimated after recording fresh weight and dry weight of flower buds (Kept in hot air oven at 70^{0}C). Moisture content was expressed in fresh weight basis in percentage and mean of replicated packages was calculated from the following formula,

$$\text{Moisture content} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

Membrane Stability Index (MSI) was determined according to the method of Premchand et al. (1990) and as modified by Deshmukh et al. (1991). Floret bits (10g) of uniform size were taken in test tubes containing 10 ml of double distilled water in two sets. Test tube in one set was kept at 40ºC in a water bath for 30 min and electrical conductivity of the water containing the sample was measured (C1) using a conductivity meter (Henna instrument, HI 2300 EC/TDS/NaCl meter). Test tubes in the other set were incubated at 100ºC in the boiling water bath for 15 minutes and their electrical conductivity was measured (C2). MSI was calculated using the formula given below:

$$MSI = (1 - C1/C2) \times 100$$

Flower petal samples (0.5 g fresh weight) were homogenated with 5 ml distilled water (repeated twice). The mixture was collected and then centrifuged at 4000 rpm for 10 minutes and the supernatant was collected to determine the contents of soluble proteins by the Coomassie Brilliant Blue G-250 method (Lowry *et al*.1951) with bovine serum albumin as the standard.

Phenol content of the flowers was estimated as per Malick and Singh (1980). Phenols were extracted using 80% ethanol, evaporated to dryness and the development of blue colour by the FC (folin-ciocalteau) reagent was measured at 690 nm and expressed as µg equivalent of pyro-catechol /g of sample.

Results and Discussion

Physio –biochemical parameters were recorded at bud stage, open stage and senescence stage. Significant differences were observed at all the three

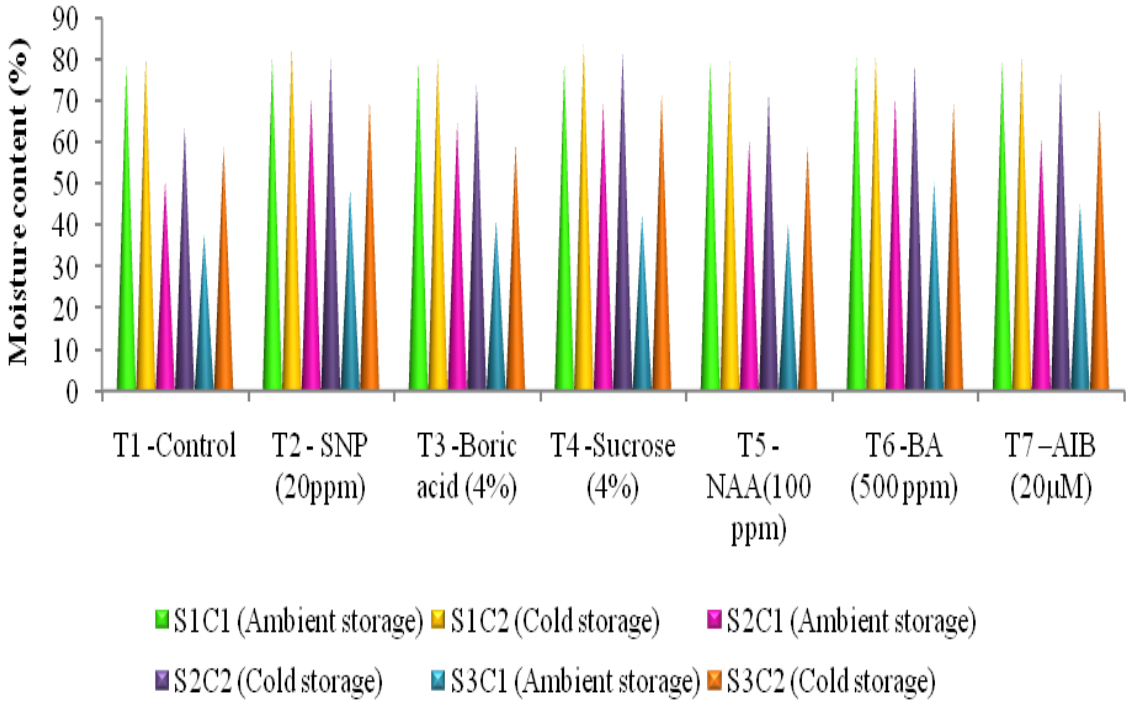

Figure 1. Effect of different anti senescence chemical treatment on moisture content (%) in *Jasminum nitidum*

stages in both ambient and cold storage conditions. In all the recorded parameters sucrose (4%) treatment maintained highest values in cold storage condition and BA (500 ppm) treatment maintained highest values in ambient storage condition.

