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The Effect of Organic and Inorganic Substances on Post Harvest Life of Tuberose

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ABSTRACT: An experiment was carried out to study the effect of organic and inorganic substances on post harvest life of tuberose for two years from 2021 to 2023. The experiment was laid out in factorial randomized block design with three replications consisting eighteen treatments of organic and inorganic substances, *viz.*, boric acid (2 % and 4 %), Salicylic acid (50 and 100 ppm), sodium benzoate (25 and 50 ppm), cow urine 20 %, Humic acid 5 %, GA_3 (100 and 150 ppm), NAA (50 and 100 ppm), coconut water 20 %, $FeSO_4$ (2 % and 4 %) and $ZnSO_4$ (2 % and 4 %) and control. The results of pooled analysis of two years indicated that the spikes of tuberose treated with 4% boric acid and Salicylic acid 100 ppm significantly improved the post harvest life. Among post harvest parameters maximum flower diameter (4.60 cm) was recorded from boric acid 4 % whereas, application of Salicylic acid 100 ppm also recorded significantly minimum physiological weight loss (27.30 %), maximum membrane stability index (27.30 %). The maximum total soluble solids (17.97) and maximum florets opening (87.00 %) were also recorded in the same treatment. Quick dip of tuberose spikes in 4% boric acid and Salicylic acid 100 ppm were found beneficial for improving post harvest life of tuberose spikes.

Keywords: Boric acid, Florets, Salicylic acid, Spike, Substances, Tuberose.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) belongs to family Amaryllidaceae and native to Mexico (Trueblood, 1973). *Polianthes* derived from a greek word '*Polis*' means white or shinning and '*anthos*' means flower. It is commonly known as Gulchari and Gulshabbo in Hindi, Sukandarji and Nelasanpengi in Telugu, Nilasompangi in Tamil, Rajanigandha in Bengali and Sugandharaja in Kannad. Tuberose is half-hardy, herbaceous perennial, bulbous plant. It is a monocotyledon and an erect herb having 60-120 cm height with short and sturdy bulbs. Due to its immense export potential and long time freshness after harvest cultivation of tuberose is gaining momentum day by day in our country. After harvesting tuberose cut flowers is mainly affected by two main factors, namely ethylene which accelerates the senescence of flowers and microorganisms which cause vascular blockage and reduce the vase life of cut flowers (Van Doorn, 1994). There is limitation for marketing in tuberose because of poor keeping quality and highly perishable nature compare to other agricultural crops because of these reasons the post-harvest losses in tuberose are significantly higher than any other crop. Due to these limitation proper treatment is required to maintain the quality of tuberose (Hardenburg, 1990).

For increasing demand of fresh spike of tuberose treating florets with different organic and inorganic substances improves the flower quality and enhancing post harvest life. There are various organic and inorganic substances which are used as an inhibitor of microorganisms and anti ethylene action or synthesis inhibitor which ultimately helps to improve the post harvest life of cut flowers.

MATERIAL AND METHODS

The experiment was carried at Horticultural Research cum Instructional Farm, IGKV, Raipur (C.G.) in ambient condition during 2021-23. This is situated in the central region of Chhattisgarh of 21°23' N latitude and 81°71°E longitude with a height of 291 meter over the mean ocean level (MSL) characterized by wet and dry tropical atmosphere with a yearly precipitation range from 1300 mm. Uniform sized two to three basal florets opened spikes of tuberose variety Prajwal and Arka Sugandhi were collected in the early morning from Horticulture Research cum Instructional Farm College of Agriculture, IGKV, Raipur (C.G.).

The experiment was laid out in factorial randomized block design with three replications consisting eighteen treatments of organic and inorganic substances, viz. boric acid (2 % and 4 %), Salicylic acid (50 and 100 ppm), sodium benzoate (25 and 50 ppm), cow urine 20 %, Humic acid 5 %, GA_3 (100 and 150 ppm), NAA (50 and 100 ppm), coconut water 20 %, $FeSO_4$ (2 % and 4 %) and $ZnSO_4$ (2 % and 4 %) and control. Different solutions were prepared in slightly warm distilled water then cooled them at ambient condition. Freshly harvested 2-3 basal florets opened spikes of tuberose were taken and quick dip treatment (20 seconds) of organic and inorganic solutions was observed in

laboratory thereafter spikes were taken out and surface dried then put in distilled water.

RESULTS AND DISCUSSION

A. Floret diameter (cm)

It is evident from the data presented in Table 1 that among various substances boric acid significantly affected flower diameter. Maximum flower diameter (4.35 cm) was under boric acid (4 %). Interaction effect also found highest flower diameter (4.60 cm) was obtained from substances combination S_2V_1 (Boric acid 4 % + Prajwal). From the aforementioned results presented in Table 1, it is evident that boric acid significantly improved postharvest parameters.

