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Standardization of Post-Harvest Management Techniques for Ixora *(Ixora* spp.*)*

Reshma R. [a*], Ganga M. [a], Visalakshi M. [a], Irene Vethamoni P. [b] and Chitdeshwari T. [c]

[a] Department of Floriculture and Landscape Architecture, TNAU, Coimbatore, India.
[b] Department of Horticulture, TNAU, Coimbatore, India.
[c] Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore, India.

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 objective of this experiment was to optimize the post-harvest handling techniques for four Ixora genotypes grown for loose flower purpose. The experiment was laid out in Factorial Completely Randomised Design (FCRD) with four genotypes namely *viz*., Red (*Ixora casei*-G_1), Pink (*I. chinensis*-G_2), Orange (*I. coccinea*-G_3) and Yellow (*I. chinensis*-G_4) and six post-harvest treatments replicated three times. Observations were made on the floral quality criteria as well as the physiological characters linked with flower post-harvest quality. The results revealed that among the genotypes, Red (*I. casei*-G_1) proved superior with respect to quality parameters and physiological parameters followed by Pink (*I. chinensis*-G_2). Among the post-harvest treatments, treating flower buds with 4% boric acid and storage under refrigeration @ 5^0C recorded superior results for all the quality parameters *viz.,* freshness index, flower opening index, colour retention and shelf life and the physiological parameters *viz.,* moisture content, relative water content and physiological loss in weight.

**Corresponding author: E-mail: reshurv1998@gmail.com;*

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1. INTRODUCTION

Ixora is a well-known blooming shrub of the Rubiaceae family. This plant is indigenous to South Asian nations. Ixora is also known as Jungle Geranium, Jungle Herb, Flame of the Woods and '*Vetchi*' in Ayurveda [1]. The genus name '*Ixora*' is believed to have derived from the Indo-Aryan term "*ikvana*" which refers to a Malaysian spiritual person or from the name of Lord Shiva, "*Iswara*" to whom the flowers are offered for worship. The plants are densely branched and the leaves are dark green in colour and oblong in shape. The inflorescences are terminal, dense corymbs and contain about 15 to 50 florets. Each individual flower is tubular with four or five calyx lobes. The most common and popular flower colours are red and red-orange. However, types with white, yellow, salmon or pink flowers are also prevalent and are now cultivated and marketed in horticultural outlets [2].

Ixora is produced commercially as a loose flower in Tamil Nadu, mainly in the districts of Karur, Tiruchirappalli and Dindigul Karthik et al. [3]. The blooms are used as loose flowers for religious offerings and floral decorations as well as value added commodities such as garlands in combination with other flowers. In recent years, new Ixora hybrids with a variety of flower colours, forms and plant heights have entered the market as a result of introduction and hybridization initiatives. It has recently become one of the most significant ornamental crops. It has recently gained popularity for its commercial usefulness as a loose flower.

Flowers of Ixora are preferred for their aesthetic appeal and long post-harvest life. Floral physiology is highly complicated and researchers frequently focus on changes that occur during petal senescence rather than the shelf life of flowers [4,5]. Taking into account the growing market preference for Ixora as loose flower, the current study was taken up with the goal of optimising post-harvest handling techniques for *Ixora* flowers.

2. MATERIALS AND METHODS

The experiment was carried out at the Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute of Tamil Nadu Agricultural University, Coimbatore. The design of experiment was laid out in FCRD with six treatments and three replications. Unopened fresh flower buds of uniform size of four different genotypes of ixora *viz.*, Red (*I. casei* - G_1), Pink (*I. chinensis* - G_2), Orange (*I. coccinea* - G_3), Yellow (*I. chinensis* - G_4) were packed in polyethylene bags with a thickness of 200-gauge microns and a size of 4 cm × 6 cm with 4% ventilation. The post-harvest treatments included T_1 - Storage at room temperature (Control), T_2 - Storage under refrigeration @ 5^0C, T_3 - Boric acid 4 % + Room temperature, T_4 - Boric acid 4% + Refrigeration @ 5^0C, T_5- Sucrose 4% + Room temperature and T_6 - Sucrose 4% + Refrigeration @ 5^0C. For each post-harvest treatment, 100 numbers of fresh flower buds of uniform size were used. For the boric acid and sucrose treatments, the treated flower buds were surface dried and packaged in zip lock polyethylene bags. These bags were kept at ambient temperature or in a cold storage facility with temperature maintained at 5°C.

