International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1730-1735

Received: 01-05-2019
Accepted: 03-06-2019

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Fruit cracking, marketable yield and quality of litchi is influenced by foliar sprays of NAA and boron

Sopal Singh and JP Singh

Abstract

An experiment was conducted at Horticulture Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture & Technology Kanpur (U.P.) during two concutive years 2017-18 and 2018-19. Factorial Completely Randomized Design was used with three replications and sixteen treatments viz. four levels each of NAA (0, 30, 60 and 90 ppm) and Boron (0, 0.2, 0.4 and 0.6%) and their combination. Spraying were done twice i.e. before flowering and at pea stage. Sprays of 60 ppm NAA significantly maximized marketable yield (70.03 and 73.40 kg per plant), T.S.S. (19.67 and 20.17 ^{0}brix), total sugar (13.23 and 13.57%), juice content (59.87 and 61.46%), sugar/acid ratio (27.81 and 28.48), vitamin-C (40.44 and 41.12 mg/100g), organoleptic rating (82.00 and 83.32), and shelf life (3.91 and 3.97 days) respectively, whereas, percentage of cracked fruit per panicle (12.57 and 9.57%) and acidity content was significantly reduced (0.478 and 0.477%) during both the years of study. NAA 90 ppm significantly reduced dry matter of fruit (17.45 and 16.54%). Boron applied at 0.4% also proved effective and significantly enhanced T.S.S. (19.80 and 20.27 ^{0}brix), vitamin-C (40.96 and 41.67 mg/100g), organoleptic score (82.36 and 83.58) and shelf life (3.95 and 4.01 days) while percentage of cracked fruit per panicle was reduced (11.52 and 8.75%). Increasing concentration of boron to 0.6% caused significant improvement in marketable yield (65.21 and 68.55 kg per plant), total sugar (13.35 and 13.68%), juice content (60.44 and 61.94%), sugar/acid ratio (26.32 and 27.31) and dry matter content in fruit (18.35 and 17.40%). However, acidity was reduced (0.508 and 0.502%) during both the years. Interactive treatments of NAA×boron caused significant increase and treatment of N_2 B_2 improved the attributes further showing significantly maximum sugar/acid ratio (29.93 and 30.10), vitamin-C (41.65 and 42.31 mg/100g) and organoleptic rating (85.50 and 86.74). Interactive treatment of N_2 B_1 revealed minimum acidity content (0.471 and 0.474%), whereas, maximum acidity was registered under N_0 B_0 (0.627 and 0.619%) during both the years. Treatment of N_0 B_3 increased dry matter content revealing 19.20 and 18.25% against the minimum of 17.20 and 16.25% expressed under N_3 B_0. Marketable yield was significantly greater 74.64 kg yield per plant with N_2 B_2 treatment during first year.

Keywords: Litchi, boron, NAA, cracking, organoleptic test and shelf life

Introduction

The litchi (*Litchi chinensis* Sonn.) is an important subtropical evergreen fruit crop being a non climacteric fruit, does not improve in quality after harvest, but has to ripen on the tree. It is a fruit with sweet translucent and juicy flesh. It has sugar content in different cultivars ranges from 6.74 to 18.86 per cent beside sugar; it has 0.7% protein, 0.3% fat, 0.7% minerals and vitamin-C 40-60 mg/100 g pulp. It is grown in Sub-mountaineous districts of Uttar Pradesh i.e. Saharanpur and Muzaffarnagar (Singh and Singh, 1954). Muzaffarpur of Bihar grows best quality litchi fruits. The fruits after harvest are very perishable and rapidly loose quality. Harvesting at proper physiological maturity is essential for tune of quality and shelf life. Wide spread deficiencies of micronutrients especially boron, zinc and copper in horticultural crop has been reported. Yellowing of citrus rosetting (little leaf), exanthema or die back, cracking and hard fruit have been attributed to the deficiency of boron (Yamdagni *et al.*, 1983) [23]. In North India in particular, where litchi variety can be seen exhibiting due to deficiency of boron as well as other nutritional disorder. Auxins greatly affects respiration, activating role of photosynthesis thereby improving growth. The auxin may increase the osmotic pressure of the cell sap which will induce water uptake and growth. Nephthalene acetic acid (auxin) increase fruit set, decrease fruit drop and change quality of many fruits (Gardner, 1951) [10]. However, there is dearth of systematic studies to improve the quality and yield of litchi combating fruits cracking simultaneously, therefore an experiment was planned to find out the effect of boron and NAA treatment with a view to improve the yield & quality and minimize the fruit cracking of this crop.

