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Effect of varying levels of pH and preservatives and basal cut of spike on post-harvest parameters in tuberose

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Abstract
The present investigation effect of varying levels of pH and preservatives on basal cut of spike in tuberose was carried out at laboratory, Department of Floriculture and Landscape Architecture, College of Agriculture, IGKV Raipur (C.G.) during two consecutive years *i.e.* years 2020-21 and 2021-22. The experiment was designed in a completely randomized design in factorial arrangement with three levels of preservatives *viz.*, citric acid (100 ppm), aluminum sulphate (100 ppm) and 8-HQC (100 ppm), three levels of basal cut of spike *viz.*, no cut, daily cut and alternate day cut, three levels of pH *viz.*, distilled water, pH-4 and pH-5. The results revealed that the 8-HQC, alternate day cut of the basal part of the spike and pH 4 recorded a significantly maximum number of opened florets at a time per spike as well as the diameter of basal florets (mm) and vase life (days) and minimum physiological loss in weight (PLW %) was recorded in 8-HQC, alternate day cut of the basal part of the spike at pH 4.

Keywords: 8-HQC, pH, aluminum sulphate, basal cut of spike, citric acid

Introduction
Tuberose is a flowering plant that holds great importance in human life, helping as a source of ornamental usage, fragrance, health benefits, economic value and ecological support. The basal cut of a spike in tuberose refers to the cut made at the base of the stem to facilitate water uptake and prolong the vase life of the flowers. The pH level of the preservative solution and the type of preservatives can significantly impact the post-harvest quality and longevity of tuberose spikes. Cut flower post-harvest longevity is affected by many factors. Among them, the pH of the vase solution which considered an important factor in controlling water uptake, reducing embolization and slowing bacterial growth (Ichimura *et al.* 2003) [8]. The use of aluminium sulphate increases the post-harvest life of tuberose flowers by reducing bacterial contamination, transpiration rate, the petal of pH, stabilizing the anthocyanin and acidifying the holding solution (Mohammadi *et al.* 2012) [12]. 8-hydroxy quinoline citrate is a very important and effective germicide used in the floral industry (Butt, 2005) [1]. Taking in to consideration the above views, the present investigation entitled "Effect of varying levels of pH and preservatives and basal cut of spike on post-harvest parameters in tuberose'' carried out to observe the effect of these factors on post-harvest parameters in tuberose.

Material and Methods
The present investigation entitled was carried out in floriculture laboratory, Department of Floriculture and Landscape Architecture, College of Agriculture, IGKV, Raipur (C.G.) during two consecutive years *i.e.* years 2020-21 and 2021-22. The flower was harvested at stage when lower florets (Two florets) of the spike were opened and all leaves on the lower section of the spike were removed. The experiment was laid out in completely randomized design in factorial arrangement with three levels of preservatives *viz.*, citric acid 100 ppm, aluminum sulphate 100 ppm and 8-HQC 100 ppm, three levels of basal cut of spike *viz.*, no cut, daily cut and alternate day cut, three levels of pH *viz.*, distilled water, pH-4 and pH-5. Freshly harvested spikes were placed in glass bottles filled with required vase solution as per treatment combinations. Observations *viz.*, physiological loss in weight (PLW %), number of opened floret at a time per spike, diameter of basal florets (mm), vase life (days) were recorded in three randomly selected and tagged spike per replication in each treatment.

Results and Discussion

A perusal of data in Table 1.0 and 1.1 revealed that the effect of preservatives concentration (P), basal cut of spike (C) and pH (H) on physiological loss of weight (PLW %), number of opened floret at a time per spike, diameter of basal florets, longest vase life (days) were found significant in two consecutive years *i.e.* years 2020-21 and 2021-22.