2.1 Quality Parameters

2.1.1 Freshness index

The number of flowers that remained fresh without showing signs of petal necrosis, drooping or browning was counted. The following score is presented as a percentage of fresh flowers or as a freshness index.

> Freshness index = (No. of flowers remained fresh / Total No. of flowers) X100

2.1.2 Flower opening index

The flower opening index was calculated by using the following formula

> Flower opening index = (No. of flowers opened / Total No. of flowers) X100

2.1.3 Colour Retention Index (CRI)

Flower colour retention of ixora was recorded as per the following score chart the following formula:

Chart 1. Colour retention index (CRI) was computed by using

$$CRI = ((9\times X_1) + (8\times X_2) + (7\times X_3) + (6\times X_4) + (5\times X_5) + (4\times X_6) + (3\times X_7) + (2\times X_8) + (1\times X_9)) / ((X_1+X_2+X_3+X_4+X_5+X_6+X_7+X_8+X_9) \times 9) \times 100$$

Flower colour development during storage	Score	Number of flower buds under this Score
Bright Red/Pink/Orange/Yellow	9	X_1
Dull Red/Pink/Orange/Yellow	8	X_2
Commencement of brownish discolouration	7	X_3
1 to 10% brown	6	X_4
11 to 15% brown	5	X_5
16 to 50% brown	4	X_6
51 to 75% brown	3	X_7
76 to 90% brown	2	X_8
100% brownish discolouration	1	X_9

2.1.4 Shelf life

The shelf life of flowers was determined by noting the number of hours that 50% or more of the blooms remained fresh. The time required for the development of necrotic signs was recorded, and the shelf life was calculated as the number of hours between the placement of the loose flowers and the wilting and fading of the petals of these loose flowers.

2.1.5 Physiological parameters

According to Barrs and Weatherley [6], physiological parameters such as Moisture Content (MC), Relative Water Content (RWC) and Physiological Loss in Weight (PLW) were measured.

The observations were taken on second, fourth, sixth and eighth day after treatment. The data from the observations were assessed for significance using the International System for Agricultural Science and Technology (AGRIS) software by [7].

3. RESULTS AND DISCUSSION

3.1 Quality Parameters

3.1.1 Freshness index

Data pertaining to freshness index are furnished in Table 1. Among the four genotypes, Red (*I. casei* - G_1) showed the maximum mean freshness index on 2nd (94.44), 4th (84.63), 6th (74.4) and 8th (64.35) day of storage and the least mean freshness index was noticed in Yellow (*I. chinensis* - G_4) on 2nd day (84.5) and 4th day (74.4). On 6th day (67.13) and 8th day (57.08) Orange (*I. coccinea* - G_3) recorded the least freshness index. Of the six different post-harvest treatments, Boric acid 4% + Refrigeration @ 5^{0}C (T_4) showed maximum mean freshness index on 2nd (94.09), 4th (84.02), 6th (76.42) and 8th (66.37) day followed by Sucrose 4% + Refrigeration @ 5^{0}C (T_6) (92.57, 82.47, 74.84 and 64.8 respectively) and the least mean freshness index (84.64, 74.57,67.02 and 56.99 respectively) was noticed in control (T_1) on 2nd, 4th, 6th and 8th day. Among the interaction effects, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^{0}C) recorded maximum freshness index (99.79,89.8, 74.4 and 69.8 on the 2nd, 4th, 6th and 8th day respectively) and least freshness index (52.4) was recorded in G_3T_1 (Genotype Orange [*I. coccinea*] + Storage at room temperature). Increase in glucose accumulation, peroxidase and catalase activity and membrane integrity coupled with reduced solute leakage from flowers have been reported as reasons for improved flower freshness [8,9]. All of these parameters are useful in preserving the freshness index of flowers and delaying wilting. The osmotic concentration and pressure potential of flower petal cells are enhanced by boric acid which in turn improves the water balance and vase life of cut flowers.