Materials and Methods

The present experiment was conducted at Horticulture Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur during the years of 2017-18 and 2018-19. The experiment was planned with 16 treatments viz. four concentration each of NAA (0, 30, 60 and 90 ppm) and Boron (0, 0.2, 0.4 and 0.6%) and their combination replicating thrice in a Factorial Completely Randomized Design. Uniform and healthy sixteen plants of litchi cv. Dehradun were selected and on each plant similar three branches were identified and each branch was used as a plot unit, thus, different levels of NAA as well as boron sprays were done twice: first prior to flower initiation (10 Feb.) and second at pea stage (06 April). Manurial requirement, cultural practices and plant protection measured were adopted according to norms. Five panicles in each direction were selected randomly in each treatment for recording observation on fruit cracking and yield. All the quality parameters i.e. T.S.S. content, total sugar, juice content, acidity, sugar/acid ratio, vitamin-C, organoleptic test and shelf life were determined in the laboratory of Department of Fruit Science of the University. T.S.S. was determined by using a Hand Refractometer. Total sugar and vitamin-C estimated according to A.O.A.C. (1984) [1], acidity content of the fruit was recorded as malic acid, by titration of juice with 0.1 NaOH using phenolphthalein as indicator. Organoleptic rating was made by a panel of 5 judges on the basis of various quality attributes. Shelf life of fruits was observed by storing them at ambient temperature.

Results and Discussion

It is obvious that significantly minimum 12.57 and 9.57% cracked fruits were recorded with NAA 60 ppm followed by NAA 90 ppm against NAA control revealing the maximum 16.12 and 12.44% during respective years of study. Reducing of fruits cracking per panicle was 22.02 and 23.07% due to optimal dose 60 ppm NAA over control during both the years. Auxin has been reported to cause cell wall plasticization due to growth of new cell wall and contents of cells such as cellulose, hemicelluloses and pectin. Thus, physiological effect of auxin possibly results in preventing the cracking of fruits. The findings are in agreement with the reports of Sahay *et al.*, (2018) [17] and Chauhan *et al.*, (2019) in litchi. Boron applied at 0.4% concentration significantly minimized (11.52 and 8.75%) fruit cracking followed by 0.6% against control showing 19.49 and 15.59% fruit cracking per panicle during both the respective years. Reducing of fruit cracking per panicle was 40.89 and 43.87% due to 0.4% boron over control during both the years. Under boron deficiency the supply of carbohydrate to the meristematic regions is reduced resulting in tissue break down which might have favourite fruit cracking in present investigation. The findings are in line with the reports of Banyal and Rangra (2011) [4] and Dixit *et al.*, (2013) [7] in litchi.

To ascertain the yield of marketable fruits all the cracked and other blemished fruits were separated from total yield of the litchi fruits the significant highest of 70.03 and 73.40 kg marketable fruits per plant were observed under 60 ppm NAA against 48.56 and 51.40 kg under control of NAA in respective years. An improvement of 44.21 and 42.80% over control was noted under 60 ppm NAA respectively. The enhanced yield obtained with optimal dose of NAA in the present investigation may be attributed to its physiological activities in the plants which could have checked fruit drop reduced cracking and minimized number of blemished fruits considerably thereby increasing marketable yield. These findings are in agreements with the reports of Sultana *et al.*, (2016) [22], Sahay *et al.*, (2018) [17] and Chauhan *et al.*, (2019) in litchi. Boron applied at 0.6% concentration significantly increased yield as 65.21 and 68.55 kg against the lowest of 56.75 and 59.50 kg per plant. The marketable yield was increased by 0.6% boron to the tune of 14.90 and 15.21% over control during respective years of study. The beneficial role of boron may be assigned to its optimal level which might have played important role in flowering and fruiting processes, nitrogen metabolism, hormone synthesis and cell division (Russel 1957). It also helps in mobilization of food material to the fruits thus, ultimately increasing the yield of healthy fruits. The findings are in accordance with the reports of Banyal and Rangra (2011) [4] and Kumar *et al.*, (2016) [13] in litchi. Interactive treatments N_2 B_2 enhanced marketable yield significantly showing maximum 74.64 kg yield per plant and minimum under N_0 B_0 (45.82 kg) in first year trial.