Effect of preservatives concentration

The number of opened floret at a time per spike, diameter of basal florets, longest vase life differed significantly with different preservatives concentration during pooled data of two years, 2020-21 to 2021-22 of experimentation. Among the different preservatives concentration, treatment 8-HQC @100 ppm recorded significantly maximum number of opened floret at a time per spike (3.47), diameter of basal florets (40.44 mm) and longest vase life (8.29 days). These might be due to microbial control properties of 8-HQC which creates optimal conditions for floret opening in a spike. Increased diameter of basal florets under this 8-HQC treatment might be due to better absorption of vase solution. Tamrakar (2016) [18] also found that cell turgidity helpful in increasing carbohydrate levels of cut spike which results increased diameter of basal florets. The chelating properties of 8-HQC prevent blockages in the flower stems, ensuring optimal water and nutrient uptake, thus enhancing longevity of individual florets. Gigar (2006) [5] also reported that 8-HQC improves floral vase life by acidifying the water, which is thought to minimize enzymatic activity and xylem degradation while boosting solution absorption. Similar results were obtained Singh *et al.* (2005) [17], in Gladiolus, Meman and Dabhi (2006) [11] in Gerbera, Das *et al.* (2020) [3] in Rose.

Effect of basal cut of spike

There was a markedly difference was noticed for physiological loss of weight (PLW %), number of opened floret at a time per spike, diameter of basal florets, longest vase life among different method of basal cut of spike during pooled data of two years. The minimum physiological loss of weight (45.48%) was registered at alternate day cut (C_3) and it was remains *at par* with daily cut (C_2). The maximum diameter of basal florets (40.65 mm) was recorded under alternate day cut (C_3) which was closely followed by daily cut (C_2), maximum number of opened florets at a time per spike (3.51), longest vase life (9.27 days) were registered in alternate day cut (C_3). The reduction in PLW% through alternate day basal spike cutting significantly increased the number of opened floret at a time per spike, diameter of basal florets, longest vase life. This might be due to the effect of basal spike cut, which facilitated the removed of damage tissue and also reduced the bacterial growth at lower portion of the spike which ultimately helps in cell turgidity in cut spikes. Chamani and Wagstaff (2019) [2] found that at least 2 cm recut is necessary to get the highest vase life. These investigations are agreement with the findings of Dole *et al.* (2004) [4] in Poinsettia, Moody *et al.* (2014) [13] in cut Rose.

Effect of pH

Varying pH level of vase solution had a significant effect on physiological loss of weight (PLW %), number of opened floret at a time per spike, diameter of basal florets, longest vase life. The minimum (45.26%) physiological loss in weight (PWL %) was recorded in pH 4 (H_2). however maximum number of opened floret at a time per spike (3.23), diameter of basal florets (39.48 mm), longest vase life (8.17 days) was recorded in pH 4 (H_2) and it were *at par* to treatment pH 5 (H_3). The results of the experiment revealed that flowers placed in pH 4 solutions observed a significant difference in number of opened floret, basal floret diameter and vase life of cut spike. The solution pH about 4 is a good pH which helped in uptake of solution faster in the water-conducting system (xylem) by preventing of plugging of the cut surface of the stem as suggested by Hajizadeh and Aliloo (2014) [7]. The increasing trend of pH during vase life might be associated with the higher multiplication of microorganisms in the solution, transport physiology and metabolism of cut flower Paul *et al.* (2021) [14]. Similar results were also suggested by Jowkar and Salehi (2003) [9] in Tuberose, Regan *et al*. (2010) [15] in Rose.

Interaction

Interaction of preservatives concentration and basal cut of spike (P x C)

Among the difference combination, treatment *i.e.* P_3C_3 (8-HQC 100 ppm + Alternate Day Cut) was recorded significantly maximum number of opened floret at a time per spike (3.98), diameter of basal florets (41.31 mm), vase life (10.97 days) and registered to be *at par* with P_2C_2, P_3C_2, and P_2C_3 treatment combination. The study found that combining 8-HQC at 100 ppm with alternate day cuts further helpful in improving water uptake and preventing microbial growth which ensured continuous hydration in spike and cut flower quality, promoting floret opening and extending vase life. 8-HQC improved water uptake, prevented microbial growth and ensured continuous hydration, enhancing overall freshness. The finding is in line with those reported by Dole *et al.* (2004) [14] in Poinsettia, Singh *et al.* (2005) [17], in Gladiolus, Moody *et al.* (2014) [13] and Das *et al.* (2020) [3] in cut Rose.