3.1.2 Flower opening index

As observed from the Table 2, among the four genotypes, the least mean flower opening indices (17.3, 36.26, 42.96 and 45.66 respectively) were noticed in Red (*Ixora casei*- G_1) and the highest values (28.1, 42.38, 48.33 and 65.01 respectively) were noticed in Yellow (*Ixora chinensis* - G_4) on 2nd, 4th ,6th and 8th day of storage. The treatment Boric acid 4% + Refrigeration 5^{0}C (T_4) recorded the lowest mean flower opening indices (16.9, 33.92, 38.45 and 45.19 respectively) and Control (T_1) recorded the highest values (29.8, 43.52, 49.17 and 60.72

respectively) on 2nd,4th, 6th and 8th day of storage. Among the interactions, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^0C) showed the least flower opening index (11.5, 28.51, 34.6 and 40.2 respectively) and G_4T_1 (Genotype Yellow [*I. chinensis*] + Storage under room temperature) showed the highest flower opening index (35.6, 48.9, 52.09 and 69.8 respectively) on 2nd, 4th, 6th and 8th day. Boric acid helps in reducing the flower opening index which helps the buds to stay fresh for longer periods. Similar results were observed by Sunny et al. [10].

3.1.3 Colour Retention Index (CRI)

As observed from Table 3, among the four genotypes, Red (*Ixora casei* - G_1) recorded the highest colour retention indices (93.23, 87.71, 77.71 and 67.71 respectively). The least mean Colour Retention Indices (88.16, 72.56, 62.5 and 52.48 respectively) were recorded in Yellow (*Ixora chinensis* - G_4) on 2nd, 4th, 6th and 8th day. Among the six treatments, Boric acid 4% + Refrigeration 5^0C (T_4) recorded the highest values (94.9, 87.3, 77.22 and 67.17 respectively) and control (T_1) noted least mean (86.12, 78.24, 68.19 and 58.22 respectively) on 2nd, 4th, 6th and 8th day. Among the interactions, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^0C) recorded highest (99.8, 97.8, 87.8 and 77.80 respectively) CRI on 2nd, 4th, 6th and 8th day. The combination G_4T_1 (Genotype Yellow [*I. chinensis*] + Storage under room temperature) recorded the least CRI (85.3, 69.89, 59.8 and 49.79 respectively on 2nd, 4th, 6th and 8th day). The boric acid-treated flowers showed expected colour preservation and scent, as well as reduced phenol accumulation than the control. The ability of boric acid to extend the life of flowers after harvest has already been reported in jasmine by [11,12,13,14] and crossandra by [15] which is consistent with the current finding.

3.1.4 Shelf Life

Data pertaining to shelf life are furnished in Table 4. Among all the four genotypes, Red (*I. casei* - G_1) showed the longest shelf life (202.09 hours) followed by Pink (*I. chinensis*- G_1) (165.68). Yellow (*Ixora chinensis* - G_4) showed the least shelf life (157.5 hours). Among the six treatments, Boric acid 4% + Refrigeration 5^0C (T_4) recorded the highest mean (187.35) and control (T_1) showed the least mean (158.25) shelf life. Among the interaction effects, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^0C) showed the longest shelf life (223.9 hours). G_4T_1 (Genotype Yellow [*I. chinensis*] + Storage under room temperature) recorded the shortest shelf life (145.4 hours). Senescence typically causes changes in floral moisture content, carbohydrate and other nutritional reserves, enzyme activity, and ethylene generation and action. The principal problem inhibiting post-harvest life of the flowers is water loss. Reduced water loss can be achieved by preserving at high relative humidity (90-98%) either by packing or by maintaining the flowers at a low temperature [16]. According to [17] the browning may be caused by the buildup of flavins and other phenolic compounds in floral cell vacuoles. Tuberose flower buds treated with 4% boric acid were found to be best with regard to maximum shelf life [18,19].

