Research Article

Response of cut rose cv. cardinal to sucrose and NaOCl concentration

Malik Owais Ullah Awan[1], Nangial Khan[2*], Murad Ali[1], Muhammad Junaid[2], Sohail[3], Farooq Nawaz[2], Rayyan Khan[2], Junaid Ali Shah[3], Akhtar Ali[2], Nasir Mehmood[4] , Zia Ullah[3], Irshad Ahmad[3] and Anis Ur Rehman Khalil[3]

1. Department of Horticulture, The University of Agriculture Peshawar-Pakistan
2. Department of Agronomy, The University of Agriculture Peshawar-Pakistan
3. Department of Water management, The University of Agriculture Peshawar-Pakistan
4. Department of Crop Protection, The University of Agriculture Peshawar-Pakistan
Corresponding author's email: nangialkhan@hotmail.com

Abstract

To find the response of cut rose cv. Cardinal to sucrose and NaOCl concentration, an experiment was conducted with normal day light under room condition and natural ventilation. Completely Randomized Design (CRD) was used for the experiment by replicating 3 times. Solutions of different combination of Sucrose levels of 0, 4, 8 and 12% and sodium hypochlorite with 0 (control), 5, 10 and 15 mgL^{-1} concentrations were applied to the cut rose cv. Cardinal. By analyzing of data collected, illustrated that cut rose cv. Cardinal significantly responded to sucrose and NaOCl levels. Combination of 15 mgl^{-1} NaOCl with 12% sucrose was found more favorable for the whole studied parameters. Early flower opening (4 days), maximum flower fresh weight (12.30g), flower size (6.01 cm), maximum flower longevity (16 days) and dry weight (3.78) were observed for cut rose retained in solution mixture of 12% sucrose and 15 mgL^{-1} NaOCl. The solution containing 12% Sucrose and 15 mgL^{-1} NaOCl significantly increased (12.30 g) flower fresh weight. Less percent petal drop (10%) was observed by solution containing combination of 12% sucrose and 15 mgL^{-1} NaOCl as compared to control (33.80 %). As for sugar application individually on cut rose, early flower opening took place (4 days), maximum flower size (6.14 cm), flower fresh weight (11.57g), minimum flower wilting (15.58%), maximum flower dry weight (3.78 g), minimum petal drop (23.96 %) and longer vase life (3.39 days) were observed for 12 % sugar solution. For NaOCl application individualy, the cut rose showed early flower opening took place (4 days), maximum flower size (6.16 cm), maximum flower fresh weight (11.27g), minimum flower wilting (15%), maximum dry weight (4.13 g), minimum petal drop (18.75 %) and longer vase life (14.77) were observed for 15 $mg.l^{-1}$ of NaOCl solution In general, 15 $mg.l^{-1}$ NaOCl and 12 % sucrose is considered a best solution combination to be used for cut rose flowers cv. cardinal longer and quality vase life.

Keywords: Cut Rose; Sucrose; NaOCl

Introduction

The significance of cut flower production globally increased after World War II due to improvement in the cut flower production. Cut flower production invented new technologies and techniques from production to utilization of cut flower. Floriculture is contributing as an important segment in agricultural businesses in several countries of the world. Cut flower trade recorded internationally 25% annual growth. Cut flower contributing 60% of the world international floriculture trade which is 11 billion dollar annually. The international trades amplified ten times from 0.5 billion in 1990 to 5.1 billion in 2005 and estimated to twofold up to 2025 [1].

Rose cut flower cultivation is gaining popularity among the farmers in Pakistan is increasing due to its reasonable price [2]. Allah (S.W.T) has gifted a wide range of climatic conditions to Pakistan providing opportunity to grow different species of cut flowers, which can improve the economic status of the growers. The local demand and consumption have not yet satisfied due mega difference between supply and demand [3].

Many areas of Khyber Pakhtunkhwa are appropriate for growing of rose flowers. Natural growth of Daffodil and Narcissus in Swat and Abbottabad provides opportunity for cut rose trade in the Province due increase in demand of Daffodils and Narcissus across the country. The farmers in the mountain areas have started growing these flowers in their agriculture lands [4].