Interaction of preservatives concentration and pH (P x H)

Significantly, minimum (42.16%) physiological loss of weight (PLW %) and maximum diameter of basal florets (40.64 mm), vase life (9.47 days) was performed with the treatment combination of aluminium sulphate 100 ppm + pH 5 (P_2H_3) and it was noted *at par* with P_2H_2 and P_3H_3 treatment combinations. Aluminium sulphate at 100 ppm and pH 5 improved cut flower quality, prolonging vase life, enhancing basal floret diameter and minimized physiological loss of weight (PLW %). Auminium sulphate with pH 5, enhanced diameter of basal florets and delayed wilting and senescence processes, prevented microbial growth, ensuring longer vase life. This combination contributed to the extended longevity of the basal cut spike. The above results are also corroborated with the finding of Gigar (2006) [5] and Meman and Dabhi (2006) [11] in Gerbera, Regan *et al*. (2010) [15] in Rose, Paul *et al.* (2021) [14] in tuberose.

Interaction of basal cut of spike and pH (C x H)

Regarding, significantly minimum (42.14%) physiological loss of weight (PLW %) and maximum number of opened floret at a time per spike (3.86), diameter of basal florets (41.67 mm), vase life (10.74 days) were recorded under treatment combination daily cut + pH 5 (C_2H_3) and which

were having *at par* C_2H_2, C_3H_2 and C_3H_3 treatment combination. The results of this study clearly showed that the combination of daily cutting and maintaining the vase solution at pH 5 significantly enhanced the quality of cut flowers. This treatment method promoted a higher number of opened floret at a time per spike, larger diameter of basal florets and prolonged overall vase life and minimized physiological loss in weight (PLW %). Daily cutting and pH 5 had facilitated better water uptake and nutrient absorption, leading to increased floret opening and promoting flower growth. The overall vase life of cut flowers had been significantly longer in this combination daily cut and pH 5 had maintained flower freshness. The results are in close conformity Jowkar and Salehi (2003) [9] in Tuberose, Dole *et al.* (2004) [4] in Poinsettia, Khan *et al*. (2009) [10] in Gladiolus, Moody *et al.* (2014) [13] in cut Rose.

Interaction of preservatives concentration, basal cut of spike and pH (P x C x H)

Among the different combinations of (P x C x H), the treatment combination *i.e.* $P_3C_3H_2$ (8-HQC 100 ppm + Alternate Day Cut + pH 4) resulted minimum (39.21%) physiological loss of weight (PLW %), maximum diameter of basal florets (43.86 mm), vase life (12.83 days) in vase condition. The similar treatment combination found *at par* $P_2C_2H_1$, $P_2C_3H_2$, $P_3C_2H_1$, $P_3C_2H_2$, $P_3C_2H_3$. The combination of 8-HQC, alternate day cuts, and maintaining pH at 4 levels created an optimal environment that minimized bacterial growth and maximized water uptake and nutrient absorption. As a result, there was an increased number of opened florets, larger basal floret diameter, enhanced longevity of individual florets in the vase, and prolonged vase life. This might be due to the effect of 8 HQC which inhibits vascular blockage and acidifies the solution with reduced microbial growth Vilas *et al*. (2017) [19]. This might be due to reduction of microbial growth by acidified vase solution and frequent cutting of basal part of spike. Singh *et al*. (2018) [16] noted that 8-HQC improves floral vase life by acidifying the water, which is thought to minimize enzymatic activity and xylem degradation while boosting solution absorption. The finding corroborates the reports of Hepzibha (2000) [6] in Gladiolus, Meman and Dabhi (2006) [11] in Gerbera, Das *et al*. (2020) [3] in Rose.

Table 1: Effect of preservatives concentration, basal cut of spike and pH on post-harvest parameters (Pooled data of two years)