3.2 Physiological Parameters

3.2.1 Moisture content

As observed from the Table 5, among the four genotypes, the highest mean moisture content (71.68,61.61, 51.73 and 41.7 respectively) was noticed in Red (*I. casei* - G_1) and least values (65.18, 55.14, 45.13 and 35.05 respectively) were noticed in Yellow (*Ixora chinensis* - G_4) on 2nd, 4th ,6th and 8th day of storage. Among the

Illustration 1. Comparison of control (T_1) on Red (*I. casei* – G_1) and Pink (*I. chinensis* – G_2)

Illustration 2. Comparison of control on Orange (*I. coccinea* – G_3) and Yellow (*I. chinensis* – G_4)

Illustration 3. Comparison of best treatment (T_4) on Red (*I. casei* – G_1) and Pink (*I. chinensis* – G_2)

Illustration 4. Comparison of best treatment(T_4) on Orange (*I. coccinea* – G_3) and Yellow (*I. chinensis* – G_4)

treatments, Boric acid 4% + Refrigeration 5^0C (T_4) recorded the highest mean moisture content (71.62, 61.54, 51.67 and 41.7 respectively) and Control (T_1) showed least mean (61.9, 52.02, 42.2 and 32.02 respectively) moisture content on 2nd, 4th, 6th and 8th day of storage. Among the interactions, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^0C) showed highest moisture content (76.5, 66.3, 56.9 and 46.8 respectively) and G_4T_1 (Genotype Yellow [*I. chinensis*] + Storage under room temperature) showed the least moisture content

Table 1. Freshness index of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors	Freshness index (%)																			
	Genotypes / Treatments	2nd day					4th day					6th day					8th day				
		G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	89.29	85.7	82.7	80.9	**84.64**	79.3	75.6	72.6	70.8	**74.57**	69.30	65.50	62.5	70.8	**67.02**	59.5	55.4	52.4	60.69	**56.99**
2	**T_2** Storage under refrigeration @ 5^0C	90.69	89.3	84.6	81.4	**86.49**	81.90	79.2	74.5	71.3	**76.72**	71.5	69.1	64.40	71.3	**69.07**	61.40	59.2	54.3	61.4	**59.07**
3	**T_3** Boric acid 4 % + Room temperature	93.4	93.3	88.7	82.7	**89.52**	83.4	83.2	78.6	72.6	**79.4**	73.2	73.10	68.5	72.6	**71.85**	63.1	63.2	58.39	62.5	**61.79**
4	**T_4** Boric acid 4% + Refrigeration 5^0C	99.79	95.9	90.8	89.9	**94.09**	89.8	85.8	80.69	79.8	**84.02**	79.8	75.7	70.6	79.6	**76.42**	69.8	65.6	60.50	69.6	**66.37**
5	**T_5** Sucrose 4% + Room temperature	95.60	92.1	87.9	83.4	**89.75**	85.8	82.2	77.8	73.3	**79.77**	75.20	72.10	67.7	73.3	**72.07**	65.3	62.2	57.7	63.19	**62.09**
6	**T_6** Sucrose 4% +Refrigeration 5^0C	97.89	94.6	89.1	88.7	**92.57**	87.60	84.49	79.2	78.6	**82.47**	77.3	74.39	69.1	78.6	**74.84**	67.2	64.30	59.2	68.5	**64.8**
	Mean	**94.44**	**91.81**	**87.3**	**84.5**		**84.63**	**81.74**	**77.23**	**74.4**		**74.4**	**71.65**	**67.13**	**74.35**		**64.35**	**61.65**	**57.08**	**64.34**	
	Treatments	**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**		
	SEd	0.76	0.94	1.88			0.66	0.81	1.63			0.56	0.68	1.37			0.54	0.66	1.32		
	CD (0.05)	1.54	1.89	3.78			1.33	1.63	3.27			1.12	1.38	2.76			1.08	1.33	2.66		