Rosa hybrida is a member of roseaceae family and Genus Rosa which containing more than 150 species and 1000 cultivars. Rose is grown-up for amazing beauty of their flowers. Rose plant is used as specimen plant, as hedges, in the border, and as creeper for training on pillars and walls [5]. Rose having superiority over other flowers due to frequent used for decoration purposes. The role of rose in manufacturing of medicine cannot be denied. Similarly, rose also having an important ingredient in many foods products of nutritional value [6]. Rose flowers are often harvested in commercial maturity or bud stage and so flowers need large amount of soluble carbohydrates for opening. Treatment with sucrose promoted unfolding of petals, inhibited the decrease in fresh weight and occurrence of petals of cut rose [7].

Usually cut flowers have a short vase life. The vase life of cut flowers can be prolonged by use of environmental conditions, sucrose solution, sodium hypochlorite and silver thiosulphate solution [8]. To avoid wilting of flowers, they are dipped in water. However, a risk of air embolism occurs when cutting the flowers during harvesting. Air is usually absorbed by the stem and this bubble of air prevents water uptake. To avoid this problem the stem is re-cut in water mixed with citric acid [9].

Sodium hypochlorite as a source of chlorine is a cheap, environment friendly agent that can be used in the vase-solutions. Chlorine is used to inhibit growth of bacteria and fungi in cut flower vase solutions. Calcium hypochlorite, Sodium hypochlorite and dichloroisocyanuric acid (DICA) are the source for chlorination. During Chlorination following equilibrium reaction takes place. $Cl_2 + OH^- \leftrightarrow HOCl + OCl^- + H^+$. HOCl is the effective form of chlorine [10].

Cut flowers need to last longer in a vase or flower arrangement with their visual qualities, scent and look maintained in order to get consumer's acceptance. Cut flower visual quality and petals turgor can remain acceptable for only two or three days under normal conditions. Since most of the people would like to enjoy the beauty and smell of flowers for a longer period of time. Pakistan as an agriculture country can find a great space in international market by adopting cut flower production as industry. Similarly

the cut rose production having a future scope in the province KP. The preservatives price used in this experiment are cheap so any one can use it. The socioeconomic value of roses and its esteem as a cut flower give among the people compel us to explore the potential of extending vase life by using various preservatives.

Materials and method

The experiment "response of cut rose cv. Cardinal to sucrose and NaOCl concentration" was performed at the Post-harvest Laboratory, Department of Horticulture in The University of Agriculture, Peshawar during the Feb, 2014 aimed to observe the impact of NaOCl and sucrose on vase life at normal room temperature and natural ventilation.

Cut rose (*Rosa hybrida*. cv. cardinal) flowers were took from Sarhad Nursery Farm, Tarnab Farm Peshawar. Flowers harvested at the morning in loose bud stage by giving a slant cut having 20 cm stalk and immersed it in buckets containing simple water in upright position. Before transportation to the lab, cut rose was placed in Shade covered with plastic minimize moisture loss. At the laboratory, the stems were re-cut by giving a slant cut, removing 5 cm, and the stem length was kept 15 cm in order to remove air emboli to prevent blockage of xylem vessels due to air bubbles accumulation.

Preparation of NaOCl

Different concentration of NaOCl solutions were prepared by taking the required amount on NaOCl in beaker and filled it with distilled water up to 1 liter.

Factor A   **NaOCl levels**
- A0= 0 mg.L^{-1}
- A1= 5 mg.L^{-1}
- A2 = 10 mg.L^{-1}
- A3 = 15 mg.L^{-1}

Preparation of Sucrose solution

Solution of sucrose was prepared by dissolving different amount of sucrose in l00 ml of distilled water in a beaker. For the required solution 0, 40, 80 and 120 g of sucrose was dissolved in 100 ml of distilled water in order to prepare 0, 4, 8, and 12% w/v solution respectively.