Moisture content

The data on moisture content recorded at bud, bud opening and senescence stage under ambient and cold storage conditions is represented in figure 1.

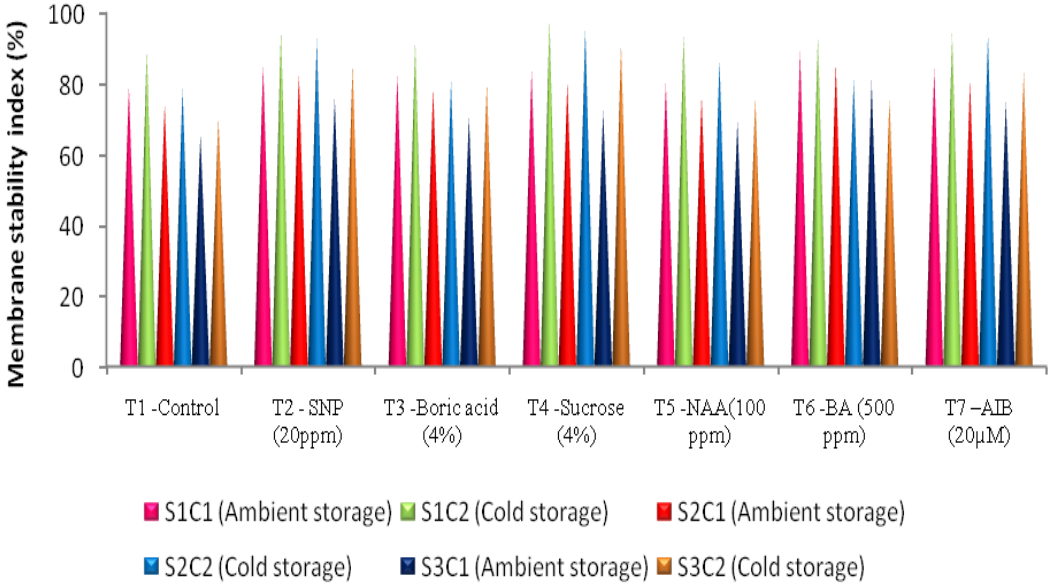

Figure 2. Effect of different anti senescence chemical treatment on membrane stability index (%) in *Jasminum nitidum*

Comparing the different treatments sucrose (4%) (T_4) recorded highest moisture content (84.06%) which was followed by SNP 20 ppm (T_2) with 83.40% at bud stage under cold storage condition when compared to control (T_1) (80.57%). Towards the senescence stage, moisture content declined in its trend. Even though the same set of treatments registered maximum moisture content with 82.05% in opening stage and 72.02% in senescence stage over control (T_1) with 63.91% (opening stage), 59.43% (senescence stage) under cold storage condition. Storage condition significantly affected the moisture content. Compared to cold storage there was slight variability noticed in ambient storage condition where the moisture content was somewhat low under this condition. However treatment BA 500 ppm (T_6) recorded maximum moisture content of 80.63% (bud stage), 71.15% (opening stage) and 50.70% (senescence stage) compared to the control (T_1) with 78.65% (bud stage), 50.79 % (opening stage) and 37.91% (senescence stage).

Significant differences were recorded among the treatments and storage condition on moisture content. Plucked flowers always wilt easily because of rapid moisture loss reported by Serek and Reid (2000). Xue and Lin (1999), reported that in rose cv. Samantha, the flowers senescence was due to rapid decline in moisture content which was identified four days after placing in vase holding solutions. Similar observation of reduction in moisture content due to rapid water loss in petals has been observed in *Rosa hybrida* (Carpenter, 1973) and Anthurium cv. Ozaki Red (Paull *et al*., 1985). These results are in accord with the findings of Nagaraja *et al*., (1999) that packaging maintained higher humidity which slows down the moisture loss in the process of respiration of the florets. Similar findings have also been reported by Nirmala and Reddy (1993) in loose flowers of jasmine under packaging with minimum ventilation as the optimum humidity and ratio of carbon dioxide, oxygen concentration was in a proper balance to reduce the rate of evapo-transpiration.