Table 2. Flower opening index of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors: Genotypes / Treatments	Flower opening index (%)																			
		2nd day					4th day					6th day					8th day				
		G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	21.8	29.4	32.4	35.6	**29.8**	42.3	40.5	42.4	48.90	**43.52**	48.9	48.9	46.8	52.09	**49.17**	50.49	53.4	69.5	69.8	**60.72**
2	**T_2** Storage under refrigeration @ 5^0C	19.4	23.4	29.6	27.9	**25.07**	39.9	39.6	39.59	46.49	**41.39**	46.50	46.5	43.49	49.5	**46.5**	48.6	50.1	66.39	66.4	**57.87**
3	**T_3** Boric acid 4 % + Room temperature	16.8	25.7	23.5	24.6	**22.65**	36.4	36.90	38.3	43.6	**38.8**	44.8	44.8	41.60	47.60	**44.7**	46.7	48.90	64.8	64.79	**56.3**
4	**T_4** Boric acid 4% + Refrigeration 5^0C	11.5	13.8	19.8	22.5	**16.9**	28.51	30.2	36.7	40.3	**33.92**	34.6	35.60	40.80	45.8	**38.45**	40.2	43.6	50.49	50.5	**46.19**
5	**T_5** Sucrose 4% + Room temperature	18.7	21.6	28.9	29.4	**24.65**	35.6	38.6	37.90	38.6	**37.67**	44.20	44.19	45.60	46.4	**45.1**	45.60	47.80	67.1	67.10	**56.9**
6	**T_6** Sucrose 4% +Refrigeration 5^0C	15.6	26.4	26.9	28.6	**24.37**	33.2	35.4	35.1	36.4	**35.02**	43.79	43.8	42.6	48.6	**44.69**	42.40	45.8	65.79	65.8	**54.95**
	Mean	**17.3**	**23.38**	**26.85**	**28.1**		**36.26**	**36.58**	**38.33**	**42.38**		**42.96**	**43.96**	**43.48**	**48.33**		**45.66**	**48.26**	**64.01**	**65.01**	
	Treatments	**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**		
	SEd	0.21	0.26	0.53			0.34	0.41	0.83			0.33	0.41	0.83			0.52	0.64	1.28		
	CD (0.05)	0.43	0.53	1.07			0.68	0.83	1.67			0.68	0.83	1.66			1.05	1.29	2.59		

Table 3. Colour retention index of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors: Genotypes / Treatments	Colour retention index (%)																			
		2nd day					4th day					6th day					8th day				
		G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	85.4	85.9	87.8	85.3	**86.12**	82.49	81.19	79.4	69.89	**78.24**	72.49	71.19	69.3	59.8	**68.19**	62.5	61.3	59.3	49.79	**58.22**
2	**T_2** Storage under refrigeration @ 5^0C	87.4	82.7	89.4	86.8	**86.57**	84.5	83.4	80.1	70.1	**79.52**	74.49	73.6	70.1	60.1	**69.57**	64.5	63.6	60.09	50.1	**59.57**
3	**T_3** Boric acid 4 % + Room temperature	95.1	93.2	90.4	87.6	**91.57**	87.40	84.50	81.2	72.4	**81.37**	77.39	74.6	71.19	62.4	**71.39**	67.39	64.39	61.2	52.3	**61.32**
4	**T_4** Boric acid 4% + Refrigeration 5^0C	99.8	96.5	92.4	90.9	**94.9**	97.8	90.50	85.3	75.6	**87.3**	87.8	80.50	75.2	65.39	**77.22**	77.80	70.29	65.2	55.4	**67.17**
5	**T_5** Sucrose 4% + Room temperature	94.4	94.3	89.9	88.2	**91.7**	86.6	85.6	83.49	73.1	**82.19**	76.6	75.49	73.39	63.1	**72.14**	66.6	65.49	63.3	53.2	**62.14**
6	**T_6** Sucrose 4% +Refrigeration 5^0C	97.3	95.4	91.2	89.6	**93.37**	87.5	87.4	84.6	74.30	**83.45**	77.5	77.39	74.6	64.2	**73.42**	67.5	67.3	64.39	54.10	**63.32**
	Mean	**93.23**	**91.25**	**90.18**	**88.16**		**87.71**	**85.43**	**82.34**	**72.56**		**77.71**	**75.46**	**72.29**	**62.5**		**67.71**	**65.39**	**62.24**	**52.48**	
	Treatments	**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**		
	SEd	0.77	0.95	1.9			0.7	0.86	1.72			0.67	0.82	1.64			0.56	0.68	1.37		
	CD (0.05)	1.56	1.91	3.82			1.42	1.74	3.49			1.34	1.65	3.3			1.13	1.38	2.76		

