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Effect of different chemicals on litchi (*Litchi chinensis* Sonn.) cv. rose scented

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Abstract
Present study was conducted to evaluate the effect of different chemicals to improve the yield and quality of litchi and for minimizing the post harvest and physiological disorders in fruits. Calcium nitrate, calcium chloride, boric acid, salicylic acid and humic acid were applied as preharvest foliar spray. Results showed that fruit cracking (11.03%) was reduced by boric acid (0.1 %). Fruit yield (90.44 kg/tree), fruit weight (25.37 g), fruit volume (23.90 ml), pulp weight (17.42 g) and pulp: peel ratio (8.90) were maximum with calcium chloride (0.5%). Humic acid @ 0.2% was better for higher total sugars (16.31%). Boric acid @ 0.1% was better for higher reducing sugars (12.76%). Calcium nitrate (0.5%) was better for higher non reducing sugars (4.93%). Humic acid @ 0.4% was better for higher TSS: acid ratio (57.97).

Keywords: Litchi, quality, fruit cracking, calcium, boron, salicylic acid, humic acid

Introduction
Litchi (*Litchi chinensis* Sonn.) belongs to Sapindaceace family. It is an important subtropical fruit crop native to southern China. Litchi was introduced to India in 17th century [21]. Litchi is a highly demanded fruit because of its delicious fruit quality as table purpose and processed products. Litchi fruit is highly nutritious. It contains 83.6 g moisture, 0.7 g protein, 0.1 g fat, 15.0 g carbohydrates, 4.0 mg calcium, 32.0 mg phosphorus, 0.7 mg iron, 0.02 mg thiamine, 0.07 mg riboflavin, 1.1 mg niacin, 15 mg ascorbic acid and traces of carotene [10]. It has a strong commercial value in international markets for its bright red skin and sweet, juicy and crisp aril [14]. India is the second largest producer of litchi in the world next after China. Presently in India litchi is cultivated on an area of about 84 thousand hectares with a total production of 585 thousand metric tons [2]. In India, it is mainly grown in Bihar, West Bengal, Uttar Pradesh, Punjab and Uttarakhand.

Being a non-climacteric fruit, litchi does not improve its quality after harvesting, but has to ripen on the tree only [8]. Therefore, fruits are harvested ripen and should reach to the ultimate consumers immediately. To extend the availability of fruits storage life of the fruits has to be increased. Pericarp browning, desiccation, loss of quality, post-harvest decays and micro cracking are major constraints affecting commercial quality during storage and transportation [29, 17]. Litchi undergoes deteriorative changes immediately after harvest which makes it otherwise highly potential commercial crop and thus lose its marketability especially in the global context. Rapid desiccation of fruits leads to browning of pericarp which brings about a decline in the consumer's appeal and acceptability although the nutritive quality and taste is still retained. Pre-harvest application of various chemicals have been reported to enhance the shelf life of fruits by reducing physiological loss in weight, decay losses during storage [13, 16] and fruit cracking [25]. Calcium, an essential nutrient maintains the cell wall integrity and is found to inhibit to some extent the senescence of litchi fruits. Pre-harvest treatment of calcium helped in maintenance of fruit quality [26, 9]. The beneficial effects of boron as pre-harvest sprays have been reported to govern several physiological and biochemical plant processes on litchi fruits [11]. Calcium is involved in cracking resistance in litchi fruit because trees with lower cracking incidence have higher calcium levels, while, a low exchange able calcium in plants results in high cracking incidence [20]. Considering the above points in view, an experiment was conducted evaluate the influence of plant growth regulators and mineral nutrients on yield and physico-chemical characteristics of litchi cv. 'Rose Scented'.

Materials and Methods
The present investigation was conducted during the year 2015 at Horticultural Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture & Technology,