Treatments	Physiological loss of weight (PLW %)	Number of opened floret at a time per spike	Diameter of basal florets (mm)	Vase life (days)
Preservatives concentration (P)				
P_1 (Citric Acid 100 ppm)	48.57	2.60	36.98	6.52
P_2 (Aluminium Sulphate 100 ppm)	46.59	3.10	38.36	7.37
P_3 (8-HQC 100 ppm Hydroxyquinoline Citrate)	46.13	3.47	40.44	8.29
Sem±	0.75	0.04	0.34	0.09
CD at 5%	NS	0.13	0.97	0.27
Basal cut of spike (C)				
C_1 (No Cut)	49.68	2.67	35.37	5.39
C_2 (Daily Cut)	46.14	3.00	39.76	7.53
C_3 (Alternate Day Cut)	45.48	3.51	40.65	9.25
Sem±	0.75	0.04	0.34	0.09
CD at 5%	2.13	0.13	0.97	0.27
pH (H)				
H_1 (Distilled Water)	49.44	2.89	37.40	6.28
H_2 (pH 4)	45.26	3.23	39.48	8.17
H_3 (pH 5)	46.60	3.06	38.90	7.71
Sem±	0.75	0.04	0.34	0.09
CD at 5%	2.13	0.13	0.97	0.27
Interactions				
P x C	-	S	S	S
P x H	S	-	S	S
C x H	S	S	S	S
P x C x H	S	-	S	S

Table 2: Infraction effect of preservatives concentration, basal cut of spike and pH on post-harvest parameters (Pooled data of two years)