Factor B   **Sucrose levels**
- B0= 0% w/v
- B1= 4% w/v
- B2 = 8% w/v
- B3 = 12% w/v

Treatment combination

A0B0	A0B1	A0B2	A0B3
A1 B0	A1 B1	A1 B2	A1 B3
A2 B0	A2 B1	A2 B2	A2 B3
A3 B0	A3 B1	A3 B2	A3 B3

Parameters that were studied

Each of these treatments of different combinations was applied to a vase solution sample of five flowers. The parameters studied during the experiment were as follows.

Flower opening (days)

Flower opening (days) were calculated for each treatment from initial time when flowers were placed in the vase solution. The flowers were counted as open when sepal of the flower unfolded and anther were seen clearly.

Flower size (cm)

Flowers sizes were calculated with help of verneir caliper when all the petal of the flower fully open

Flower fresh weight (g)

When flower attain its maximum size, flower fresh weight was calculated with the help of electronic balance.

Petal drop (%)

Petal drop percentage was found by counting total petals of each treatment and dropped petal and then using the given formula.

Petal drop (%) = $\dfrac{\text{No. of dropped petal}}{\text{Total No. petal}} \times 100$

Vase life (days)

Vase life of flower is termed as detaching flower from its plant until its possession of decorative value. Vase life (days) were calculated by given formula.

Vase life (days) = Day when cut rose was placed in solution to day when flower loss decorative value

Flower dry weight (g)

Flower dry weight in grams was calculated when flowers of the each sample were fully dried with help of balance and data was noted.

Statistical method

Statistical analysis

During data analysis CRD model by applying least significance Difference Test. The detail of treatments is given as under.

Results and discussion

To study the response of cut rose CV. Cardinal to sucrose and NaOCl, an experiment was carried out at Post harvest laboratory, The University of Agriculture, Peshawar in February 2014.

Flower opening

The data for average flower opening (days) is given in Table 1. The mean data clearly show that late flower opening (5.16) days were recorded for flower supplied with 0 mgL^{-1} sodium hypochlorite, followed by average flower opening (5.01) days for NaOCl at 5mg.L^{-1} while early flower opening (4.32) days were recorded by flower interacted with 15 mg.L^{-1} NaOCl solution. The data for sucrose solution showed that 8% Sucrose Solution resulted early flower opening (4.27) days, followed by flower opening (4.71) days for 4% sucrose solution while late flower opening (5.23) days were obtained from flower supplied with distilled water i.e. control treatment.

Quality retention of cut roses are kept due to carbohydrate and soluble sucrose in the petals for extended period. So the flower sample applied with sucrose and NaOCl was found significant. Due to NaOCl the pH of the solution in vase became lower which prevent bacterial growth which to prevent vessel blockage thus advance the uptake of water by cut rose flower stem. These Results are in conformity with Liao et al. [6] which resulted that application NaOCl at 15 mg.$^{-1}$ and sucrose at 40 g helped to open the cut rose flowers early.

Table 1. Flower opening (days) of cut rose as influenced by different concentration of sucrose and NaOCl concentration

Sucrose levels (%)	NaOCl levels (mg.L^{-1})				Mean
	0	5	10	15	
0	4.71	3.86	4.90	5.40	5.23 a
4	3.82	3.83	4.70	4.74	4.71ab
8	4.35	4.58	4.90	5.02	4.27 b
12	4.91	5.00	5.52	5.48	4.72 ab
Mean	5.16 a	5.01a	4.32b	4.45b	

LSD at α 0.05 for NaOCl and Sucrose level = 0.55

Flower size

The data for flower size is shown in Table 2. The mean data clearly show that larger flower size (6.16 cm) was noted for flower supplied with 15mg.L^{-1}sodium hypochlorite, followed by average flower size (5.94 cm) for NaOCl at 10mg.L^{-1} while small size flower (5.52 cm) were obtained by flower

interacted with NaOCl at 0mg.L^{-1}. The data for sucrose solution showed that 12 % sucrose solution produced maximum size flowers (6.14 cm), followed by flower size (5.77cm) for 8 % sucrose solution and smaller flower size (5.47 cm) were obtained from flower supplied with distilled water i.e. control treatment. The application of sucrose and sodium hypochlorite showed significance increase in size of cut rose flower. Finding showed that sucrose has increased the size cut rose flowers life [11, 12]. Sodium hypochlorite postpones any formation of microorganism colonies in stem xylems due to the effects of anti-microbe properties. Therefore it may also cause an increase in water absorption and also increasing of flower diameter.

