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Effect of calcium, boron and sorbitol on fruit set, yield and quality of mango (*Mangifera indica* L.) cv. langra.

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Abstract

Low fruit setting and heavy fruit drop in cv. Langra is a serious problem for mango growers despite the profuse flowering, good fruit setting. Some chemicals like Calcium nitrate, Boric and Sorbitol are able to minimize the loss. The experiment was conducted during the two successive seasons in the years 2012 & 2013 on mango (*Mangifera indica* L.) cv. Langra with treatments T₁-(Calcium nitrate @0.06%), T₂-(Boric acid @0.02%), T₃-(Sorbitol @2.0%) T₄-(Calcium nitrate @ 0.06% + Boric acid @ 0.02%), T₅-(Calcium nitrate @ 0.06% + Sorbitol @ 2.0%), T₆-(Boric acid @ 0.02% + Sorbitol @ 2.0%) and T₇-(Control) with four replications to study on fruit set, yield and quality. The pooled data for the year 2012 and 2013 indicated that the foliar spray of Boric acid @ 0.02% significantly performed better result in regards to highest pulp (78.60%), TSS (19.08°Brix), total sugar (11.57%), reducing sugar (2.68%), non-reducing sugar (8.89%), ascorbic acid (33.76mg/100gfw) and carotenoids (8.62mg/100gfw) with lowest value peel (7.45%), stone (13.86%) and acidity (0.30%). The combination effect of Calcium nitrate @ 0.06% + Boric acid @ 0.02% significantly proves better in respect of minimum fruit drop percent (91.19%), whereas; maximum in control (97.35%) as well as in terms of increasing fruit set and yield (138.43kg/tree) of mango cv. Langra.

Keywords: Mango, calcium nitrate, boric acid, sorbitol, fruit set, yield, fruit quality

Introduction

Mango (*Mangifera indica* L.) is a very popular fruit crop of family Anacardiaceae. It is cultivated in a very large area of India as well as tropical and subtropical countries of the world. Mango considered as the king of fruits in several countries of the world due to its delicious taste, excellent flavour and pleasant fragrance. Low fruit setting and heavy fruit drop is a serious problem of cultivar Langra. Fruitlet abscission is a very complex physiological process during the early stages of fruit development. Micronutrients are playing a very important role in plants growth and development. Their acute deficiencies some time causes lower fruit yield and quality of mango (Patil *et al.* 2018) [1]. Boron plays an important role in many functions of the plant such as hormone movement, activate salt absorption, flowering and fruiting process and pollen germination specially its influences on the directionality of pollen tube growth (Robbertsen *et al.*, 1990) [2]. Calcium is considered as one of the most important minerals determining the quality of fruit, since it is required for cell elongation and cell division (Rizzi *et al.*, 1990) [3]. Carbohydrate also plays an essential role in pollen tube growth. Deficiency in carbohydrate metabolism in the anther leads to abnormal pollen development in many plants. Sorbitol is a carbohydrate that can be transported in many plants (Sankar *et al.*, 2013) [4].

Keeping the above-mentioned views in mind the present investigation was carried out to assess the foliar application of Calcium, Boron and Sorbitol on fruit retention, yield and quality of mango cv. Langra.

Materials and Methods

The present investigation was conducted in All India Co-ordinated Research Project on Fruits under Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India on mango cv. Langra

during two successive seasons of 2012 and 2013. The 30 years old trees were selected for experiment and maintained uniform cultural practices during the course of investigation. The experimental plot had well drained sandy loam soil of good fertility with leveled surface. Trees were spaced at 10 m x 12 m with irrigation facility via modified basin system. The treatments were T₁.(Calcium nitrate @0.06%), T₂.(Boric acid @0.02%), T₃.(Sorbitol @2.0%) T₄.(Calcium nitrate @ 0.06% + Boric acid @ 0.02%), T₅.(Calcium nitrate @ 0.06% + Sorbitol @ 2.0%), T₆.(Boric acid @ 0.02% + Sorbitol @ 2.0%) and T₇.(Control) with randomized block design with four replications. The foliar spray was done by the help of Gator sprayer in the early hours of morning at all parts of the foliar were drenched fully. The first spray was done at the time of 50 percent flower bloomed in per panicle and second spray at the time of fruit set at mustard size. Physical parameters of fruit via skin or peel percentage, stone percentage, pulp percentage, fruit weight and yield per tree were recorded as per recommended methods. Yield parameters such as number of fruits set per panicle, fruit drop percentage (at 15 days interval till maturity) and numbers of fruit per tree were also recorded as per following standard procedure.