Treatments	Treatment combination	Physiological loss of weight (PLW %)	Number of opened floret at a time per spike	Diameter of basal florets (mm)	Vase life (Days)
Preservatives concentration and basal cut of spike (P x C)					
Citric Acid 100 ppm + No cut	P_1C_1	52.10	2.43	33.14	5.04
Aluminium Sulphate 100 ppm + No cut	P_2C_1	47.28	2.44	37.23	6.83
8-HQC 100 ppm + No cut	P_3C_1	46.33	2.91	39.40	7.68
Citric Acid 100 ppm + Daily cutting	P_1C_2	45.34	2.53	34.26	5.37
Aluminium Sulphate 100 ppm + Daily cut	P_2C_2	48.27	3.14	40.75	7.62
8-HQC 100 ppm + Daily cut	P_3C_2	45.32	3.63	41.19	9.11
Citric Acid 100 ppm + Alternate day cut	P_1C_3	45.79	3.02	38.70	5.76
Aluminium Sulphate 100 ppm + Alternate day cut	P_2C_3	48.67	3.42	41.29	8.13
8-HQC 100 ppm + Alternate day cut	P_3C_3	44.79	3.98	41.31	10.97
Sem±		1.30	0.07	0.59	0.16
CD at 5%		NS	0.22	1.69	0.46
Preservatives concentration and pH (P x H)					
Citric Acid 100 ppm + Distilled water	P_1H_1	51.83	2.42	33.80	5.28
Aluminium Sulphate 100 ppm + Distilled water	P_2H_1	47.84	2.77	37.37	6.83
8-HQC 100 ppm + Distilled water	P_3H_1	46.03	2.60	39.77	7.44
Citric Acid 100 ppm + pH 4	P_1H_2	47.97	3.00	37.93	6.26
Aluminium Sulphate 100 ppm + pH 4	P_2H_2	45.78	3.24	38.66	8.22
8-HQC 100 ppm + pH 4	P_3H_2	48.27	3.07	38.47	7.62
Citric Acid 100 ppm + pH 5	P_1H_3	48.50	3.24	40.46	7.31
Aluminium Sulphate 100 ppm + pH 5	P_2H_3	42.16	3.68	40.64	9.47
8-HQC 100 ppm + pH 5	P_3H_3	45.49	3.50	40.21	8.08
Sem±		1.30	0.08	0.59	0.16
CD at 5%		3.69	NS	1.69	0.46
Basal cut of spike and pH (C x H)					
No cut + Distilled water	C_1H_1	51.87	2.49	34.02	4.56
Daily cut + Distilled water	C_2H_1	44.40	2.74	34.10	6.10
Alternate day cut + Distilled water	C_3H_1	43.19	2.77	37.98	5.51
No cut + pH 4	C_1H_2	49.74	2.88	38.13	6.44
Daily cut + pH 4	C_2H_2	48.19	3.09	40.94	7.68
Alternate day cut + pH 4	C_3H_2	51.09	3.04	40.23	8.47
No cut + pH 5	C_1H_3	46.69	3.31	39.71	7.84
Daily cut + pH 5	C_2H_3	42.14	3.86	41.67	10.74
Alternate day cut + pH 5	C_3H_3	46.56	3.36	40.24	9.17
Sem±		1.30	0.07	0.59	0.16
CD at 5%		3.69	0.22	1.69	0.46
Preservatives concentration, basal cut of spike and pH (P x C x H)					
Citric Acid 100 ppm + No cut + Distilled water	$P_1C_1H_1$	55.65	2.23	29.84	4.20
Citric Acid 100 ppm + No cut + pH 4	$P_1C_1H_2$	43.68	2.63	33.60	5.43
Citric Acid 100 ppm + No cut + pH 5	$P_1C_1H_3$	42.50	2.47	39.33	5.50
Citric Acid 100 ppm + Daily cutting + Distilled water	$P_1C_2H_1$	53.95	2.37	31.22	4.50
Citric Acid100 ppm + Daily cutting + pH 4	$P_1C_2H_2$	50.45	2.53	40.44	7.23
Citric Acid 100 ppm + Daily cutting + pH 5	$P_1C_2H_3$	51.89	2.43	39.95	8.77
Citric Acid 100 ppm + Alternate day cut + Distilled water	$P_1C_3H_1$	45.90	2.70	40.34	7.13
Citric Acid 100 ppm + Alternate day cut + pH 4	$P_1C_3H_2$	49.41	3.13	37.99	7.83
Citric Acid 100 ppm + Alternate day cut + pH 5	$P_1C_3H_3$	43.69	2.90	40.04	8.07
Aluminium Sulphate 100 ppm + No cut + Distilled water	$P_2C_1H_1$	50.82	2.50	32.64	4.70
Aluminium Sulphate 100 ppm + No cut + pH 4	$P_2C_1H_2$	43.32	2.50	32.05	5.63
Aluminium Sulphate 100 ppm + No cut + pH 5	$P_2C_1H_3$	41.88	2.60	34.74	5.77
Aluminium Sulphate 100 ppm + Daily cut + Distilled water	$P_2C_2H_1$	49.86	2.97	41.62	6.70
Aluminium Sulphate 100 ppm + Daily cut + pH 4	$P_2C_2H_2$	42.20	3.20	40.86	7.47
Aluminium Sulphate 100 ppm + Daily cut + pH 5	$P_2C_2H_3$	52.74	3.27	39.78	8.70
Aluminium Sulphate 100 ppm + Alternate day cut + Distilled water	$P_2C_3H_1$	43.24	3.53	39.54	7.37
Aluminium Sulphate 100 ppm + Alternate day cut + pH 4	$P_2C_3H_2$	40.95	4.03	43.15	11.57
Aluminium Sulphate 100 ppm + Alternate day cut + pH 5	$P_2C_3H_3$	50.19	3.33	40.89	8.40
8-HQC 100 ppm + No cut + Distilled water	$P_3C_1H_1$	49.14	2.73	39.58	4.77
8-HQC 100 ppm + No cut + pH 4	$P_3C_1H_2$	46.19	3.10	36.65	7.23
8-HQC 100 ppm + No cut + pH 5	$P_3C_1H_3$	42.03	3.23	39.88	5.27
8-HQC 100 ppm + Daily cut + Distilled water	$P_3C_2H_1$	45.41	3.30	41.55	8.13
8-HQC 100 ppm + Daily cut + pH 4	$P_3C_2H_2$	51.93	3.53	41.43	8.33
8-HQC 100 ppm + Daily cut + pH 5	$P_3C_2H_3$	48.65	3.43	40.96	7.93
8-HQC 100 ppm + Alternate day cut + Distilled water	$P_3C_3H_1$	50.94	3.70	40.25	9.03
8-HQC 100 ppm + Alternate day cut + pH 4	$P_3C_3H_2$	39.21	4.40	43.86	12.83
8-HQC 100 ppm + Alternate day cut + pH 5	$P_3C_3H_3$	45.80	3.83	39.78	11.03
Sem±		2.25	0.13	1.03	0.28
CD at 5%		6.39	NS	2.92	0.81

Conclusions

It may be concluded form the finding of the present investigation to minimize physiological loss in weight (PLW %) and maximize number of opened floret at a time per spike, diameter of basal florets (mm) and vase life (days) of cut spike of tuberose by using 8-HQC at 100 ppm concentration, basal cut of spike in alternate day and maintaining a pH of 4 of vase solution. Investigation can explore the specific physiological mechanisms behind these findings, enabling even more targeted approaches to improve the quality of cut spike.

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