Table 2. Flower size (cm) of cut rose flower as influenced by different concentration of NaOCl and Sucrose

Sucrose levels (%)	NaOCl levels (mgL^{-1})				Mean
	0	5	10	15	
0	6.04	6.20	6.00	6.30	5.47 a
4	5.10	5.25	5.72	5.80	5.77 b
2	5.23	5.86	5.88	6.09	5.97 a
3	5.72	5.55	6.14	6.47	6.14 a
Mean	5.52 b	5.72 b	5.94 ab	6.16 a	

LSD at α 0.05 for NaOCl and Sucrose level = 0.44

Fresh Weight

The data for average flower fresh weight is given in Table 3. The mean data clearly show that extreme flower fresh weight (11.27 g) were noted for flower supplied with 15mg.L^{-1} sodium hypochlorite, followed by average flower fresh weight (10.74g) for NaOCl at 10 mg.L^{-1}while least flower fresh weight (10.44) were obtained by flower interacted with control i.e 0mg.L^{-1}NaOCl. The data for sucrose solution showed that   12 % Sucrose Solution produced maximum flowers fresh weight (11.27g), followed by flower fresh weight (10.81g) for 8 % while minimum flower fresh weight(10.14 g)were obtained from flower supplied with distilled water i.e control treatment.

Decorative plants like rose flower is also responsive to increasing of bacteria amount in liquid. In case of bacteria concentration in flower vase liquid has a scope of 107-108 ml, it may cause a reduction in water absorption. In a colony of 3x10 ml first signs of wilted after one hour was witnessed [13]. Carbohydrates are responsible for controlling of structure and mitochondria, water balance and any transfers in plant. Any applying of water free from any microbes, reducing acidity of maintenance liquid, anti-microbes, re-cut of the stem at the time of putting it inside the liquid may cause better absorption of water. Higher water uptake and development of corolla are the properties concerned with increase in Fresh weight. While consumption of available carbohydrate in respiration causes decrease in fresh weight. The rate of Respiration is enhanced by ethylene manufacture in the senescing tissues. So improving in quality and increase in vase life of cut rose and increase in fresh weight is due to the supply of carbohydrates by sucrose for respiration process. While, NaOCl act as ethylene inhibitor which resulted increase in fresh weight [14]. Sucrose and NaOCl combination is best for increase of flower weight than other chemicals

Table 3. Fresh weight of cut rose flower as influenced by different concentration of Sucrose and NaOCl

Sucrose levels (%)	NaOCl levels (mg.L^{-1})				Mean
	0	5	10	15	
0	9.63	10.10	10.25	10.59	10.14 c
1	10.12	10.06	10.74	11.24	10.54 b
2	10.60	11.11	10.58	10.94	10.81 b
3	11.43	11.18	11.37	12.30	11.57 a
Mean	10.44 b	10.61 b	10.74 b	11.27 a	

LSD at α 0.05 for NaOCl and Sucrose level = 0.33

Flower wilting (%)

The data for average flower wilting (%) is given in Table 4. The mean data clearly show that least flower wilting (15%) was recorded for flower supplied with 15mg.L^{-1} sodium hypochlorite, followed by average flower wilting (17.50%) for NaOCl at 10 mg.L^{-1} while greater flower wilting (34.17%)were obtained by flower interacted with control. The data for sucrose solution showed that 12 % Sucrose Solution showed minimum flower wilting (15.58%), followed by flower wilting (21.92%) for 8%while maximum flower wiling (33.42%) were obtained from flower supplied with distilled water i.e control treatment.