Pantnagar, Uttarakhand, India. Pantnagar is geographically situated in the *Tarai* region at the foot hills of Himalayas at 29° N latitude and 79.3° E longitude and at an altitude of 243.83 meters above mean sea level. The climate of Pantnagar is sub humid, subtropical with hot dry summers and cool winters. The summer temperature rises up to 46 °C, while the winter temperature falls to 2 °C. The mean annual rainfall is 2382 mm and relative humidity fluctuates around 98% during rainy season and remains above 85% in February after which it decreases up to 5% in May. The data on air temperature (maximum and minimum), relative humidity, rainfall, and velocity were recorded at weekly interval during the period of field investigation. The experiment was conducted with 24 years old bearing litchi (*Litchi chinensis* Sonn.) cv. Rose Scented of uniform vigour and size. All the trees were maintained under uniform cultural practices during the course of investigation. The plants were sprayed with different concentration of calcium nitrate, calcium chloride, boric acid, salicylic acid and humic acid twice with the help of foot sprayer. First application was done on April 24, 2015 and second on May 10, 2015. The experiment was laid out in completely randomized block design (RBD) as given by Snedecor and Cochran [30] consisted of eight treatments viz., T_1: Calcium nitrate (0.5%), T_2: Calcium chloride (0.5%), T_3: Boric acid (0.1%), T_4: Salicylic acid (50 µ mol l^{-1}), T_5: Salicylic acid (100 µ mol l^{-1}), T_6: Humic acid (0.2%), T_7: Humic acid (0.4%) and T_8: Control (water spray). All the treatments were replicated thrice and one tree served as a treatment unit in each replication. The overall significance of differences among the treatments was tested, using critical difference (C.D.) at 5% level of significance [12]. The percentage of fruit retention was calculated by taking the average of data obtained from the whole tree from each replication on the basis of formula; Fruit retention (%) $= \frac{\text{Number of fruits retained per panicle}}{\text{Number of fruit set initially per panicle}} \text{X } 100$. The per cent fruit cracking, on the basis of the formula; Fruit cracking (%) $= \frac{\text{Number of fruits cracked per panicle at the time of harvesting}}{\text{Number of fruits ratained per panicle at the time of harvesting}} \text{x } 100.$

The per cent fruit sun burning was calculated by the formula; Sun burning (%) $= \frac{\text{Number of fruits sun burn per panicle at the time of harvesting}}{\text{Number of fruits ratained per panicle at the time of harvesting}} \text{X } 100.$

Fruit yield was recorded in kg/tree. Fruit length, fruit diameter, seed length and seed diameter was measured with digital vernier caliper. Fruits weight, pulp weight, peel weight and stone weight were recorded using an electronic balance and expressed in grams. Fruit volume calculated by water displacement method and expressed in ml. Fruit specific gravity was calculated by dividing fruit weight with fruit volume. Total soluble solids (TSS) of the fruits was measured by using digital hand refractometer at room temperature and expressed in terms of degree Brix. Titratable acidity of litchi fruits was calculated by titrating the pulp extract with 0.1 N NaOH and sugars were estimated as described by Ranganna [24] using phenolphthalein as an indicator and was expressed in percentage (%). TSS: Acid level was calculated by dividing TSS with acidity and expressed as a ratio of TSS and acidity. Pulp: peel ratio was calculate by dividing pulp weight with peel weight. Pulp: stone ratio was calculated by dividing pulp weight with stone weight.

Results and Discussion

The data presented in Table 1 showed that all the treatments did not have any significant effect on increased fruit retention in litchi. However, the highest fruit retention (23.23%) was recorded in T_2 [Calcium chloride @ 0.5%] followed by T_1 [Calcium nitrate @ 0.5%] (22.59%) and minimum fruit retention (18.75%) was recorded in T_8 [control] followed by T_4 [Salicylic acid @ 50 µ mol/l] (20.61%). The present finding are corroborates with the findings of Korkmazl and Askın [15] who reported that the application of calcium nitrate 2% and boron 3% increased fruit set.

Fruit cracking was minimum (11.03%) with T_3 [Boric acid @ 0.1%] while maximum (22.43%) fruit cracking was recorded with T_8 [control]. All treatments significantly reduced the fruit cracking in comparison to control. Boron is a constituent of cell membrane and essential for cell division. The data presented on fruit cracking in litchi was supported with the findings of Sharma and Belsare [28] who concluded that extent of fruit cracking was reduced significantly with the application of boron at 0.2%. Reduction in fruit cracking with the application of boron has been reported in litchi [3]. Korkmazl and Askın [15] reported that the ratio of fruit cracking was reduced to a maximum with the application of boric acid 1.5% and calcium nitrate 4%).

Sun burning in fruits was minimum with T_5 [Salicylic acid @ 100 µ mol/l] (7.33%) followed by T_4 [Salicylic acid @ 50 µ mol/l] (7.67%) while maximum fruit sun burning (9.33%) was recorded with T_8 [control] followed by T_7 [Humic acid @ 0.4%] (9.00%). There was no significant difference among the all treatments.