Membrane stability index

Membrane stability index **(**MSI) recorded under ambient and cold storage conditions was significantly influenced by treatments and storage condition which was expressed as per cent solute leakage. The least MSI was recorded in the treatment of sucrose (4%) (T_4) with 98.15, 95.42, 90.85% at bud, opening and senescence stage under cold storage condition over the control (T_1) 89.66, 78.63, 70.35% respectively. Among the chemical treatments, maximum MSI was observed in Benzyl Adenine 500 ppm with 89.44, 85.79 and 80.70 % at bud, opening and senescence stage respectively which show significant difference among the treatments. However, in control (T_1) registered minimum membrane stability index of 79.02, 74.11 and 65.54% at all three stages at ambient storage condition (Figure 2).

The membrane stability index indicates the loss of membrane stability and cell death proceeding to the early petal senescence and decreased shelf life (Van Doorn, 2004). In rose petals, the loss of water

content increased with an ion leakage (Van Meeteren, 1979). Release of the ions into the interspaces of plant cells is a resultant process of disturbed water content leading to early breakdown of plasma membrane in cut flowers (Vijaya Bhaskar *et al*., 2006). The favourable effect of benzyl adenine and sucrose has significantly improved the membrane stability index at cold and ambient storage condition at advanced stage of senescence of *Jasminum nitidum* and decreased towards senescence stage as observed in the present study, which was supported in the literature by Santarius (1973). However, Van Doorn (2004) stated that sucrose is known to stabilize selective permeability of cell membrane. Besides this, leakage of cell constituents due to loss of structural integrity of cell membrane results in death of flowers and also by retaining high sugar levels in petal tissue provided stable CAT and POX activities in petals that contributed in stabilizing cell membrane structure in poly film packaged buds and also registered high retention of absolute integrity of cell membrane in the petal tissue (Bhattacharjee, 2003).

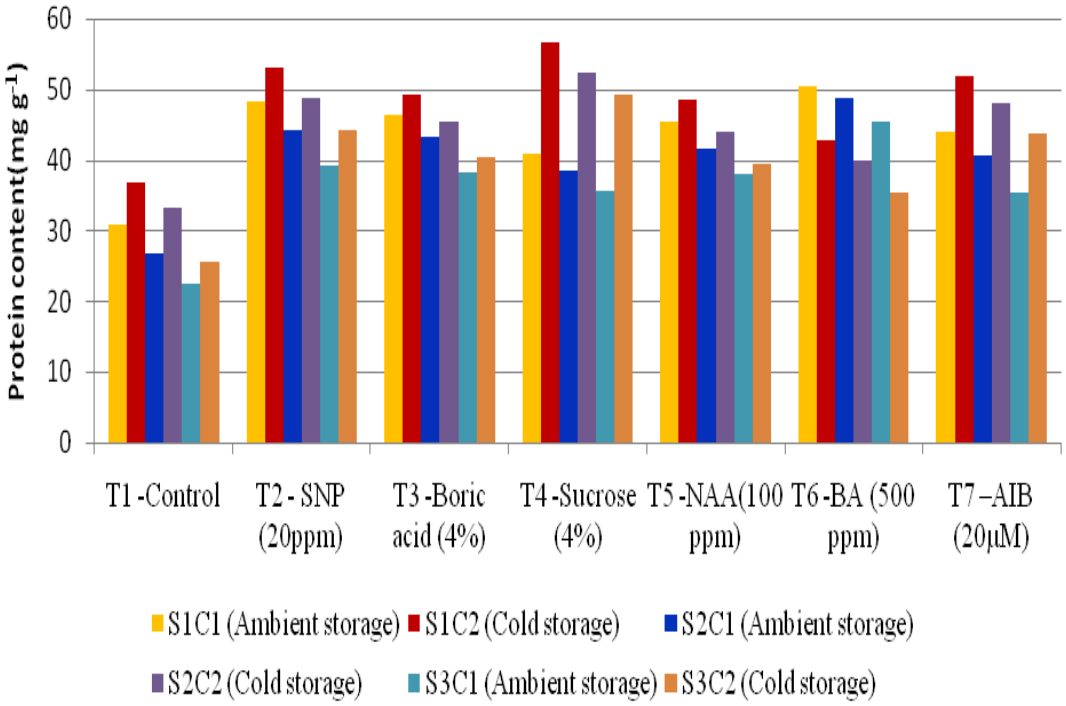

Figure 3. Effect of different anti senescence chemical treatment on protein content (mg g^{-1}) in *Jasminum nitidum*