Table 1: Effect of organic and inorganic substances on flower diameter (cm).

Substances	2021-22	2022-23	Pool Mean
S_1(Boric acid 2 %)	4.23	4.22	4.23
S_2(Boric acid 4 %)	4.22	4.35	4.28
S_3(Salicylic acid 50 ppm)	4.0	4.18	4.09
S_4(Salicylic acid 100 ppm)	4.2	4.27	4.23
S_5(Sodium Benzoate 25 ppm)	3.8	4.05	3.93
S_6(Sodium Benzote 50 ppm)	4.0	4.23	4.12
S_7(Cow Urine 20 %)	3.95	4.12	4.03
S_8 (Humic acid 5 %)	3.73	4.10	3.92
S_9(GA_3 100 ppm)	3.98	4.12	4.05
S_{10}(GA_3 150 ppm)	4.1	4.18	4.14
S_{11}(NAA 50 ppm)	3.78	3.92	3.85
S_{12}(NAA 100 ppm)	4.0	4.12	4.06
S_{13}(Coconut water 20 %)	3.83	3.93	3.88
S_{14}($FeSO_4$ 2 %)	3.95	4.05	4.00
S_{15}($FeSO_4$ 4%)	4.07	4.20	4.13
S_{16} ($ZnSO_4$ 2 %)	3.77	4.0	3.88
S_{17}($ZnSO_4$ 4 %)	3.92	4.10	4.01
S_{18}(Control)	3.70	4.0	3.85
SEm(±)	0.07	0.10	0.07
CD(P=0.05%)	0.21	0.29	0.21
Varieties			
V_1 (Prajwal)	4.16	4.26	4.21
V_2 (Arka Sugandhi)	3.75	3.97	3.86
SEm(±)	0.02	0.03	0.02
CD(P=0.05%)	0.07	0.10	0.07
Interaction			
S_1V_1(Boric acid 2 % + Prajwal)	4.6	4.4	4.48
S_2V_1(Boric acid 4 % + Prajwal)	4.4	4.6	4.52
S_3V_1(Salicylic acid 50 ppm + Prajwal)	4.3	4.5	4.38
S_4V_1(Salicylic acid 100 ppm + Prajwal)	4.5	4.5	4.48
S_5V_1(Sodium Benzoate 25 ppm + Prajwal)	4.0	4.3	4.17
S_6V_1(Sodium Benzote 50 ppm + Prajwal)	4.2	4.6	4.40
S_7V_1(Cow Urine 20 % + Prajwal)	4.1	4.2	4.17
S_8V_1(Humic acid 5 % + Prajwal)	4.0	4.1	4.02
S_9V_1(GA_3 100 ppm+ Prajwal)	4.4	4.4	4.37
$S_{10}V_1$(GA_3 150 ppm+ Prajwal)	4.4	4.4	4.42
$S_{11}V_1$(NAA 50 ppm + Prajwal)	3.9	3.9	3.88
$S_{12}V_1$(NAA 100 ppm + Prajwal)	4.1	4.2	4.15
$S_{13}V_1$(Coconut water 20 % + Prajwal)	4.1	4.1	4.10
$S_{14}V_1$($FeSO_4$ 2 % + Prajwal)	4.1	4.1	4.10
$S_{15}V_1$($FeSO_4$ 4% + Prajwal)	4.3	4.4	4.32
$S_{16}V_1$($ZnSO_4$ 2 % + Prajwal)	3.9	4.0	3.93
$S_{17}V_1$($ZnSO_4$ 4 % + Prajwal)	4.0	4.1	4.03
$S_{18}V_1$(Control + Prajwal)	3.9	3.9	3.90
S_1V_2(Boric acid 2 % + Arka Sugandhi)	3.9	4.0	3.97
S_2V_2(Boric acid 4 % + Arka Sugandhi)	4.0	4.1	4.05
S_3V_2(Salicylic acid 50 ppm + Arka Sugandhi)	3.7	3.9	3.80
S_4V_2(Salicylic acid 100 ppm + Arka Sugandhi)	3.9	4.1	3.98
S_5V_2(Sodium Benzoate 25 ppm + Arka Sugandhi)	3.6	3.8	3.68
S_6V_2(Sodium Benzote 50 ppm + Arka Sugandhi)	3.8	3.9	3.83
S_7V_2(Cow Urine 20 % + Arka Sugandhi)	3.8	4.0	3.90
S_8V_2(Humic acid 5 % + Arka Sugandhi)	3.5	4.1	3.82
S_9V_2(GA_3 100 ppm+ Arka Sugandhi)	3.6	3.9	3.73
$S_{10}V_2$(GA_3 150 ppm+ Arka Sugandhi)	3.8	3.9	3.87
$S_{11}V_2$(NAA 50 ppm + Arka Sugandhi)	3.7	3.9	3.82
$S_{12}V_2$(NAA 100 ppm + Arka Sugandhi)	3.9	4.0	3.97
$S_{13}V_2$(Coconut water 20 % + Arka Sugandhi)	3.6	3.7	3.67
$S_{14}V_2$($FeSO_4$ 2 % + Arka Sugandhi)	3.8	4.0	3.90
$S_{15}V_2$($FeSO_4$ 4% + Arka Sugandhi)	3.9	4.0	3.95
$S_{16}V_2$($ZnSO_4$ 2 % + Arka Sugandhi)	3.7	4.0	3.83
$S_{17}V_2$($ZnSO_4$ 4 % + Arka Sugandhi)	3.9	4.1	3.98
$S_{18}V_2$(Control + Arka Sugandhi)	3.5	4.1	3.80
SEm(±)	0.10	0.14	0.10
CD(P=0.05%)	0.30	0.41	0.30