The property of less wilting percentage of flowers leads to longer vase life, therefore it is considered better as compared to more wilting. NaOCl affords an acidic medium which avoids pathogenic growth at vascular tissues which enable flower to sufficient water uptake Carbohydrate source improve vase life and quality of flower by imminent carbohydrate undernourishment. So NaOCl causes inhibition blockage of vessels is and ethylene levels is kept same and causes improved vase life which results in flower fading % age decrease. Application of Sucrose and NaOCl resulted to minimize percent fading by falling chlorophyll content of the flower from consumption and carbohydrates conservation in petals [15]. 10% sucrose application and NaOCl 15mg stemmed in highest water uptake and lowest transpiration losses [14].

Table 4. % flower wilting as influenced by different concentration of NaOCl and sucrose

Sucrose levels (%)	NaOCl levels (mg.L-1)				Mean
	0	5	10	15	
0	54.67	39.00	20.00	20.00	33.42 a
4	35.00	29.33	15.33	14.00	23.42 b
8	26.33	26.00	20.00	15.33	21.92 b
12	20.67	16.33	14.67	10.67	15.58 c
Mean	34.17 a	27.67 b	17.50 c	15.00 d	

LSD at α 0.05 for NaOCl and Sucrose level = 2.23
LSD at α 0.05 for NaOCl x Sucrose = 4.46

Dry Weight (g)

The data for average flower dry weight is given in Table 5. The mean data clearly show that greater flower dry weight (4.13 g) was noted for flower supplied with 15mg.L^{-1} sodium hypochlorite, followed by average flower dry weight (3.78 g) for NaOCl at 10mg.L^{-1} while smaller flower dry weight (2.91 g) were obtained by flower interacted with control treatment. The data for sucrose solution showed that 12 % Sucrose Solution resulted in maximum size

flower dry weight (3.78g), followed by flower dry weight (3.77 g) for 8 % sucrose solution while lowest flower dry weight (3.52g) were obtained from flower supplied with control treatment.

Until detachment of flower from plant, it gets if food from plant ant then starts to consumption of stored food on detachment.

Therefore cut rose requires nutrient for its vase life continuation. The role of sucrose is to act as substrate for maintaining turgidity and as nutrient subtrates. Cut rose flower placed in solution of 15 mg.L-1 and 12% sucrose maintained fresh weights above initial weights even up to the 8th day of vase life [16].

Table 5. Flower dry weight of cut rose as influenced by different concentration of Sucrose and NaOCl

Sucrose levels (%)	NaOCl levels (mg.L-1)				Mean
	0	5	10	15	
0	2.69	3.24	3.47	3.61	3.25 c
1	2.85	3.48	3.78	3.97	3.52 b
2	2.96	3.84	3.98	4.30	3.77 a
3	3.15	3.43	3.90	4.62	3.78 a
Mean	2.91 d	3.50 c	3.78 b	4.13 a	

Petal Drop (%)

The data for average petal drop (%) is given in Table 6. The mean data clearly show that least petal drop (18.75%) was recorded for flower supplied with 10mg.L^{-1} sodium hypochlorite, followed by average flower size (26.04%) for NaOCl at 5mg.L^{-1} while greater petal drop (35.42%) were obtained by flower for control solution. The data for sucrose solution showed that 12% Sucrose Solution produced minimum petal drop (23.96%), followed by petal drop (25%) for 8% sucrose solution, while maximum petal drop (33.33%), were obtained from flower supplied with distilled water i.e control treatment.

Ethylene production is main factor in Petal drop due to leaf abscission in cut flowers. Literature review showed that both sucrose and NaOCL proved to be useful in this regard as sucrose reduces chlorophyll content and preserves carbohydrate contents of cut roses. It can be understood that sucrose acts as anti-ethylene compound and thus prolonging vase life and leaf abscission. NaOCl is also an anti-ethylene in nature, thus limiting the activities of ethylene by application of sucrose and NaOCL, leaf abscission and petal drop can be reduced. NaOCl and sucrose resulted in longer vase life and reduced petal drop as compared to distilled water in cut rose flowers [14].