Data Recorded On each tree 30 terminal shoots at all directions were tagged at the beginning of flowering for determining the following parameters:

Initial Fruit Set

It was determined as number of fruitlets per panicle two weeks after petal fall for panicles on tagged shoots.

Fruit drop

It was determined by counting the number of retained fruits per panicle at fortnightly intervals and it was subtracted from initial fruit set per panicle and expressed in percentage by following formula-

$$\text{Fruit drop (\%)} = \frac{(\text{Initial fruit set per panicle} - \text{Fruit retained per panicle at fortnightly intervals})}{\text{Initial fruit set per panicle}} \times 100$$

Number of Fruits per Panicle:

It was determined by counting number of retained fruits per panicle at harvest. (Last week July)

Fruit weight

Immediately after the harvest of the matured fruit, stalk was removed and randomly 10 fruits were weighed and average fruit was calculated in grams.

Fruit yield per tree

Total numbers of fruit per plant was multiplied by average fruit weight and calculated it kg per tree

Peel weight

The skin of fruit obtained after peeling were weighed on electronic balance and percentage was calculated with the following formula.

$$\text{Peel percentage} = \frac{\text{Weight of peel}}{\text{Weight of fruit}} \times 100$$

Stone weight

When the fruits ripened well, the pulp was extracted by hand. Both peel and stone were cleaned by mean of knife to ensure

than no pulp remained sticking with them. Then the average weight per stone was measured. The stone percentage was calculated on the basis of fruit weight.

$$\text{Stone percent} = \frac{\text{Weight of stone}}{\text{Weight of fruit}} \times 100$$

Pulp weight

The weight of pulp was derived by deducting the total weight of skin plus stone from the weight of whole fruit and the percentage of pulp was then calculated with the following formula.

$$\text{Pulp percentage} = \frac{\text{Weight of pulp}}{\text{Weight of fruit}} \times 100$$

Quality Parameters:

TSS

The fruits harvested from each tree were randomly selected to estimate the quality attributes of fruit.

Total soluble solids content of a solution was determined by the index of refraction. This was measured using a refractometer and was referred to as the degrees Brix.

Acidity

Titratable acidity was determined by using titration method (A.O.A.C., 2000). For this 2 g of fruit sample was weighed and added to 50 ml water. It was thoroughly mixed and then filtered. The filtered sample was titrated against 0.1 N NaOH using a few drops of 1% phenolphthalein solution as indicator. The observed titer value was used for calculating acidity and the results were expressed as percentage of citric acid.

The formula used for its calculation was expressed as grams of anhydrous citric acid per 100g of pulp. The formula used was:

$$\text{Titratable acidity (\%)} = \frac{\text{Volume of 0.1 N NaOH consumed} \times 64}{\text{Volume of juice taken} \times 1000} \times 100$$

Sugar estimation

Total sugar

Total sugars were determined by Lane and Eynone (1923). For this it was taken 50ml of filtrated solution in 100 ml volumetric flask and added 5ml concentrated HCl. Then it was kept for 24hr. After that added 2 drops of phenolphthalein indicator, added 40% NaOH solution until pink colour appear. After that added N/1 HCl drops wiser until pink colour disappear. Then made the volume with distilled water and taken this solution in burette and followed the procedure same as for reducing sugars.

$$\text{Total sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight of sample or volume}} \times 100$$