Significantly higher fruit yield (90.44 kg/tree) was recorded in T_2 [Calcium chloride @ 0.5%] followed by T_1 [Calcium nitrate @ 0.5%] (88.08kg $tree^{-1}$) while minimum fruit yield (79.88 kg/tree) was observed in T_8 [control] followed by T_6 [Humic acid @ 0.2%] (82.68 kg/tree). All treatments significantly increased yield over control. However, non-significant difference was between T_2 [Calcium chloride @ 0.5%], T_3 [Boric acid @ 0.1%] and T_4 [Salicylic acid @ 50 µ mol/l]. Increased fruit yield in litchi was supported with the findings of Upreti and Kumar [31] who reported that foliar application of calcium nitrate or calcium chloride (Either of the two concentrations of 1.0% and 0.5%) significantly increased the yield of litchi cv. Rose Scented as compared to control. Bhat *et al.* [4] assessed effect of pre-harvest sprays of calcium and potassium on quality characteristics of cherry cv. Makhmali. Maximum fruit yield (44.00 kg/tree) was found under the treatment of calcium chloride at 0.5% concentration followed by 37.33 kg/tree in 1.0% and 34.67 kg/tree in 1.5% concentration.

Influence of different concentrations of chemicals on fruit length was non-significant. Maximum fruit length (39.80 mm) was recorded in T_2 [Calcium chloride @ 0.5%] followed by T_1 [Calcium nitrate @ 0.5%] (38.79 mm) while minimum fruit length (36.68 mm) was recorded in T_8 [control] followed by T_4 [Salicylic acid @ 50 µ mol/l] (36.80 mm). There was no significant difference among the all treatments. The present finding are in supported of Bhat *et al.* [5] who reported that a non-significant increase in fruit size was noticed with 0.75% $CaCl_2$. Korkmazl and Aşkın [15] observed that the application of calcium nitrate 2% and boron 3% increased the characters fruit size (length and diameter), but was not significant.

The effect of chemicals on the fruit diameter was found non-significant. Maximum fruit width (33.83 mm) was recorded in T_1 [Calcium nitrate @ 0.5%] followed by T_2 [Calcium chloride @ 0.5%] (33.82 mm) while minimum fruit width (31.84 mm) was recorded in T_8 [control] followed by T_6 [Humic acid @ 0.2%] (31.87 mm). The present results corroborate with the finding of Xu *et al.* [32] who reported that no obvious differences in fruit vertical diameter, transverse

diameter, lateral diameter and fruit shape index among fruits of all treatments and control at bloom stage. However, average fruit weight by 0.2% borax + 0.5% $CaCl_2$ treatment was obviously higher than others. Korkmazl and Aşkın [15] the application of calcium nitrate 2% and boric acid 3% increased the characters fruit size (length and diameter), but was not significant.

Treatment T_2 [Calcium chloride @ 0.5%] recorded maximum seed length (26.63 mm) followed by T_4 [Salicylic acid @ 50 µ mol/l] (25.85 mm) while minimum seed length (25.00 mm) was recorded in T_8 [control] followed by T_7 [Humic acid @ 0.4%] (25.49 mm). There was no significant difference among the all treatments. Fruits of T_7 [Humic acid @ 0.4%] showed minimum seed width (15.78 mm) and maximum in seed width was found with T_4 [Salicylic acid @ 50 µ mol/l] (17.73 mm). There was no significant difference among the all treatments.

Treatment T_2 [Calcium chloride @ 0.5%] attained maximum fruit weight (25.37 g) followed by T_1 [Calcium nitrate @ 0.5%] (24.25 g) while minimum fruit weight (20.30 g) was recorded in T_8 [control] followed by T_6 [Humic acid @ 0.2%] (22.54 g). There was significant difference among the all treatments. The present findings are fully supported with the findings of Roychaudhary *et al.* [27] who reported that spray of 0.6 per cent calcium chloride increases the fruit weight of litchi cv. Bombai.

There was no significant difference among the all the treatments regarding fruit volume. Maximum fruit volume (23.90 ml) was recorded in T_2 [Calcium chloride @ 0.5%] followed by T_1 [Calcium nitrate @ 0.5%] (23.22 ml) while minimum fruit volume (19.79 ml) was recorded in T_8 [control] followed by T_5 [Salicylic acid @ 100 µ mol/l] (21.40 ml). The present findings are in supported of Lal *et al.* [19] observed that the effect of calcium nitrate (2.0 and 3.0%) and borax (0.5 and 1.0%) on fruit volume of litchi fruits cv. Rose Scented was found non-significant.