Protein content

Effect of chemical treatments and storage condition of *J. nitidum* on protein content was recorded and the results are presented in Figure 3. It has been clearly observed from the results that protein content in petals significantly influenced by different anti-senescence chemicals and storage conditions of *J. nitidum* flowers. The maximum protein was recorded in sucrose (4%) (T_4) in bud stage with 56.74 mg g^{-1}, 52.32 mg g^{-1} in bud opening stage and 49.19 mg g^{-1} in senescence stage under cold storage condition. While lowest protein content was registered in control (T_1) with 36.73 mg g^{-1} at bud stage,33.11 mg g^{-1} at opening stage and 25.65 mg g^{-1} of protein at senescence stage. However, minimum protein content in bud stage with 36.73 mg g^{-1}, in opening stage with 33.11 mg g^{-1} and in senescence stage with 25.65 mg g^{-1} was observed in control (T_1) at cold storage. The results on protein content showed a significant influence of chemical treatments in ambient storage condition. Benzyl Adenine 500 ppm (T_6) registered maximum protein content with 50.45 mg g^{-1} which showed significant difference among the treatments while control (T_1) recorded minimum protein content of 30.72 mg g^{-1}. Protein content declined over the time period, Benzyl Adenine 500 ppm treatment registered the highest protein content with 48.82 and 45.33 mg g^{-1} in opening and senescence stages respectively. Least protein content was found in control (T_1) with 26.67 mg g^{-1} in opening stage and 22.44 mg g^{-1} in senescence stage respectively. It could be observed in the present study that the protein content were significantly affected by treatments and storage conditions. In various ornamental cut flowers, protein play an important role in flower senescence (Van Doorn and Woltering 2008). Similar finding has been reported in *Ranunculus asiaticus* L. The level of protein content varied with flower development to senescence stage (Shahri and Tahir, 2011a). In carnation, protein content were getting declined along with senescence (Borochov *et al*, 1976). Protein losses in petals have been constantly associated with petal senescence (Stead and Van Doorn, 1994). The dismantling of membranes is a resultant feature of protein degradation (Woolhouse, 1984). The protein content decreased with the simultaneous

increase in specific protease activity and α-amino acid content during different stages of flower development (Shahri and Tahir, 2011b). In this present study also, the increased protein content was considerably induced by the application of sucrose at 4% in bud stage, bud opening stage and senescence stages under cold storage condition. These finding of the present study is in line with the results of Azeez *et al*., (2007) in *Gladiolus grandiflorus* was attributed with the degradation of protein which accompanies with rise in serine protease activity. Protein degradation and remobilization is mediated through the action specific proteases and protein ubiquitination (Jones *et al*., 1995; Sugawara *et al*., 2002; Wagstaff *et al*., 2002). The higher protein level in best treatment suggested more protein synthesis and less protein degradation. Decrease in protein degradation is due to lesser activity or expression of proteolytic enzymes. Cellular redox state can modulate the Ubiquitin-mediated proteolysis (Obin *et al*., 1998).