Flower diameter increased with the application of Boric acid 4 % over control could probably be due to its growth promotional effect in stimulating and accelerating cell division, increased cell elongation and enlargement or both, flower diameter also be increased due to osmotic uptake of water and nutrients under the influence of boric acid. Our findings are in conformity with results of Chawla *et al.* (2020); Khongwir *et al.* (2017); Kumar *et al*. (2006) in tuberose. Our findings are in conformity with results of Chawla *et al.* (2020); Khongwir *et al*. (2017); sin tuberose.

B. Physiological weight loss (%)

The data on influence of substances, varieties and their interactions on physiological weight loss (%) showed in Table 2 that this was significantly affected and the minimum value (21.22 %) was recorded in S_4 (Salicylic acid 100 ppm) whereas, S_{18} (Control) resulted maximum physiological weight loss (43.40 %) respectively.

Table 2: Effect of organic and inorganic substances on physiological weight loss (%).

Physiological weight loss (%)			
Treatments	**2021-22**	**2022-23**	**Pooled Mean**
S_1(Boric acid 2 %)	29.02	29.77	29.39
S_2(Boric acid 4 %)	26.22	27.36	27.15
S_3(Salicylic acid 50 ppm)	25.32	27.19	26.55
S_4(Salicylic acid 100 ppm)	21.22	24.15	22.68
S_5(Sodium Benzoate 25 ppm)	30.08	31.85	30.97
S_6(Sodium Benzote 50 ppm)	29.23	33.25	31.24
S_7(Cow Urine 20 %)	41.63	40.97	41.30
S_8 (Humic acid 5 %)	42.43	41.93	42.18
S_9(GA_3 100 ppm)	35.13	37.45	36.29
S_{10}(GA_3 150 ppm)	35.03	34.93	34.98
S_{11}(NAA 50 ppm)	38.53	39.70	39.12
S_{12}(NAA 100 ppm)	35.08	37.08	36.08
S_{13}(Coconut water 20 %)	39.98	41.48	40.73
S_{14}($FeSO_4$ 2 %)	39.72	40.72	40.22
S_{15}($FeSO_4$ 4%)	38.32	38.98	38.65
S_{16} ($ZnSO_4$ 2 %)	38.65	40.15	39.40
S_{17}($ZnSO_4$ 4 %)	35.70	37.70	36.70
S_{18}(Control)	43.40	44.40	43.90
SEm(±)	0.91	1.70	0.57
CD(P=0.05%)	2.58	1.60	1.62
Varieties			
V_1 (Prajwal)	32.84	32.68	33.31
V_2 (Arka Sugandhi)	36.57	38.47	37.52
SEm(±)	0.30	0.56	0.19
CD(P=0.05%)	0.86	1.60	0.54
Interaction			
S_1V_1(Boric acid 2 % + Prajwal)	29.3	29.3	29.30
S_2V_1(Boric acid 4 % + Prajwal)	25.3	25.9	26.28
S_3V_1(Salicylic acid 50 ppm + Prajwal)	26.9	26.7	27.35
S_4V_1(Salicylic acid 100 ppm + Prajwal)	22	25.6	23.80
S_5V_1(Sodium Benzoate 25 ppm + Prajwal)	30.1	32.2	31.15
S_6V_1(Sodium Benzote 50 ppm + Prajwal)	30	31.1	30.53
S_7V_1(Cow Urine 20 % + Prajwal)	40.2	37.9	39.07
S_8V_1(Humic acid 5 % + Prajwal)	40.1	36.8	38.43
S_9V_1(GA_3 100 ppm+ Prajwal)	27.3	29.3	28.32
$S_{10}V_1$(GA_3 150 ppm+ Prajwal)	26.8	29	27.90
$S_{11}V_1$(NAA 50 ppm + Prajwal)	41.1	41.4	41.23
$S_{12}V_1$(NAA 100 ppm + Prajwal)	34.9	36.9	35.90