Application of NAA 60 ppm indicated significantly maximum 19.67 and 20.17 ^{0}brix T.S.S. against the minimum of T.S.S. 18.59 and 19.08 ^{0}brix under control during corresponding years. The enhancement in T.S.S. by 5.80 and 5.71% over control caused by NAA treatment might be due to diversion of more solid metabolites towards developing fruits increasing amylase activities and thus, there would have been conversion of starch into simple sugar thereby enhancing total soluble solid. These findings are in line with the reports of Kumar *et al.*, (2016) [13] in litchi and Dodiya *et al.*, (2018) [8] in guava. Boron 0.4% concentration recorded significantly highest of 19.80 and 20.27 ^{0}brix T.S.S. and its (B_0) 18.33 and 18.42 ^{0}brix foliar application of 0.4% boron improved the T.S.S. to the tune of 8.01 and 7.70% over control respectively. The beneficial effect brought about by boron treatment may be attributed to malic enzyme and pyruvic carboxylase which raise carbon dioxide production at the ripening period and these changes in the present investigation might have taken place under the optimal presence of boron accelerating T.S.S. accumulation in fruit. These findings are in agreement with the reports of Sarkar and Ghosh (2009) [18] and Lal *et al.*, (2010) [14] in litchi.

Application of 60 ppm NAA significantly maximized (13.23 and 13.57%) total sugar content than the rest of treatments against the minimum of 12.01 and 12.22% recorded under NAA control during both the years. An enhancement of 10.15 and 11.04% in respect of sugar content was noted due to 60 ppm concentration over control. This increase may be attributed to conversion of reserved starch and other polysaccharides into soluble form of sugar. These findings are in accordance with the reports of Singh and Phogat (1984) and Sahay *et al.*, (2018) [17] in litchi. Boron treatment at 0.6% induced the maximum of 13.35 and 13.68% sugar being at par with 0.4% differed significantly with control (11.73 and 11.98%). The beneficial role of boron might be due to hydrolytic changes caused during ripening which usually lead to the formation of sugar, however, boron also probably augmented the conversion of starch to sugar as well as increase transportation of sugar from leaf to developing fruits. These findings are in line with the reports of Babu and Singh (2002) [2] and Lal *et al.*, (2010) [14] in litchi.

The Juice of litchi was obtained by squeezing the pulp. All the treatments produced significantly greater juice than control during both the years. The maximum 59.87 and 61.46% juice was registered under 60 ppm NAA against the lowest under control (55.02 and 56.40%) during corresponding years of study. The juice content enhanced by 8.81 and 8.97% over control. The juice content obviously increased owing to the harvest of larger fruits of greater weight. However, apart from this auxin play significant role in increasing RNA synthesis which appears to improve quantitative and qualitative parameters. A type of RNA is specific for auxin induced growth, present in cells (Key, 1969) and due to this physiological change juice content in litchi fruits might have improved. These findings towards juice content are in line with the reports of Kumar *et al.*, (2016) [13] in litchi and Bhatt *et al.*, (2017) [5] in lemon. Boron at 0.6% remaining at par with 0.4% produced significantly greater 60.44 and 61.94% juice content in litchi fruits against significantly lowest under control (53.95 and 55.35%) during corresponding years. The juice content was enhanced by 12.02 and 11.90% over control during respective years. These findings are similar to the reports of Sarkar and Ghosh (2009) [18] and Lal *et al.,* (2010) [14] in litchi.

Foliar sprays of 60 ppm NAA produced significantly less acidic fruits 0.478 and 0.477% followed by its 90 ppm level. NAA control (N_0) revealed most acidic fruits having 0.569 and 0.561% acidity during corresponding years of study. The maximum reduction in acidity (15.99 and 14.97%) was exhibited under 60 ppm over control. The role of growth regulators in decreasing the acidity of fruits might be either due to conversion of sugar and their derivatives by reaction involving reveres glycolytic pathway or its utilization in respiration or both which may be held responsible for reducing acidity in the present investigation. These findings are in agreement with the reports of Kumar *et al.*, (2016) [13] in litchi and Dodiya *et al.*, (2018) [8] in guava. Boron applied at 0.6% produced significantly less acidic fruits (0.508 and 0.502%) remaining at par with 0.4%. The most acidic fruit (0.529 and 0.523%) were registered under control (B_0) during both the years. Reduction in acidity of fruits was noted 3.96 and 4.01% due to boron 0.6% treatment over control. The findings are close conformity with the reports of Sarkar and Ghosh (2009) [18] and Lal *et al.*, (2010) [14] in litchi. Interactive treatment N_2 B_1 caused minimum acidic fruits (0.471 and 0.474%) during both years of study.