Table 4. Shelf life of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors	Shelf life (Hours)				
	Genotypes / Treatments	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	194.1	147.7	145.8	145.4	**158.25**
2	T_2 Storage under refrigeration @ 5^0C	193.3	159.4	153.6	146.9	**163.3**
3	T_3 Boric acid 4 % + Room temperature	198.4	170.3	158.4	160.4	**171.87**
4	T_4 Boric acid 4% + Refrigeration 5^0C	223.9	183.7	169.9	171.9	**187.35**
5	T_5 Sucrose 4% + Room temperature	199.3	165.8	159.4	158.6	**170.77**
6	T_6Sucrose 4% +Refrigeration 5^0C	203.58	167.2	163.1	161.8	**173.92**
Mean		**202.09**	**165.68**	**158.36**	**157.5**	
	Treatments	**G**		**T**		**GXT**
	SEd	1.81		2.22		4.45
	CD (0.05)	3.65		4.48		8.96

Table 5. Moisture content of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors: Genotypes / Treatment	Moisture content (%)																			
		2nd day					4th day					6th day					8th day				
		G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	64.7	62.9	60.2	60.1	**61.97**	54.7	52.8	50.4	50.2	**52.02**	44.8	42.3	40.89	40.8	**42.2**	34.5	32.1	30.59	30.4	**32.02**
2	**T_2** Storage under refrigeration @ 5^0C	66.8	64.7	62.3	61.9	**63.92**	56.8	54.8	52.4	51.7	**53.92**	46.7	44.8	42.59	41.6	**43.92**	36.9	34.6	32.79	31.4	**33.92**
3	**T_3** Boric acid 4 % + Room temperature	72.4	70.2	64.7	65.8	**68.27**	62.50	60.1	54.8	55.79	**58.3**	52.8	50.6	44.89	45.8	**48.52**	42.7	40.8	34.5	35.70	**38.42**
4	**T_4** Boric acid 4% + Refrigeration 5^0C	76.5	72.3	69.8	67.9	**71.62**	66.3	62.3	59.7	57.89	**61.54**	56.9	52.4	49.6	47.8	**51.67**	46.8	42.69	39.8	37.50	**41.7**
5	**T_5** Sucrose 4% + Room temperature	73.9	69.7	66.9	66.9	**69.35**	63.7	59.8	56.7	56.8	**59.25**	53.4	49.7	46.5	46.6	**49.05**	43.9	39.3	36.4	36.7	**39.07**
6	**T_6** Sucrose 4% +Refrigeration 5^0C	75.8	71.4	67.4	68.4	**70.75**	65.7	61.29	57.29	58.29	**60.64**	55.79	51.6	47.9	48.2	**50.87**	45.4	41.7	37.50	38.1	**40.67**
	Mean	**71.68**	**68.53**	**65.2**	**65.18**		**61.61**	**58.51**	**55.18**	**55.14**		**51.73**	**48.56**	**45.39**	**45.13**		**41.7**	**38.53**	**35.26**	**35.05**	
	Treatments	**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**		
	SEd	0.72	0.89	1.78			0.5	0.61	1.23			0.33	0.4	0.81			0.34	0.42	0.85		
	CD (0.05)	1.46	1.79	3.58			1.01	1.23	2.47			0.66	0.81	1.63			0.7	0.85	1.71		