$S_{13}V_1$(Coconut water 20 % + Prajwal)	36.2	37.6	36.90
$S_{14}V_1$($FeSO_4$ 2 % + Prajwal)	37.2	37.2	37.20
$S_{15}V_1$($FeSO_4$ 4% + Prajwal)	33.3	34.6	33.97
$S_{16}V_1$($ZnSO_4$ 2 % + Prajwal)	36.6	37.6	37.07
$S_{17}V_1$($ZnSO_4$ 4 % + Prajwal)	32.5	34.5	33.53
$S_{18}V_1$(Control + Prajwal)	41.3	42.3	41.77
S_1V_2(Boric acid 2 % + Arka Sugandhi)	28.7	30.2	29.48
S_2V_2(Boric acid 4 % + Arka Sugandhi)	27.2	28.9	28.02
S_3V_2(Salicylic acid 50 ppm + Arka Sugandhi)	23.8	27.7	25.75
S_4V_2(Salicylic acid 100 ppm + Arka Sugandhi)	20.4	22.7	21.57
S_5V_2(Sodium Benzoate 25 ppm + Arka Sugandhi)	30.1	31.5	30.78
S_6V_2(Sodium Benzote 50 ppm + Arka Sugandhi)	28.5	35.4	31.95
S_7V_2(Cow Urine 20 % + Arka Sugandhi)	43	44	43.53
S_8V_2(Humic acid 5 % + Arka Sugandhi)	44.8	47.1	45.93
S_9V_2(GA_3 100 ppm+ Arka Sugandhi)	42.9	45.6	44.27
$S_{10}V_2$(GA_3 150 ppm+ Arka Sugandhi)	43.2	40.9	42.07
$S_{11}V_2$(NAA 50 ppm + Arka Sugandhi)	36.0	38.0	37.00
$S_{12}V_2$(NAA 100 ppm + Arka Sugandhi)	35.3	37.3	36.27
$S_{13}V_2$(Coconut water 20 % + Arka Sugandhi)	43.7	45.4	44.57
$S_{14}V_2$($FeSO_4$ 2 % + Arka Sugandhi)	42.2	44.2	43.23
$S_{15}V_2$($FeSO_4$ 4% + Arka Sugandhi)	43.3	43.3	43.33
$S_{16}V_2$($ZnSO_4$ 2 % + Arka Sugandhi)	40.7	42.7	41.73
$S_{17}V_2$($ZnSO_4$ 4 % + Arka Sugandhi)	38.9	40.9	39.87
$S_{18}V_2$(Control + Arka Sugandhi)	45.5	46.5	46.03
SEm(±)	1.29	2.41	0.81
CD(P=0.05%)	3.65	6.79	2.30

Physiological weight loss is also affected from different varieties of tuberose, minimum PLW (32.84 %) was recorded in V_1 (Prajwal), while V_2 (Arka Sugandhi) resulted maximum physiological weight loss (36.57 %). Interaction effect was also found to be significant in the combination S_4V_2 (Salicylic acid 100 ppm + Arka Sugandhi) (20.4 5 %). Physiological weight loss significantly decreased with application of Salicylic acid. This might be due to the Salicylic acid that helps to reduce water loss by controlling plant responses to various oxidative conditions and preventing cell wall breakdown. The results are also in accordance with findings of Alka *et al.* (2022) in chrysanthemum, Sudagar *et al*. (2010); Reethu *et al.* (2022); Kumar *et al*. (2006) in tuberose.

C. Membrane Stability Index (%)

The data pertaining to membrane stability index presented in Table 3 revealed that maximum membrane stability index (25.92) under Salicylic acid 100 ppm (S_4) which was found statistically similar to S_3 (Salicylic acid 50 ppm) and variety V_1 (Prajwal) recorded maximum membrane stability index (20.35).

Table 3: Effect of various organic and inorganic substances on Membrane Stability Index (%).