Reducing sugar

Reducing sugar was obtained by titration with Fehling solution. For this 10gm of fruit was grinded in a blender or using pestle and mortar and transfer in a 250 ml volumetric flask. Make up the volume 100 ml distilled water and 2 ml lead acetate solution. Added 1.9 ml of potassium oxalate solution and made the volume up to 250 ml with distilled

water. Now filtered the sample through filter paper for estimating reducing sugar, taken the filtrate in burette now taken 5ml each of Fehling's solution A & B in a conical flask and added 50ml distilled water in it. Boiled the solution until it became colourless. Now added 2 drops of Methylene blue indicator and titrate it with filtrate solution until brick red end point comes.

$$\text{Reducing sugar (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight of sample or volume}} \times 100$$

Non-reducing sugar

It was calculated by deducting the estimated value of reducing sugar from the estimated value of total sugar of the particular replication and treatment.

Ascorbic acid (vitamin 'C') (mg/100ml juice)

For estimation of ascorbic acid fresh harvested fruits was used. Ascorbic acid was quantitatively determined by 2, 6-dichlorophenol indophenols dye method as described by Jones and Hughes (1983) with slight modifications. For each sample, 10 g pulp was homogenized with 10 ml of 3% Meta phosphoric acid. The extract was made up to a volume of 100 ml and centrifuged at 3000 rpm for 15 min. at room temperature. Ten milliliters of supernatant was titrated against standard 2,6-dichlorophenol indophenols dye, which had already been standardized against standard ascorbic acid. Results were expressed as mg 100 g-1 FW basis.

$$\text{Ascorbic acid content (mg/100g)} = \frac{\text{Titre value} \times \text{dye factor} \times \text{volume made up}}{\text{Weight of sample} \times \text{volume of sample taken}} \times 100$$

Total Carotenoids content

Total carotenoids content of mango fruit was determined by the method of Roy (1973) with some modifications. In which 5 g of mango pulp was crushed in acetone till the tissue became colourless. Then the extracted solution was poured into a separating funnel. Petroleum ether and small amount of sodium sulphate solution was added and shaken rigorously. Then the separating funnel was kept undisturbed to separate the carotenoids from acetone to petroleum ether layer. After that, coloured solution was separated in a 50 ml volumetric flask and the volume was adjusted with petroleum ether. Finally, the sample absorbance was measured at 452 nm in a spectrophotometer, using petroleum ether as blank. The results were expressed as mg 100 g-1 FW (fresh weight) basis.

$$\text{Total Carotenoids content (mg/100g)} = \frac{3.87 \times \text{O.D} \times \text{volumes made up}}{\text{Weight of sample} \times 1000} \times 100$$

Research Findings and Discussion

The results obtained from the present investigation as well as

relevant discussion have been summarized under following heads:

(a) Fruit set (%), fruit weight (g) and yield (kg/ tree)