Sugar/acid ratio was noted maximum 27.81 and 28.48 under 60 ppm NAA followed by 90 ppm treatment. The minimum 21.26 and 21.96 of it was noted under control during respective years. The improvement in sugar/acid ratio was derived to be 30.80 and 29.69% due to 60 ppm NAA over control. NAA treatment in the present trial could have accelerated hydrolysis mechanism of starch into sugar or reduced competition in the fruits for metabolite accumulation. The increase in total sugar might have further attributed to conversion of starch and polysaccharides into soluble form of sugar. Thus, the total soluble solid obviously enhanced and acid content of the fruits reduced simultaneously which promoted sugar/acid ratio. These findings are in line with the reports of Gurjar *et al.,* (2018) [11] in guava. Boron 0.6% recorded significantly maximum 26.32 and 27.31 sugar/acid ratio followed by 0.4% treatment against the minimum of 22.39 and 23.21 ratio derived under control. There was, however, an increase of 17.55 and 17.66% caused by 0.6% over control. The enhancement in this ratio is obviously due to increase and decrease in sugar and acidity respectively. These findings are in conformity with the reports of Babu and Singh (2002) [2] and Kumar *et al.*, (2016) [13] in litchi. Boron and NAA interaction N_2 B_2 exhibited significantly highest of 29.93 and 30.10 ratio improving quality of fruits.

Application of 60 ppm NAA induced significantly highest 40.44 and 41.12 mg/100g vitamin-C content in litchi fruits followed by 30 ppm treatment against the lowest 38.52 and 39.25 mg/100g under control. Vitamin-C in the fruits increased by 4.98 and 4.76% due to application of 60 ppm NAA over control during corresponding years of study. These findings are in line with the reports of Dutta *et al.*, (2011) in litchi and Dodiya *et al.*, (2018) [8] in guava. Boron at 0.4% concentration induced significantly highest of 40.96 and 41.67 mg/100g vitamin-C during corresponding years. The plants under control recorded significantly lowest content (36.56 and 37.27 mg/100g) during both the years. Improvement in this metabolites was to the tune of 12.03 and 11.80% over control respectively. These findings are in close conformity with the reports of Kumar *et al.*, (2016) [13] and Lal *et al.*, (2010) [14] in litchi, N_2 B_2 interaction over all maximized vitamin-C revealing 41.65 and 42.31 mg/100g values and N_0 B_0 exhibited poorest of it (32.55 and 33.18 mg/100g) during corresponding years.

The excellent quality fruits were harvested under the treatment of 60 ppm NAA scoring significantly highest 82.00 and 83.32 marks followed by 90 ppm treatment while NAA control scored lowest 75.85 and 76.99 marks owing to relatively inferior quality during both the years. The maximum enhancement in the rating of fruits due to NAA 60 ppm was 8.10 and 8.22% over control which is obviously because of better colour, sugar content and less acidic fruits. Boron at 0.4% also showed better rating of fruits (82.36 and 83.58 marks). Untreated fruits having relatively inferior quality scored poor marks (74.37 and 75.56) during both the years. The marks improved to the tune of 10.74 and 10.61% due to boron 0.4% treatment over control. N_2 B_2 interaction exhibited highest score of 85.50 and 86.74 marks during respective years.

The shelf life was observed by storing them at ambient temperature. However, the environmental minimum & maximum temperature ranged from 26.20 to 39.50 ^{0}C during the period of storage. NAA 60 ppm exhibited significantly longest 3.91 and 3.97 days shelf life against the shortest of 3.41 and 3.47 days under NAA control (N_0). The storage of shelf life was 14.66 and 14.40% longer under 60 ppm over control during respective years. NAA acts as an antisenescent and antirespirent which might have inhibited catabolic activities, motivating prolonged shelf life during storage. These findings are in close conformity with the reports of Bhatt *et al.*, (2017) [5] in lemon and Bagul and Masu (2017) [3] in custard apple. Boron applied at 0.4% expressed significantly longest 3.95 and 4.01 days shelf life followed by 0.6% and its control (B_0) exhibited poorest (3.30 and 3.37 days) shelf life. The fruits treated with 0.4% boron were stored for 19.69 and 18.99% longer period over control (B_0) during respective years. These findings are in line with the reports of Panwar *et al.*, (2017) [15] and Singh *et al.*, (2018) in litchi.