Membrane Stability Index (%)			
Treatments	**2021-22**	**2022-23**	**Pool Mean**
S_1(Boric acid 2 %)	20.28	20.95	20.62
S_2(Boric acid 4 %)	22.03	23.03	22.53
S_3(Salicylic acid 50 ppm)	23.98	25.32	24.65
S_4(Salicylic acid 100 ppm)	24.92	25.92	25.42
S_5(Sodium Benzoate 25 ppm)	19.85	20.02	19.93
S_6(Sodium Benzote 50 ppm)	19.10	19.95	19.53
S_7(Cow Urine 20 %)	17.13	17.97	17.55
S_8 (Humic acid 5 %)	17.43	18.10	17.77
S_9(GA_3 100 ppm)	19.05	19.38	19.22
S_{10}(GA_3 150 ppm)	20.53	20.87	20.70
S_{11}(NAA 50 ppm)	17.40	18.57	17.98
S_{12}(NAA 100 ppm)	18.35	19.00	18.68
S_{13}(Coconut water 20 %)	15.62	16.28	15.95
S_{14}($FeSO_4$ 2 %)	15.37	16.37	15.87
S_{15}($FeSO_4$ 4%)	16.22	17.38	16.80
S_{16} ($ZnSO_4$ 2 %)	16.32	17.15	16.73
S_{17}($ZnSO_4$ 4 %)	17.30	17.97	17.63
S_{18}(Control)	15.07	16.40	15.73
SEm(±)	0.69	0.72	0.56
CD(P=0.05%)	1.96	2.03	1.59
Varieties			
V_1 (Prajwal)	18.70	20.35	19.53
V_2 (Arka Sugandhi)	18.63	18.61	18.62
SEm(±)	0.23	0.24	0.18
CD(P=0.05%)	0.65	0.68	0.53
Interaction			
S_1V_1(Boric acid 2 % + Prajwal)	20.03	21.37	20.70
S_2V_1(Boric acid 4 % + Prajwal)	21.93	23.93	22.93
S_3V_1(Salicylic acid 50 ppm + Prajwal)	23.43	26.10	24.77
S_4V_1(Salicylic acid 100 ppm + Prajwal)	25.30	27.30	26.30
S_5V_1(Sodium Benzoate 25 ppm + Prajwal)	19.13	20.80	19.97
S_6V_1(Sodium Benzote 50 ppm + Prajwal)	19.40	21.10	20.25
S_7V_1(Cow Urine 20 % + Prajwal)	19.10	20.77	19.93
S_8V_1(Humic acid 5 % + Prajwal)	18.77	20.10	19.43
S_9V_1(GA_3 100 ppm+ Prajwal)	18.60	19.27	18.93
$S_{10}V_1$(GA_3 150 ppm+ Prajwal)	19.87	20.53	20.20
$S_{11}V_1$(NAA 50 ppm + Prajwal)	17.27	19.60	18.43
$S_{12}V_1$(NAA 100 ppm + Prajwal)	18.33	19.63	18.98
$S_{13}V_1$(Coconut water 20 % + Prajwal)	16.60	17.93	17.27
$S_{14}V_1$($FeSO_4$ 2 % + Prajwal)	15.13	17.13	16.13
$S_{15}V_1$($FeSO_4$ 4% + Prajwal)	15.47	17.80	16.63
$S_{16}V_1$($ZnSO_4$ 2 % + Prajwal)	15.97	17.63	16.80
$S_{17}V_1$($ZnSO_4$ 4 % + Prajwal)	16.70	18.03	17.37
$S_{18}V_1$(Control + Prajwal)	15.60	17.27	16.43
S_1V_2(Boric acid 2 % + Arka Sugandhi)	20.53	20.53	20.53
S_2V_2(Boric acid 4 % + Arka Sugandhi)	22.13	22.13	22.13
S_3V_2(Salicylic acid 50 ppm + Arka Sugandhi)	24.53	24.53	24.53
S_4V_2(Salicylic acid 100 ppm + Arka Sugandhi)	24.53	24.53	24.53
S_5V_2(Sodium Benzoate 25 ppm + Arka Sugandhi)	20.57	19.23	19.90
S_6V_2(Sodium Benzote 50 ppm + Arka Sugandhi)	18.80	18.80	18.80
S_7V_2(Cow Urine 20 % + Arka Sugandhi)	15.17	15.17	15.17
S_8V_2(Humic acid 5 % + Arka Sugandhi)	16.10	16.10	16.10
S_9V_2(GA_3 100 ppm+ Arka Sugandhi)	19.50	19.50	19.50
$S_{10}V_2$(GA_3 150 ppm+ Arka Sugandhi)	21.20	21.20	21.20
$S_{11}V_2$(NAA 50 ppm + Arka Sugandhi)	17.53	17.53	17.53
$S_{12}V_2$(NAA 100 ppm + Arka Sugandhi)	18.37	18.37	18.37
$S_{13}V_2$(Coconut water 20 % + Arka Sugandhi)	14.63	14.63	14.63
$S_{14}V_2$($FeSO_4$ 2 % + Arka Sugandhi)	15.60	15.60	15.60
$S_{15}V_2$($FeSO_4$ 4% + Arka Sugandhi)	16.97	16.97	16.97
$S_{16}V_2$($ZnSO_4$ 2 % + Arka Sugandhi)	16.67	16.67	16.67
$S_{17}V_2$($ZnSO_4$ 4 % + Arka Sugandhi)	17.90	17.90	17.90
$S_{18}V_2$(Control + Arka Sugandhi)	14.53	15.53	15.03
SEm(±)	0.98	1.01	0.79
CD(P=0.05%)	2.77	2.87	2.25