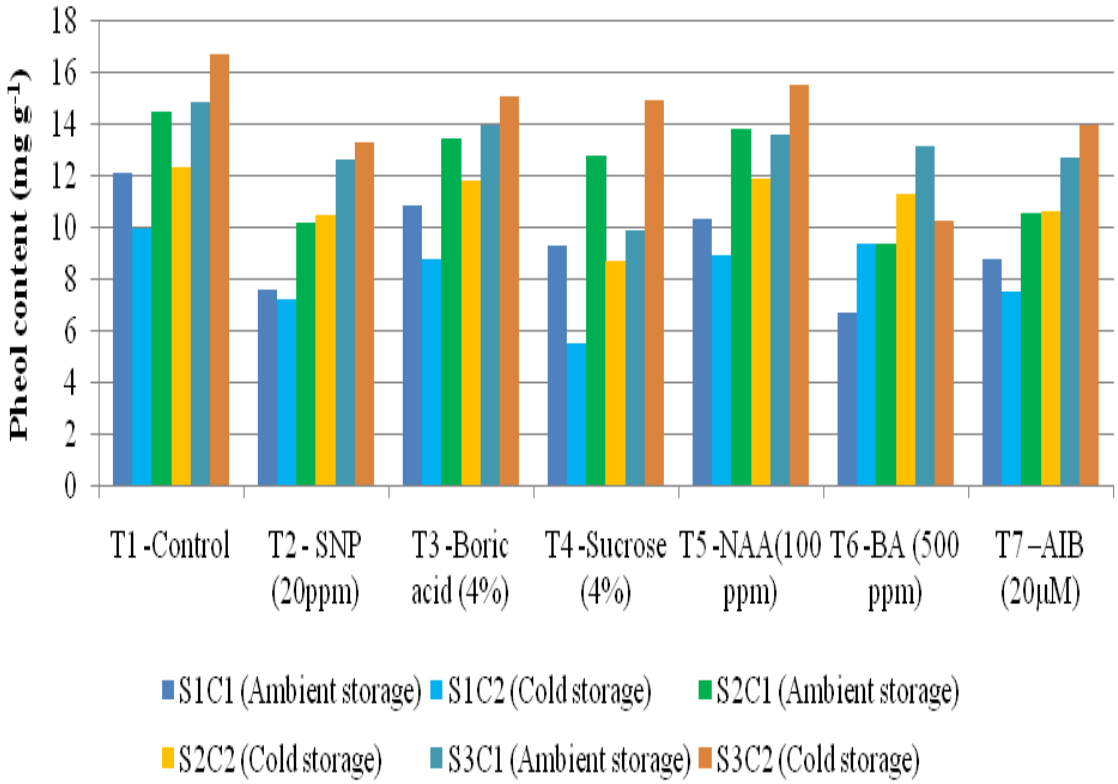

Figure 4. Effect of different anti senescence chemical treatment on protein phenol (mg g^{-1}) in *Jasminum nitidum*

Total phenol content

It is evident from the data that different chemical and storage condition was found significant by reduced with respect to total phenol content of *J. nitidum*. The trend line shows the sharp increase in phenol content towards the senescence stage. Sucrose (4%) (T_4) recorded the minimum of 5.48 mg g^{-1} of phenol content and control (T_1) recorded maximum phenol content of 9.95 mg g^{-1} under cold storage condition at bud stage. As trend line of phenol content noticed to be increased corresponding to the opening stage and senescence stage (Figure 4). Minimum phenol content noticed in the treatment sucrose (4%) (T_4) with 8.69 mg g^{-1} in opening stage and 9.89 mg g^{-1} in senescence stage at cold storage condition. It has been noticed that storage condition significantly affects the total phenol content. Benzyl Adenine 500 ppm (T_6) recorded minimum phenol content of 6.67 mg g^{-1} in bud stage, 9.37 mg g^{-1} in opening stage and 10.23 mg g^{-1} in senescence stage when compared with control (T_1) which registered 12.12 mg g^{-1}, 14.53 mg g^{-1} and 16.74 mg g^{-1} at bud, opening and senescence stage under ambient storage condition.

Enzymatic discolouration leading to browning of petals is the resultant process of oxidation of phenolic compounds by the action of polyphenol oxidase enzyme. Phenol compounds are potent antioxidant to scavenge the reactive oxygen species during senescence. Phenol is having the ability to protect the tissue from the harmful oxidative stress damage. The deleterious active oxygen species (AOS) such as singlet oxygen, superoxide radical, hydrogen peroxide, hydroxylation and free hydroxyl radical ($_1O^2$, $•O^{-2}$, H_2O_2, OH^- and $^•OH$) which are invariably produced during normal metabolism and exposure to stresses which ultimately cause the most of the metabolic abnormalities in living organisms. Phenol decreases the reactive oxygen species by increasing