Table 1: effect of foliar spray of NAA and boron on fruit cracking and marketable yield of litchi

Percentage of cracked fruits

	2017-18					2018-19				
Treatments	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**
Control	21.65	15.16	13.78	13.88	16.12	17.18	11.50	10.56	10.51	12.44
NAA 30 ppm	18.89	14.09	11.43	11.18	13.90	15.02	10.36	8.57	8.44	10.60
NAA 60 ppm	18.75	11.74	9.69	10.10	12.57	14.92	8.27	7.45	7.65	9.57
NAA 90 ppm	18.69	11.34	11.19	11.28	13.12	15.24	8.54	8.42	8.67	10.22
Mean	19.49	13.08	11.52	11.61		15.59	9.67	8.75	8.82	
N B N×B N B N×B C.D. 0.759 0.759 N.S. 0.870 0.870 N.S S.E. (d) 0.373 0.373 0.745 0.427 0.427 0.854										

Marketable yield (kg/plant)

	2017-18					2018-19				
Treatments	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**
Control	45.82	47.90	49.61	50.91	48.56	48.18	50.28	53.03	54.12	51.40
NAA 30 ppm	58.80	61.17	65.16	69.86	63.74	61.66	64.62	68.72	72.68	66.92
NAA 60 ppm	60.96	71.36	74.64	73.15	70.03	63.85	74.53	78.14	77.07	73.40
NAA 90 ppm	61.42	66.76	68.26	66.94	65.84	64.33	69.86	72.12	70.32	69.16
Mean	56.75	61.80	64.42	65.21		59.50	64.82	68.00	68.55	
N B N×B N B N×B C.D. 2.250 2.250 4.500 2.325 2.325 N.S. S.E. (d) 1.104 1.104 2.209 1.141 1.141 2.282										

Table 2: Effect of foliar spray of NAA and boron on quality of litchi

T.S.S. Content (^{0}Brix)

	2017-18					2018-19				
Treatments	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**
Control	17.80	18.35	19.03	19.19	18.59	18.26	18.87	19.52	19.68	19.08
NAA 30 ppm	18.30	18.87	19.55	19.71	19.11	18.81	19.34	20.01	20.17	19.58
NAA 60 ppm	18.70	19.52	20.43	20.05	19.67	19.18	20.03	20.89	20.57	20.17
NAA 90 ppm	18.52	19.41	20.19	19.88	19.50	19.04	19.94	20.66	20.39	20.01
Mean	18.33	19.04	19.80	19.71		18.82	19.54	20.27	20.20	
N B N×B N B N×B C.D. 0.582 0.582 N.S. 0.262 0.262 N.S. S.E. (d) 0.286 0.286 0.572 0.129 0.129 0.257										

Total sugar content (%)

	2017-18					2018-19				
Treatments	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**
Control	11.51	11.58	12.36	12.59	12.01	11.51	11.87	12.66	12.86	12.22
NAA 30 ppm	11.74	12.16	13.12	13.40	12.60	12.04	12.41	13.44	13.75	12.91
NAA 60 ppm	11.91	13.15	14.05	13.80	13.23	12.23	13.57	14.33	14.16	13.57
NAA 90 ppm	11.76	12.82	13.78	13.61	12.99	12.13	13.16	14.13	13.96	13.34
Mean	11.73	12.43	13.33	13.35		11.98	12.75	13.64	13.68	
N B N×B N B N×B C.D. 0.314 0.314 N.S. 0.285 0.285 N.S. S.E. (d) 0.154 0.154 0.308 0.140 0.140 0.280										

Juice content (%)

	2017-18					2018-19				
Treatments	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**	**B_0**	**B_1 (0.2%)**	**B_2 (0.4%)**	**B_3 (0.6%)**	**Mean**
Control	52.56	53.31	56.76	57.45	55.02	53.16	54.87	58.44	59.12	56.40
NAA 30 ppm	54.10	55.00	59.35	60.84	57.32	55.81	57.52	60.91	62.13	59.09
NAA 60 ppm	55.00	59.20	63.05	62.24	59.87	56.61	60.77	64.63	63.84	61.46
NAA 90 ppm	54.14	58.07	62.18	61.23	58.90	55.81	59.69	63.41	62.69	60.40
Mean	53.95	56.39	60.33	60.44		55.35	58.21	61.85	61.94	
N B N×B N B N×B C.D. 1.163 1.163 N.S. 0.865 0.865 N.S. S.E. (d) 0.571 0.571 1.141 0.424 0.424 0.849										