Significantly maximum (27.30) interaction effect also seen under S_4V_1 (Salicylic acid 100 ppm + Prajwal). Membrane stability index increased with the application of salicylic acid 100 ppm. The membrane stability index (MSI) is another physiological index that has been widely used to evaluate drought and heat tolerance. Similar conclusions were found by Farahat *et al.* (2014); Khongwir *et al*. (2017).

D. Total Soluble solids

The result depicted in Table 4 that among substances, significantly maximum total soluble solids (17.63) from S_4 (Salicylic acid 100 ppm). The interaction effect was also found non significant. Maximum total soluble solids was recorded (17.97) under S_3V_1 (Salicylic acid 50 ppm + Prajwal) among substances variety interaction. These levels of TSS is increased towards florets opening and decreased as the spike progressed towards senescence. Cut flower senescence is closely associated with water uptake stem and RWC of petals, whereas, these characteristics are closely related to the contents of osmoregulation substances such as soluble sugars and soluble proteins.

Table 4: Effect of various organic and inorganic substances on total soluble solids.

Total soluble solids			
Treatments	**2021-22**	**2022-23**	**Pool Mean**
S_1(Boric acid 2 %)	15.35	17.18	16.27
S_2(Boric acid 4 %)	15.72	17.63	16.68
S_3(Salicylic acid 50 ppm)	15.97	17.47	16.72
S_4(Salicylic acid 100 ppm)	16.42	17.58	17.00
S_5(Sodium Benzoate 25 ppm)	13.42	15.75	14.58
S_6(Sodium Benzote 50 ppm)	13.95	15.28	14.62
S_7(Cow Urine 20 %)	12.40	13.23	12.82
S_8 (Humic acid 5 %)	12.80	13.30	13.05
S_9(GA_3 100 ppm)	13.18	14.02	13.60
S_{10}(GA_3 150 ppm)	13.57	14.73	14.15
S_{11}(NAA 50 ppm)	13.20	15.53	14.37
S_{12}(NAA 100 ppm)	13.40	15.40	14.40
S_{13}(Coconut water 20 %)	12.42	15.25	13.83
S_{14}($FeSO_4$ 2 %)	12.30	12.97	12.63
S_{15}($FeSO_4$ 4%)	12.87	15.03	13.95
S_{16} ($ZnSO_4$ 2 %)	12.22	14.38	13.30
S_{17}($ZnSO_4$ 4 %)	12.73	15.23	13.98
S_{18}(Control)	12.05	14.35	13.20
SEm(±)	0.611	1.05	0.51
CD(P=0.05%)	1.724	2.98	1.44
Varieties			
V_1 (Prajwal)	13.7	15.29	14.49
V_2 (Arka Sugandhi)	13.40	15.18	14.29
SEm(±)	0.20	0.35	0.17
CD(P=0.05%)	0.57	0.99	0.48
Interactions			
S_1V_1(Boric acid 2 % + Prajwal)	16.10	17.10	16.60
S_2V_1(Boric acid 4 % + Prajwal)	16.03	17.87	16.95
S_3V_1(Salicylic acid 50 ppm + Prajwal)	16.63	17.97	17.30
S_4V_1(Salicylic acid 100 ppm + Prajwal)	16.30	17.30	16.80
S_5V_1(Sodium Benzoate 25 ppm + Prajwal)	13.60	15.93	14.77
S_6V_1(Sodium Benzote 50 ppm + Prajwal)	14.40	14.40	14.40
S_7V_1(Cow Urine 20 % + Prajwal)	11.83	12.83	12.33
S_8V_1(Humic acid 5 % + Prajwal)	12.67	12.67	12.67
S_9V_1(GA_3 100 ppm+ Prajwal)	13.17	12.83	13.00
$S_{10}V_1$(GA_3 150 ppm+ Prajwal)	13.37	16.03	14.70
$S_{11}V_1$(NAA 50 ppm + Prajwal)	13.50	16.17	14.83
$S_{12}V_1$(NAA 100 ppm + Prajwal)	13.57	15.90	14.73
$S_{13}V_1$(Coconut water 20 % + Prajwal)	12.80	15.47	14.13
$S_{14}V_1$($FeSO_4$ 2 % + Prajwal)	13.23	14.57	13.90
$S_{15}V_1$($FeSO_4$ 4% + Prajwal)	12.13	13.80	12.97
$S_{16}V_1$($ZnSO_4$ 2 % + Prajwal)	12.20	15.20	13.70
$S_{17}V_1$($ZnSO_4$ 4 % + Prajwal)	12.63	14.97	13.80
$S_{18}V_1$(Control + Prajwal)	12.43	14.37	13.40
S_1V_2(Boric acid 2 % + Arka Sugandhi)	14.60	17.27	15.93
S_2V_2(Boric acid 4 % + Arka Sugandhi)	15.40	17.40	16.40
S_3V_2(Salicylic acid 50 ppm + Arka Sugandhi)	15.30	16.97	16.13
S_4V_2(Salicylic acid 100 ppm + Arka Sugandhi)	16.53	17.87	17.20
S_5V_2(Sodium Benzoate 25 ppm + Arka Sugandhi)	13.23	15.57	14.40
S_6V_2(Sodium Benzote 50 ppm + Arka Sugandhi)	13.50	16.17	14.83
S_7V_2(Cow Urine 20 % + Arka Sugandhi)	12.97	13.63	13.30
S_8V_2(Humic acid 5 % + Arka Sugandhi)	12.93	13.93	13.43
S_9V_2(GA_3 100 ppm+ Arka Sugandhi)	13.20	15.20	14.20
$S_{10}V_2$(GA_3 150 ppm+ Arka Sugandhi)	13.77	13.43	13.60
$S_{11}V_2$(NAA 50 ppm + Arka Sugandhi)	12.90	14.90	13.90
$S_{12}V_2$(NAA 100 ppm + Arka Sugandhi)	13.23	14.90	14.07
$S_{13}V_2$(Coconut water 20 % + Arka Sugandhi)	12.03	15.03	13.53
$S_{14}V_2$($FeSO_4$ 2 % + Arka Sugandhi)	11.37	11.37	11.37
$S_{15}V_2$($FeSO_4$ 4% + Arka Sugandhi)	13.60	16.27	14.93
$S_{16}V_2$($ZnSO_4$ 2 % + Arka Sugandhi)	12.23	13.57	12.90
$S_{17}V_2$($ZnSO_4$ 4 % + Arka Sugandhi)	12.83	15.50	14.17
$S_{18}V_2$(Control + Arka Sugandhi)	11.67	14.33	13.00
SEm(±)	0.86	1.49	0.722
CD(P=0.05%)	2.43	4.22	2.036