Fruits of T_1 [Calcium nitrate @ 0.5%] had maximum specific gravity (1.14) followed by T_3 [Boric acid @ 0.1%] and T_5 [Salicylic acid @ 100 µ mol/l] (1.08). The minimum specific gravity (1.02) was obtained with T_8 [control] followed by T_2 [Calcium chloride @ 0.5%] and T_4 [Salicylic acid @ 50 µ mol/l] (1.03). There was no significant difference among the all treatments. The present findings are in agreement with the findings of Kumar *et al.* [18] who reported that effect of foliar spray of different nutrient (boron, zinc, calcium and potassium) on specific gravity was non-significant.

Fruits of T_2 [Calcium chloride @ 0.5%] had maximum pulp weight (17.42 g) followed by T_1 [Calcium nitrate @ 0.5%] (16.60 g) and minimum of (12.08 g) in T_8 [control] followed by T_6 [Humic acid @ 0.2%] (14.99 g). There was no significant difference among the all treatments. The present results were fully supported with the findings of Roychaudhary *et al.* [27] who reported the maximum fruit weight (16.2 g) and percentage of pulp (59.0%) and lowest per cent of peel and stone by pre-harvest foliar spraying of 0.6 percent $CaCl_2$ in litchi cv. Bombai.

Fruits of T_5 [Salicylic acid @ 100 µ mol/l] showed maximum peel weight (2.23 g) followed by T_6 [Humic acid @ 0.2%] (2.16 g) and minimum (1.93 g) in T_3 [Boric acid @ 0.1%] followed by T_2 [Calcium chloride @ 0.5%] (1.96 g). The present results corroborate with the finding of Bhusan *et al.* [6] who reported that the effect of borax (1.0%) along with black LDPE mulching was observed but there was no significance variation found among treatment on stone weight and peel weight of mango cv. Amrapali. Lal *et al.* [19] reported a non-significant effect of calcium nitrate (2.0 and 3.0%) and borax (0.5 and 1.0%) on peel weight of litchi fruits cv. Rose Scented.

Stone weight was not significantly influenced by various treatments. However, T_4 [Salicylic acid @ 50 µ mol/l] showed maximum stone weight (4.31 g) followed by T_2 [Calcium chloride @ 0.5%] (4.26 g) and minimum (3.70 g) in T_8 [control] followed by T_3 [Boric acid @ 0.1%] (3.95 g). Fruits of T_2 [Calcium chloride @ 0.5%] had maximum pulp percentage (68.59%) followed by T_1 [Calcium nitrate @ 0.5%] (67.94%) and minimum pulp percentage (59.36%) was recorded in T_8 [control] followed by T_6 [Humic acid @ 0.2%] (66.36%). There was no significant difference among the all treatments.

Fruits of T_2 [Calcium chloride @ 0.5%] showed maximum pulp: peel ratio (8.90) followed by T_3 [Boric acid @ 0.1%] (8.73) and minimum in T_8 [control] (6.31) followed by T_6 [Humic acid @ 0.2%] (6.92). There was no significant difference in between most of the treatments. T_3 [Boric acid @ 0.1%] had maximum Pulp: stone ratio (4.40) followed by T_2 [Calcium chloride @ 0.5%] (4.33) and minimum (3.43) in T_8 [control] followed by T_6 [Humic acid @ 0.2%] (3.69). There were no significant differences in between most of the treatments.

The maximum total sugar content (16.31%) was found in T_6 [Humic acid @ 0.2%] followed by T_3 [Boric acid @ 0.1%] and T_7 [Humic acid @ 0.4%] (16.30%). However, the minimum total sugar content (14.44%) was found in T_8 [control] followed by T_5 [Salicylic acid @ 100 µ mol/l] (14.88%). The maximum reducing sugar content of 12.76% was found in T_3 [Boric acid @ 0.1%] followed by T_4 [Salicylic acid @ 50 µ mol/l] (12.39%) and minimum (11.29%) was found in T_1 [Calcium nitrate @ 0.5%] followed by T_8 [control] (11.55%). The maximum non-reducing sugar content of (4.93%) was found in T_1 [Calcium nitrate @ 0.5%] followed by T_6 [Humic acid @ 0.2%] (4.39%) and minimum (2.84%) was found in T_8 [control] followed by T_2 [Calcium chloride @ 0.5%] (3.18%). All treatments significantly increased sugar content over control.