antioxidants activity. Phenol content increases as flower progress towards senescence (Waseem and Inayatullah, 2011). Low phenol content in sucrose (4%) treatment designate delayed senescence which was further seen by highest shelf life and high membrane stability index. The results of the present investigation revealed that the level of the level of total phenol increased from stage 1 to stage 3 and the highest total phenols were recorded in stage 3 *i.e.* flowers showing senescence. Phenolic compounds are a class of antioxidant agents which act as free radical terminators (Tiwari and Tripathi, 2007). The increased levels of phenols at senescence stage may have contributed in reduction of the degradative processes occurring with the progress of senescence. Similar results was observed in *Ranunculus asiaticus* L. (Shahri and Tahir, 2011a). Increased levels of bound phenols have been reported in the full bloom stage of *Rosa damascena* (Sood and Nagar, 2003). In cut *Nerine sarniensis* flowers, increased phenols with progress in flower development and senescence have also been recorded (Gul *et al*., 2012).

Conclusion

The above study with treatment of different anti-senescence chemicals and two storage conditions of cold storage and ambient storage at three different flower stages *viz.,* bud, open and senescence stages concluded that flower bud stored in cold storage condition with post harvest anti-senescence chemical (sucrose 4%) treatment recorded highest shelf life compared to control and BA (500 ppm) treatment maintained highest values in ambient storage condition. Post harvest anti-senescence chemical (sucrose 4%) and BA (500 ppm) treatment enhanced the value of physio-biochemical parameters of moisture content, membrane stability index, protein content and less phenol content, which improved the shelf life of *Jasminum nitidum*..

References

Azeez, A., Sane, A. P., Bhatnagar, D. and P. Nath. 2007. Enhanced expression of serine proteases during floral senescence in Gladiolus. *Phytochemistry,* ***68*****(10),** 1352-1357.

Bailly, C., Benamar, A., Corbineau, F. and D. Come. 1997. Changes in superoxide dismutase, catalase and glutathione reductase activities in sunflower seeds during accelerated ageing and subsequent priming *Basic and applied aspects of seed biology* (pp. 665-672): Springer.

Bhattacharjee, S. 2003. Post harvest life and quality of rose cut flowers as affected by precooling, storage and gamma irradiation. *Indian Rose Annual,* ***19*****,** 116-143.

Borohov, A., Tirosh, T. and A.H.Halevy. 1976. Abscisic acid content of senescing petals on cut rose flowers as affected by sucrose and water stress. *Plant physiology,* ***58*****(2)**, 175-178.

Carpenter, W. 1973. Water uptake rates by cut roses (Rosa hybrida) in light and dark. *J. Amer. Soc. Hort. Sci.,* ***98***, 309-313.

Deshmukh, P., Sairam, R. and D.Shukla. 1991. Measurement of ion leakage as a screening technique for drought resistance in wheat genotypes-Short Communication. *Indian Journal of Plant Physiology (India)*.

Gul, F., Tahir, I. and I.U. Rasool. 2012. Senescence and Postharvest Performance of Cut Nerine sarniensis Flowers: Effects of Cycloheximide. *International Journal of Botany*.

Jones, M. L., Larsen, P. B. and W. R. Woodson. 1995. Ethylene-regulated expression of a carnation cysteine proteinase during flower petal senescence. *Plant molecular biology,* ***28*****(3)**, 505-512.

Lowry, O.H., N.J. Rosenbrough, A.L. Farr and R.J. Randall. 1951. Protein measurement with folin phenol reagent. *Biol. Chem.,* ***193***: 265-275.

Malick, C. P., and M.B. Singh. 1980. Plant Enzymology and Histo-enzymology. *Flori.Exchange,*.

Nagaraja, G., Gowda, J. and A. Farooqi. 1999. Influence of chemicals and packaging on the shelf life of tuberose flowers. *Karnataka Journal of Agricultural Sciences,* ***12*****(1/4)**, 132-136.

Nirmala, S., and T. V. Reddy . 1993. Extension of shelf life of Jasminum multiflorum through packaging.

Obin, M., Shang, F., Gong, X., Handelman, G., Blumberg, J. and A. Taylor. 1998. Redox regulation of ubiquitin-conjugating enzymes: mechanistic insights using the thiol-specific oxidant diamide. *The FASEB Journal,* ***12*****(7)**, 561-569.

Paull, R., Chen, N. J. and J. Deputy. 1985. Physiological changes associated with senescence of cut anthurium flowers. *Journal of the American Society for Horticultural Science (USA)*.