Table 6. Flower petal drop (%) influenced by different concentration of NaOCl and sucrose

Sucrose levels (%)	NaOCl levels (mg.L^{-1})				Mean
	0	5	10	15	
0	41.67	33.33	29.17	29.17	33.33 a
4	37.50	29.17	16.67	20.83	26.04 b
8	33.33	20.83	16.67	29.17	25.00 b
12	29.17	20.83	12.50	33.33	23.96 b
Mean	35.42 a	26.04 b	18.75 c	28.13 b	

LSD at α 0.05 for NaOCl and Sucrose level = 6.19

Vase life (days)

The data for average vase life of flower (days) size is given in Table 7. The mean data clearly show that larger vase life of flower (14.77days) was recorded for flower supplied with 15 mg.L^{-1} sodium hypochlorite, followed by vase life of flower (13.03 days) for NaOCl at mg.L^{-1} while least vase life of flower (9.53days) were obtained by flower kept in control treatment. The data for sucrose solution showed that 12% Sucrose Solution resulted in vase life of flower (14.77 days), followed by vase life of flower (13.03 days) for 8% while minimum vase life of flower (9.53 days) were obtained from flower supplied with distilled water i.e control treatment.

The part of sucrose and NaOCl in the extension of cut rose flowers vase was studied during this research showed that effect of sucrose on the provision of substrates for respiration and other function for performing different processes, sodium hypochlorite, therefore lengthier cut rose flowers vase life was noted. This widely accepted role of sucrose as provider of additional substrates for respiration has perhaps largely over-shadowed other important roles.

Gray mold is caused by Botrytis cinerea., a fungal pathogen that causes in Rose, gerbera chrysanthemum and other cut flower species. Deposition of conidia on petals during flower development is infected in rose. NaOCl application of rose flowers more useful in reducing B. cinerea infection than many other fungicides [17]. Sucrose extended the vase life Heuchera sanguine Engelm flowers, Limonium, spray carnations [18]. Liatris spicata, sweet pea, Delphinium, Gentiana, snapdragon, Eustoma, rose and Oncidiu [19].

Table 7. Flower longevity (days) influenced by different concentration of NaOCl and Sucrose

Sucrose levels (%)	NaOCl levels (mg.L^{-1})				Mean
	0	5	10	15	
0	8.77	8.50	9.42	11.45	9.53 d
4	9.90	9.90	12.69	12.68	11.29 c
8	10.91	12.33	13.50	16.03	13.19 b
12	12.41	15.79	16.48	18.93	15.90 a
Mean	10.50 d	11.63 c	13.03 b	14.77 a	

LSD at α 0.05 for NaOCl and Sucrose level = 0.57
LSD at α 0.05 for NaOCl x Sucrose = 1.13

Conclusions

12 % of sucrose solution gave the best result regarding early flower opening, larger flower size, maximum flower fresh, dry weight, minimum percent petal drop and wilting and longer vase life. 15 mgl^{-1} solution gave the best result regarding early flower opening, larger flower size, maximum flower fresh and dry weight, minimum percent petal drop and wilting and longer vase life. The interaction of sucrose and NaOCl at 12% sucrose solution and 15 mg.l^{-1} of NaOCl was best by giving good response on minimum flower wilting, dry weight and vase life.

Recommendations

12 % of sucrose solution and 15 mgl^{-1} of NaOCl should be applied for prolonging vase life. Future research should be conducted to study higher concentration of sucrose and NaOCl.

Authors' contributions

Conceived and designed the experiments: MOU Awan, N Khan & M Ali, Performed the experiments: MOU Awan, Analyzed the data: JA Shah, A Ali, N Mehmood, I Ahmad & AUR Khalil, Contributed reagents/ materials/

analysis tools: M Jounaid, Sohail, F Nawaz & R Khan, Wrote the paper: N Khan, MOU Awan & Z Ullah.

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