The data presented on pulp weight in litchi was fully supported with the findings of Alila and Achumi [1] who reported that pre-harvest application of 0.4% boric acid resulted in higher TSS and lower acidity content in fruits during storage (5-7°C). Total sugars (15.92%) and reducing sugars (11.94%) were also enhanced with 0.4% boric acid pre-harvest application. The physical parameters of fruits (weight and diameter of fruit and pulp weight) were found to be positively influenced with the application of calcium nitrate at 1.5% as pre-harvest spray. Misra and Khan [22] observed that foliar spray of boric acid reduced acid levels in fruits of litchi. Brahamchari *et al.* [7] reported that spray of 0.4 per cent borax increase TSS, sugar and ascorbic acid content in litchi cv. Purvi while acidity was lowest. Nath *et al.* [23] conducted an investigation to assess the effect of chemical spray on physico-chemical properties and yield of litchi fruits revealed that spraying of borax @ 0.5% or 1% increased TSS (17.48 ˚B), ascorbic acid (51.82 mg/100g), total sugar (15.33%) and reducing sugar content (11.10%) of litchi fruits while the same spray decreased the acidity percentage.

The TSS content of litchi fruit was maximum (19.13 °B) in T_1 [Calcium nitrate @ 0.5%] followed by T_7 [Humic acid @ 0.4%] (18.73 °B).The minimum TSS content of (17.07 °B) was found in T_3 [Boric acid @ 0.1%] followed by T_6 [Humic acid @ 0.2%] and T_8 [control] (17.13 °B). There was no significant difference among the all treatments. The presented

findings are in supported of Korkmazl and Aşkın [15] observed that the application of calcium nitrate 2% and boron 3% increased TSS, but was not significant. There was also no clear effect among all treatments at bloom in fruit total content of soluble solids and vitamin C [32].

Titratable acidity (%) was maximum in T_1 [Calcium nitrate @ 0.5%] and T_3 [Boric acid @ 0.1%] (0.35%) followed by T_4 [Salicylic acid @ 50 µ mol/l], T_5 [Salicylic acid @ 100 µ mol/l] and T_6 [Humic acid @ 0.2%] (0.34). Minimum acidity was recorded in T_2 [Calcium chloride @ 0.5%] (0.31%) followed by T_7 [Humic acid @ 0.4%] (0.32%). There was no significant difference among the all treatments. The present results are supported with the findings of Misra and Khan [22] who observed that foliar spray of boric acid reduced acid levels in fruits of litchi. Brahamchari *et al.* [7] reported that spray of 0.4 per cent borax increased TSS, sugar and ascorbic acid content in litchi cv. Purvi while acidity was lowest. Korkmaz and Aşkın [15] reported that application of calcium nitrate 2% and Boron 3% increased titratable acidity, but was not significant.

Highest ascorbic acid content was found in T_2 [Calcium chloride @ 0.5%] (29.70 mg/ 100 g pulp) followed by T_1 [Calcium nitrate @ 0.5%] (28.30 mg/ 100 g pulp). Lowest ascorbic acid content was found in T_8 [control] (24.17 mg/ 100 g pulp) followed by T_4 [Salicylic acid @ 50 µ mol/l] (26.36 mg/ 100 g pulp). There was no significant difference between most of the treatments. The present results corroborate with the findings of Korkmazl and Aşkın [15] who reported that the application of calcium nitrate 2% and boron 3% increased ascorbic acid content, but was not significant.

TSS: acid was maximum in T_7 [Humic acid @ 0.4%] (57.97) followed by T_1 [Calcium nitrate @ 0.5%] (56.94). Minimum TSS: acid was recorded in T_3 [Boric acid @ 0.1%] (48.31) followed by T_4 [Salicylic acid @ 50 µ mol/l] (50.27). There was no significant difference between most of the treatments.