Table 6. RWC of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors: Genotypes / Treatments	Relative water content (%)																			
		2nd day					4th day					6th day					8th day				
		G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	91.2	90.8	85.4	80.1	**86.87**	81.6	80.60	75.6	70.29	**77.02**	71.19	70.9	64.89	60.60	**66.69**	61.6	60.8	54.69	50.89	**56.99**
2	**T_2** Storage under refrigeration @ 5^0C	93.4	91.6	87.6	81.3	**88.47**	83.79	81.5	77.8	71.69	**78.69**	73.9	71.2	67.5	61.6	**68.55**	63.7	61.7	57.89	51.7	**58.74**
3	**T_3** Boric acid 4 % + Room temperature	95.7	92.8	89.1	83.6	**90.3**	85.79	82.7	79.2	73.89	**80.39**	75.6	72.6	69.50	63.49	**70.3**	65.40	62.8	59.2	53.8	**60.3**
4	**T_4** Boric acid 4% + Refrigeration 5^0C	97.8	93.4	90.8	85.6	**91.9**	87.89	83.5	80.80	75.69	**81.97**	77.6	73.8	70.7	65.39	**71.87**	67.89	63.4	60.4	55.3	**61.74**
5	**T_5** Sucrose 4% + Room temperature	94.6	91.7	86.7	82.8	**88.95**	84.49	81.6	76.90	72.90	**78.97**	74.29	71.4	66.6	62.69	**68.74**	64.2	61.3	56.70	52.59	**58.7**
6	**T_6** Sucrose 4% +Refrigeration 5^0C	96.3	92.9	88.1	84.6	**90.47**	86.20	82.7	78.29	74.5	**80.42**	76.1	72.60	68.4	64.2	**70.32**	66.20	62.7	58.4	54.3	**60.4**
	Mean	**94.83**	**92.2**	**87.95**	**83**		**84.96**	**82.1**	**78.1**	**73.16**		**74.78**	**72.08**	**67.93**	**62.99**		**64.83**	**62.11**	**57.88**	**53.09**	
	Treatments	**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**		
	SEd	0.73	0.9	1.81			0.65	0.8	1.61			0.51	0.63	1.26			0.53	0.65	1.31		
	CD (0.05)	1.48	1.82	3.64			1.32	1.62	3.24			1.03	1.27	2.54			1.07	1.32	2.64		

Table 7. PLW of Ixora flowers as influenced by genotypes and post-harvest treatments

S. No.	Factors: Genotypes / Treatments	Physiological loss in weight (%)																			
		2nd day					4th day					6th day					8th day				
		G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean	G_1	G_2	G_3	G_4	Mean
1	**T1 (Control)** Storage at room temperature)	7.9	8.1	7.5	7.2	**7.9**	15.6	14.08	15.69	18.6	**15.8**	19.8	22.4	27.8	35.59	**26.39**	24.7	24.79	34.8	49.3	**33.4**
2	**T_2** Storage under refrigeration @ 5^0C	6.7	7.6	7.2	7	**7.2**	15.12	13.54	16.66	17.36	**15.6**	18.69	21.9	26.5	34.9	**25.49**	23.6	23.70	48.4	33.60	**32.3**
3	**T_3** Boric acid 4 % + Room temperature	6.3	7.5	6.5	6.2	**6.62**	14.36	17.8	16.53	17.9	**16.65**	17.29	21.7	27.1	32.69	**24.69**	22.90	23.4	33.6	32.9	**28.2**
4	**T_4** Boric acid 4% + Refrigeration 5^0C	5.6	6.4	6.8	6.5	**6.32**	13.71	17.41	16.04	18.41	**16.39**	16.59	19.10	26.79	27.80	**22.57**	21.59	25.6	30.5	30.9	**27.14**
5	**T_5** Sucrose 4% + Room temperature	6.4	7.9	7	7.1	**7.1**	12.3	16.59	18.2	18.19	**16.44**	18.5	19.80	27.9	33.90	**25.02**	23.80	26.30	34.8	33.9	**29.7**
6	**T_6** Sucrose 4% +Refrigeration 5^0C	6.1	6.7	7.1	6.4	**6.57**	13.81	16.46	18.40	18.51	**16.79**	17.20	20.69	26.6	29.8	**23.57**	22.5	25.90	29.8	31.7	**27.47**
	Mean	**6.5**	**7.41**	**7.01**	**6.73**		**14.15**	**15.98**	**17**	**18.07**		**18.01**	**20.93**	**27.11**	**32.45**		**23.18**	**24.95**	**37.73**	**32.96**	
	Treatments	**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**			**G**	**T**	**GXT**		
	SEd	0.05	0.07	0.14			0.17	0.21	0.42			0.2	0.25	0.5			0.24	0.29	0.58		
	CD (0.05)	0.11	0.14	0.29			0.35	0.42	0.85			0.41	0.5	1			0.48	0.59	1.18		