Acidity content (%)

	2017-18					2018-19				
Treatments	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean
Control	0.627	0.581	0.540	0.527	0.569	0.619	0.575	0.533	0.519	0.561
NAA 30 ppm	0.515	0.511	0.509	0.507	0.511	0.509	0.504	0.512	0.499	0.506
NAA 60 ppm	0.482	0.471	0.478	0.481	0.478	0.477	0.474	0.476	0.479	0.477
NAA 90 ppm	0.494	0.498	0.516	0.518	0.506	0.488	0.491	0.507	0.510	0.499
Mean	0.529	0.515	0.511	0.508		0.523	0.511	0.507	0.502	
N B N×B N B N×B										
C.D. 0.016 0.016 0.032 0.011 0.011 0.021										
S.E. (d) 0.008 0.008 0.016 0.005 0.005 0.010										

Sugar/acid ratio

	2017-18					2018-19				
Treatments	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean
Control	18.35	19.93	22.88	23.89	21.26	18.69	20.64	23.75	24.78	21.96
NAA 30 ppm	22.80	23.80	25.78	26.43	24.70	23.65	24.62	26.25	27.55	25.52
NAA 60 ppm	24.71	27.92	29.93	28.69	27.81	25.63	28.63	30.10	29.56	28.48
NAA 90 ppm	23.72	25.74	26.70	26.27	25.61	24.86	26.80	27.86	27.37	26.72
Mean	22.39	24.35	26.31	26.32		23.21	25.17	26.99	27.31	
N B N×B N B N×B										
C.D. 0.281 0.281 0.562 0.559 0.559 1.119										
S.E. (d) 0.138 0.138 0.276 0.275 0.275 0.549										

Vitamin-C content (mg/100g)

	2017-18					2018-19				
Treatments	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean
Control	32.55	40.44	40.50	40.62	38.52	33.18	41.22	41.28	41.33	39.25
NAA 30 ppm	39.17	40.31	40.70	41.13	40.33	39.89	41.08	41.43	41.81	41.05
NAA 60 ppm	38.11	41.07	41.65	40.92	40.44	38.84	41.72	42.31	41.61	41.12
NAA 90 ppm	36.42	40.80	41.00	40.35	39.64	37.16	41.53	41.68	41.09	40.36
Mean	36.56	40.65	40.96	40.75		37.27	41.38	41.67	41.46	
N B N×B N B N×B										
C.D. 0.255 0.255 0.509 0.454 0.454 0.908										
S.E. (d) 0.125 0.125 0.250 0.223 0.223 0.445										

Organoleptic test (Marks out of 100)

	2017-18					2018-19				
Treatments	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean
Control	70.71	75.39	78.29	79.00	75.85	71.86	76.46	79.41	80.23	76.99
NAA 30 ppm	74.17	77.79	81.17	82.27	78.85	75.27	78.96	82.38	83.45	80.01
NAA 60 ppm	76.52	81.25	85.50	84.75	82.00	77.74	82.51	86.74	86.29	83.32
NAA 90 ppm	76.09	80.26	84.50	83.13	80.99	77.38	81.52	85.78	84.39	82.27
Mean	74.37	78.67	82.36	82.29		75.56	79.86	83.58	83.57	
N B N×B N B N×B										
C.D. 0.356 0.356 0.713 0.405 0.405 0.810										
S.E. (d) 0.175 0.175 0.350 0.199 0.199 0.398										

Shelf life (Days)

	2017-18					2018-19				
Treatments	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean	B_0	B_1 (0.2%)	B_2 (0.4%)	B_3 (0.6%)	Mean
Control	3.11	3.29	3.60	3.65	3.41	3.18	3.35	3.67	3.70	3.47
NAA 30 ppm	3.26	3.52	3.79	3.90	3.62	3.33	3.59	3.87	3.98	3.69
NAA 60 ppm	3.46	3.81	4.25	4.13	3.91	3.53	3.88	4.29	4.18	3.97
NAA 90 ppm	3.39	3.74	4.16	4.02	3.83	3.45	3.91	4.23	4.10	3.92
Mean	3.30	3.59	3.95	3.92		3.37	3.68	4.01	3.99	
N B N×B N B N×B										
C.D. 0.137 0.137 N.S. 0.220 0.220 N.S.										
S.E. (d) 0.067 0.067 0.135 0.108 0.108 0.216										

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