These results are in close conformity with the findings of Van Doorn (2004); Kumar and Singh (1996) in tuberose and Hou *et al*. (2018).

E. Floret opening (%)

The result showed in Table 5 that among various substances S_4 (Salicylic acid 100 ppm), significantly maximum floret opening (83.12 %). Interaction effect was found superior (87.00 %) under S_5V_2 (Sodium Benzoate 25 ppm + Arka Sugandhi). Maximum floret opening (%) was recorded from Salicylic acid 100 ppm which helps in membrane stability and resistance enhancement against senescence related changes which increases the amount of protein resulting increases bud opening and highest floret opening at advanced stage might also be due to sufficient accumulation of carbohydrates, enhancing petal movement. Similar results were observed by Hashemabadi (2011); Varu and Barad (2005).

Table 5: Effect of various organic and inorganic substances on floret opening (%).

Floret opening (%)			
Treatments	**2021-22**	**2022-23**	**Pool Mean**
S_1(Boric acid 2 %)	79.38	80.55	79.97
S_2(Boric acid 4 %)	80.53	82.03	81.28
S_3(Salicylic acid 50 ppm)	80.93	82.60	81.77
S_4(Salicylic acid 100 ppm)	81.45	83.12	82.28
S_5(Sodium Benzoate 25 ppm)	82.65	77.12	80.03
S_6(Sodium Benzote 50 ppm)	75.67	77.50	76.58
S_7(Cow Urine 20 %)	68.72	71.05	69.88
S_8 (Humic acid 5 %)	70.83	72.33	76.58
S_9(GA_3 100 ppm)	74.45	76.95	75.70
S_{10}(GA_3 150 ppm)	76.00	78.50	77.25
S_{11}(NAA 50 ppm)	74.92	77.58	76.25
S_{12}(NAA 100 ppm)	76.78	79.12	77.95
S_{13}(Coconut water 20 %)	66.18	68.02	67.10
S_{14}($FeSO_4$ 2 %)	68.57	70.23	69.40
S_{15}($FeSO_4$ 4%)	70.80	72.80	71.80
S_{16} ($ZnSO_4$ 2 %)	69.47	72.80	71.47
S_{17}($ZnSO_4$ 4 %)	71.00	73.17	72.08
S_{18}(Control)	64.95	66.15	65.55
SEm(±)	0.75	1.05	1.18
CD(P=0.05%)	2.12	2.98	3.34
Varieties			
V_1 (Prajwal)	74.99	76.66	75.83
V_2 (Arka Sugandhi)	73.15	74.63	74.50
SEm(±)	0.25	0.35	0.39
CD(P=0.05%)	0.71	0.99	1.11
Interactions			
S_1V_1(Boric acid 2 % + Prajwal)	80.37	80.70	80.53
S_2V_1(Boric acid 4 % + Prajwal)	81.60	82.60	82.10
S_3V_1(Salicylic acid 50 ppm + Prajwal)	82.57	84.57	83.57
S_4V_1(Salicylic acid 100 ppm + Prajwal)	82.50	85.17	83.83
S_5V_1(Sodium Benzoate 25 ppm + Prajwal)	78.30	78.97	78.63