Premachand, G. S, H. Saneoka and S. Ogata. 1990. Cell membrane stability, an indicator of drought tolerance, as affected by applied nitrogen in soyabean. *The Journal of Agricultural Science.****115(1)***: 63-66.

Rogers, H. J. 2006. Programmed cell death in floral organs: how and why do flowers die? *Annals of Botany,* ***97*****(3)**, 309-315.

Santarius, K. A. 1973. The protective effect of sugars on chloroplast membranes during temperature and water stress and its relationship to frost, desiccation and heat resistance. *Planta,* ***113*****(2)**, 105-114.

Serek, M. and M. Reid. 2000. Role of growth regulators in the postharvest life of ornamentals *Plant Growth Regulators in Agriculture and Horticulture* (pp. 147-174): Food Products Press.

Shahri, W. and I. Tahir. 2011a. Flower development and senescence in Ranunculus asiaticus L. *Journal of Fruit and Ornamental Plant Research,* ***19*****(2)**, 123-131.

Shahri, W. and I.Tahir. 2011b. Flower senescence-strategies and some associated events. *The Botanical Review,* ***77*****(2)**, 152-184.

Sood, S. and P. K. Nagar. 2003. Changes in abscisic acid and phenols during flower development in two diverse species of rose. *Acta physiologiae plantarum,* ***25*****(4)**, 411-416.

Stead, A. and W. Van Doorn. 1994. *Strategies of flower senescence.* Paper presented at the SEMINAR SERIES-SOCIETY FOR EXPERIMENTAL BIOLOGY.

Sugawara, H., Shibuya, K., Yoshioka, T., Hashiba, T. and S. Satoh. 2002. Is a cysteine proteinase inhibitor involved in the regulation of petal wilting in senescing carnation (Dianthus caryophyllus L.) flowers? *Journal of Experimental Botany,* ***53*****(368)**, 407-413.

Tiwari, O. P. and Y. B.Tripathi. 2007. Antioxidant properties of different fractions of Vitex negundo Linn. *Food Chemistry,* ***100*****(3)**, 1170-1176.

Van Doorn, W. G. 2004. Is petal senescence due to sugar

starvation? *Plant physiology,* ***134*****(1)**, 35-42.

Van Doorn, W. G. and E.J. Woltering, 2008. Physiology and molecular biology of petal senescence. *J Exp Bot,* ***59*****(3),** 453-480.

Van Meeteren, U. 1979. Water relations and keeping-quality of cut Gerbera flowers. III. Water content, permeability and dry weight of ageing petals. *Scientia horticulturae,* ***10*****(3)**, 261-269.

Vijaya Bhaskar, V., Venkata Rao, P. and J. Dilip Babu, 2006. Effect of postharvest application of antioxidants on physiological and biochemical changes of cut rose (Rosa hybrida L.) petals during vase life period. *Journal of ornamental horticulture,* ***9*****(2)**, 75-79.

Wagstaff, C., Leverentz, M. K., Griffiths, G., Thomas, B., Chanasut, U., Stead, A. D. and H. J.Rogers. 2002. Cysteine protease gene expression and proteolytic activity during senescence of Alstroemeria petals. *Journal of Experimental Botany,* ***53*****(367)**, 233-240.

Waseem, S. and T.Inayatullah. 2011. Physiological and biochemical changes associated with flower development and senescence in Consolida ajacis Nieuwl cv. Violet blue. *Frontiers of agriculture in China,* ***5*****(2)**, 201-208.

Woolhouse, H. W. 1984. The biochemistry and regulation of senescence in chloroplasts. *Canadian Journal of Botany,* ***62*****(12)**, 2934-2942.

Xue, Q. H. and R. Lin. 1999. Senescence of China rose cut flower and its relationship to moisture content, lipid peroxidation and protective enzyme activity. *J. Fujian Agri. Univ,* ***28***, 304-308.

Yamada, T., Ichimura, K., Kanekatsu, M. and W. G. Van Doorn. 2009. Homologs of genes associated with programmed cell death in animal cells are differentially expressed during senescence of Ipomoea nil petals. Plant and Cell Physiology, 50(3), 610-625.

Received : February 20, 2018; Revised : March 10, 2018; Accepted : March 25, 2018