(60.1, 50.2, 40.8 and 30.4 respectively) on 2nd, 4th, 6th and 8th day. Similar reduction in moisture content due to rapid water loss in petals was reported in *Rosa hybrida* by [20] and in anthurium cv. Ozaki Red by [21].

3.2.2 Relative water content

As observed in Table 6, among the four genotypes, Red (*Ixora casei* - G_1) recorded highest mean (94.83, 84.96, 74.78 and 64.83 respectively) relative water content and least mean RWC (83,73.16, 62.99 and 53.09 respectively) was recorded in Yellow (*Ixora chinensis* - G4) on 2nd, 4th ,6th and 8th day. Of the six treatments, Boric acid 4% + Refrigeration 5^0C (T_4) recorded the highest mean (91.9, 81.97, 71.87 and 61.74 respectively) and control (T_1) noted least mean (86.87,77.02, 66.69 and 56.99 respectively) on 2nd, 4th, 6th and 8th day. Among interactions, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^0C) recorded highest (97.8, 83.5, 77.6 and 67.89 respectively) RWC and G_4T_1 (Genotype Yellow [*I. chinensis*] + Storage under room temperature) recorded the least RWC (80.1, 70.29, 60.6 and 50.89 respectively) on 2nd, 4th, 6th and 8th day. In agreement with the present findings, in gladiolus a reduction in RWC of tepals produced tissue dryness and wilting as reported by [22]. The water state of flower petals is indicated by the relative water content of the blooms. When moisture content is higher and weight loss is lower, relative water content remains higher.

3.2.3 Physiological loss in weight

As observed from Table 7, among the four genotypes, the least mean PLW (6.5, 14.15, 18.07 and 23.18 respectively) was noticed in Red (*Ixora casei* - G_1) and the highest (67.3, 18.07, 32.45 and 32.96 respectively) was noticed in Yellow (*Ixora chinensis* - G_4) on 2nd, 4th ,6th and 8th day of storage. Among the treatments, Boric acid 4% + Refrigeration 5^0C (T_4) recorded the lowest mean PLW (6.32, 16.39, 22.57 and 27.14 respectively) and Control (T_1) showed highest mean (7.9, 15.8, 26.39 and 33.4 respectively) PLW on 2nd, 4th, 6th and 8th day of storage. Among the interactions, G_1T_4 (Genotype Red [*I. casei*] + Boric acid 4% + Refrigeration @ 5^0C) showed least PLW (5.6, 13.71, 16.59 and 21.59 respectively) and G_4T_1 (Genotype Yellow [*I. chinensis*] + Storage under room temperature) showed highest PLW (8.1, 18.6, 35.59 and 49.3 respectively) on 2nd, 4th, 6th and 8th day. Increased PLW produces a decline in the fresh weight of flowers, as noted by [23] in carnation and [24] in *Rosa damascena*.

4. CONCLUSION

The present investigation which was carried out to standardize post-harvest treatments for Ixora genotypes led to the inference that among the genotypes, Red (*I. casei*-G_1) proved superior with respect to quality parameters and physiological parameters followed by Pink (*I. chinensis*-G_2). Among the post-harvest treatments, treating flower buds with 4% boric acid and storage under refrigeration @ 5^0C recorded superior results for all the quality parameters *viz.,* freshness index, flower opening index, colour retention and shelf life and the physiological parameters *viz.,* moisture content, relative water content and physiological loss in weight.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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