S_6V_1(Sodium Benzote 50 ppm + Prajwal)	80.13	81.13	80.63
S_7V_1(Cow Urine 20 % + Prajwal)	71.53	74.20	72.87
S_8V_1(Humic acid 5 % + Prajwal)	74.07	76.40	75.23
S_9V_1(GA_3 100 ppm+ Prajwal)	74.30	76.63	75.47
$S_{10}V_1$(GA_3 150 ppm+ Prajwal)	75.93	77.60	76.77
$S_{11}V_1$(NAA 50 ppm + Prajwal)	76.33	78.33	77.33
$S_{12}V_1$(NAA 100 ppm + Prajwal)	79.90	81.90	80.90
$S_{13}V_1$(Coconut water 20 % + Prajwal)	65.23	66.90	66.07
$S_{14}V_1$($FeSO_4$ 2 % + Prajwal)	70.03	71.37	70.70
$S_{15}V_1$($FeSO_4$ 4% + Prajwal)	70.77	72.10	71.43
$S_{16}V_1$($ZnSO_4$ 2 % + Prajwal)	69.93	73.27	71.60
$S_{17}V_1$($ZnSO_4$ 4 % + Prajwal)	71.67	73.00	72.33
$S_{18}V_1$(Control + Prajwal)	64.73	65.07	64.90
S_1V_2(Boric acid 2 % + Arka Sugandhi)	78.40	80.40	79.40
S_2V_2(Boric acid 4 % + Arka Sugandhi)	79.47	81.47	80.47
S_3V_2(Salicylic acid 50 ppm + Arka Sugandhi)	79.30	80.63	79.97
S_4V_2(Salicylic acid 100 ppm + Arka Sugandhi)	80.40	81.07	80.73
S_5V_2(Sodium Benzoate 25 ppm + Arka Sugandhi)	87.00	75.27	81.43
S_6V_2(Sodium Benzote 50 ppm + Arka Sugandhi)	71.20	73.87	72.53
S_7V_2(Cow Urine 20 % + Arka Sugandhi)	65.90	67.90	66.90
S_8V_2(Humic acid 5 % + Arka Sugandhi)	67.60	68.27	77.93
S_9V_2(GA_3 100 ppm+ Arka Sugandhi)	74.60	77.27	75.93
$S_{10}V_2$(GA_3 150 ppm+ Arka Sugandhi)	76.07	79.40	77.73
$S_{11}V_2$(NAA 50 ppm + Arka Sugandhi)	73.50	76.83	75.17
$S_{12}V_2$(NAA 100 ppm + Arka Sugandhi)	73.67	76.33	75.00
$S_{13}V_2$(Coconut water 20 % + Arka Sugandhi)	67.13	69.13	68.13
$S_{14}V_2$($FeSO_4$ 2 % + Arka Sugandhi)	67.10	69.10	68.10
$S_{15}V_2$($FeSO_4$ 4% + Arka Sugandhi)	70.83	73.50	72.17
$S_{16}V_2$($ZnSO_4$ 2 % + Arka Sugandhi)	69.00	72.33	71.33
$S_{17}V_2$($ZnSO_4$ 4 % + Arka Sugandhi)	70.33	73.33	71.83
$S_{18}V_2$(Control + Arka Sugandhi)	65.17	67.23	66.20
SEm(±)	1.06	1.49	1.67
CD(P=0.05%)	3.00	4.21	4.72

CONCLUSIONS

From the present investigation, it can be concluded that quick dip (20 seconds) with boric acid @ 4% and Salicylic acid 100 ppm improved the postharvest life of tuberose flowers with maximum flower diameter, minimum physiological weight loss, maximum membrane stability index, maximum total soluble solids and maximum florets opening %.

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