Table 1: Effect of different chemicals on litchi cv. Rose Scented

Treatments	FR (%)	FC (%)	SB (%)	FY (kg/tree)	FS		SS		FW (g)	FV (ml)	FSG
					FL (mm)	FD (mm)	SL (mm)	SD (mm)			
T1: Calcium nitrate @ 0.5%	22.59	16.87	8.00	88.08	38.79	33.83	25.77	16.41	24.25	23.22	1.14
T2: Calcium chloride @ 0.5%	23.23	13.12	8.67	90.44	39.80	33.82	26.63	16.54	25.37	23.90	1.03
T3: Boric acid @ 0.1%	22.02	11.03	8.33	87.84	37.09	32.01	25.82	16.35	24.08	22.33	1.08
T4: Salicylic acid @ 50 µ mol l-1	20.61	11.79	7.67	84.95	36.80	32.20	25.85	17.63	23.55	22.91	1.03
T5: Salicylic acid @ 100 µ mol l-1	21.00	14.76	7.33	86.44	37.97	32.24	25.61	16.75	23.09	21.40	1.08
T6: Humic acid @ 0.2%	21.00	17.00	8.33	82.68	38.35	31.87	25.58	16.78	22.54	21.58	1.05
T7: Humic acid @ 0.4%	20.63	14.20	9.00	84.77	37.29	32.14	25.49	15.78	22.88	21.64	1.06
T8: Control (water spray)	18.75	22.43	9.33	79.88	36.68	31.84	25.00	16.21	20.30	19.79	1.02
SEm ±	1.57	1.31	1.30	1.12	1.79	1.23	1.39	0.55	0.85	0.95	0.05
C.D. at 5%	NS	4.01	NS	3.44	NS	NS	NS	NS	2.60	NS	NS

FR=Fruit retention, FC=Fruit cracking, SB=Sun burning, FY=Fruit yield, FS=Fruit size, FL=Fruit length, FD=Fruit diameter, SS=Seed size, SL=Seed length, SD=Seed diameter, FW=Fruit weight, FV=Fruit volume, FSG=Fruit specific gravity

Table 2: Effect of different chemicals on litchi cv. Rose Scented

Treatments	PW (g)	PEW (g)	SW (g)	P (%)	PPR	PSR	TS (%)	RS (%)	NRS (%)	TSS (°B)	TA (%)	AA (mg/100 g pulp)	TAR
T1: Calcium nitrate @ 0.5%	16.60	2.00	4.10	67.94	8.30	4.15	16.21	11.29	4.93	19.13	0.35	28.30	56.94
T2: Calcium chloride @ 0.5%	17.42	1.96	4.26	68.59	8.90	4.33	15.04	11.83	3.18	17.73	0.31	29.70	56.67
T3: Boric acid @ 0.1%	16.56	1.93	3.95	66.50	8.73	4.40	16.30	12.76	3.54	17.07	0.35	27.17	48.31
T4: Salicylic acid @ 50 µ mol l-1	15.96	1.98	4.31	67.85	8.14	3.89	16.23	12.39	3.84	18.07	0.34	26.36	50.27
T5: Salicylic acid @ 100 µ mol l-1	15.66	2.23	4.06	67.61	7.02	3.97	14.88	11.66	3.22	18.13	0.34	28.12	53.36
T6: Humic acid @ 0.2%	14.99	2.16	4.20	66.36	6.92	3.69	16.31	11.92	4.39	17.13	0.34	27.53	50.42
T7: Humic acid @ 0.4%	15.41	2.13	4.01	67.35	7.25	4.03	16.30	12.20	4.12	18.73	0.32	27.83	57.97
T8: Control (water spray)	12.08	1.97	3.70	59.36	6.31	3.43	14.44	11.55	2.84	17.13	0.33	24.17	51.68
SEm ±	0.87	0.11	0.59	2.47	0.50	0.46	0.20	0.23	0.24	0.88	0.29	5.76	1.88
C.D. at 5%	2.66	NS	NS	NS	1.52	NS	0.61	0.69	0.74	NS	NS	NS	5.76

PW=Pulp weight, PEW=Peel weight, SW=Stone weight, P=Pulp, PPR=Pulp : peel ratio, PSR=Pulp : stone ratio, TS=Total sugars, RS= Reducing sugar, NRS= Non-reducing sugars, TSS=Total soluble sugars, TA=Titratable acidity, AA=Ascorbic acid, TAR=TSS : Acid ratio

Conclusion

Findings of present study revealed that application of calcium chloride (0.5 %) was most effective for yield related characteristics like yield, fruit weight, fruit volume, pulp weight and pulp: peel ratio. Calcium nitrate, boric acid and humic acid were found effective for improving quality characteristics like minimizing fruit cracking and improving sugars and TSS. For further studies combinations of these chemicals should be tried to get best combination treatments.

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