The data presented in Table - 1 showed the foliar spray of Calcium nitrate (0.06%), Boric acid (0.02%) and Sorbitol (2.0%) alone & in combinations significantly increased the fruit set as compared to the control in both the years. The minimum number of fruits drop per panicle was noticed after 90 days of fruit set during both the years 2012 and 2013 with the effect of foliar spray of Calcium nitrate @ 0.06% + Boric acid @ 0.02% with having value of 90.28% and 92.10% respectively, whereas; pooled data of both years also exhibited the minimum fruit drop of 91.19% than the other treatments including control (97.35%). This might be due to Calcium is a critical component of the cell wall that produces strong structural rigidity by forming cross-links within the pectin polysaccharide matrix. With rapid plant growth, the structural integrity of stems that hold flowers and fruit, as well as the quality of the fruit produced, is strongly coupled to calcium availability. Stino *et al.* (2011) [5] observed that combined treatment of Boric acid (0.02%) with addition of Calcium nitrate and Potassium nitrate (2.0%) foliar application produced the very positive effective effect on fruit set per panicle. Gauch and Duggar, (1954) [6] reported Boron in higher plants showed a crucial role in flowering, pollen germination and fruit set, it also increased the pollen producing capacity of the anthers and pollen viability, thus finally leads to higher fruit set. During both the years all treatments of Calcium, Boron and Sorbitol significantly increased fruit yield (kg /tree) as compared to control (Table-2). The pooled data of both years showed more or less similar trends as it was recorded in individual years. Plants sprayed with Calcium nitrate @ 0.06% + Boric acid @ 0.02% produced higher yield during years 2012 and 2013 with having value of 50.61 kg per tree and 226.26 kg per tree respectively. When the data of both years were pooled, the higher yield of 138.43 kg per tree was noted under the same treatment of Calcium nitrate @ 0.06% + Boric acid @ 0.02%, which was found significantly higher than remaining treatments, whereas; the lower yield of 59.20 kg per tree was observed under the control. The yield was varied in both the years due to biennial in nature of cultivar Langra. These observations were confirmed by the earlier findings of Jutamanee *et al.* (2002) [7], Sanker *et al.* (2013) [4] and Merwad *et al.* (2016) [8]. The application of Calcium nitrate @ 0.06% + Boric acid @ 0.02% also proved the most effective for increasing the fruit weight in both the years 2012 and 2013 with value of 273.00g and 348.50g respectively and pooled result of both the years of 310.75g has been supported by Raychaudhary *et al.* (1992) [9], Singh *et al.* (2013) [10], Merwad *et al.* (2016) [8], Talag *et al.* (2016) [11] and Kumari *et al.* (2017) [12].

Table 1: Effect of chemicals on minimum fruit drop (%) in mango cv.Langra.

Treat.	Fruit drop (%) at 15 days intervals																	
	15			30			45			60			75			90		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1	63.24	78.01	70.62	79.26	88.48	83.87	82.07	89.74	85.90	90.56	91.43	91.00	92.42	92.55	92.48	92.64	93.19	92.92
T2	71.81	74.52	73.16	88.10	83.41	85.75	91.48	87.14	89.31	93.99	88.81	91.40	94.41	90.56	92.49	94.83	92.16	93.50
T3	66.75	77.14	71.94	80.54	86.78	83.66	86.63	89.21	87.92	92.84	89.31	91.07	93.65	90.88	92.26	94.09	93.00	93.54
T4	60.79	70.71	65.75	75.10	87.69	81.40	79.47	89.73	84.60	88.42	90.71	89.56	90.07	91.43	90.75	90.28	92.10	91.19
T5	70.45	75.95	73.20	87.13	88.74	87.93	89.47	90.36	89.92	92.95	91.33	92.14	93.98	92.31	93.14	94.79	93.50	94.14
T6	68.26	77.36	72.81	87.71	89.50	88.60	91.85	91.45	91.65	93.59	92.85	93.22	94.42	93.73	94.07	95.05	93.93	94.49
T7	74.16	89.41	81.78	93.73	92.14	92.93	94.68	93.48	94.08	95.33	94.72	95.02	95.85	96.18	96.02	97.36	97.35	97.35

SEm±	1.64	1.57	1.13	1.73	1.56	1.17	1.81	1.35	1.13	1.70	1.11	1.02	1.74	0.92	0.98	1.76	0.80	0.97
CD (P=0.05)	4.86	4.66	3.25	5.15	4.62	3.34	5.38	4.01	3.24	5.06	3.30	2.91	5.16	2.74	2.82	5.22	2.38	2.77
CV%	4.82	4.05	4.41	4.10	3.53	3.82	4.12	2.99	3.59	3.68	2.43	3.13	3.71	2.00	2.99	3.73	1.71	2.91

T1- Calcium nitrate (0.06%), T2-Boric acid (0.02%), T3-Sorbitol (2.0%), T4-Calcium nitrate @ 0.06% + boric acid @ 0.02%, T5- Calcium nitrate @ 0.06% + sorbitol @ 2.0% and T6-Boric acid @ 0.02% + sorbitol @ 2.0% and T7- Control (water spray)

Table 2: Effect of chemicals on fruit weight and yield of mango cv.Langra.

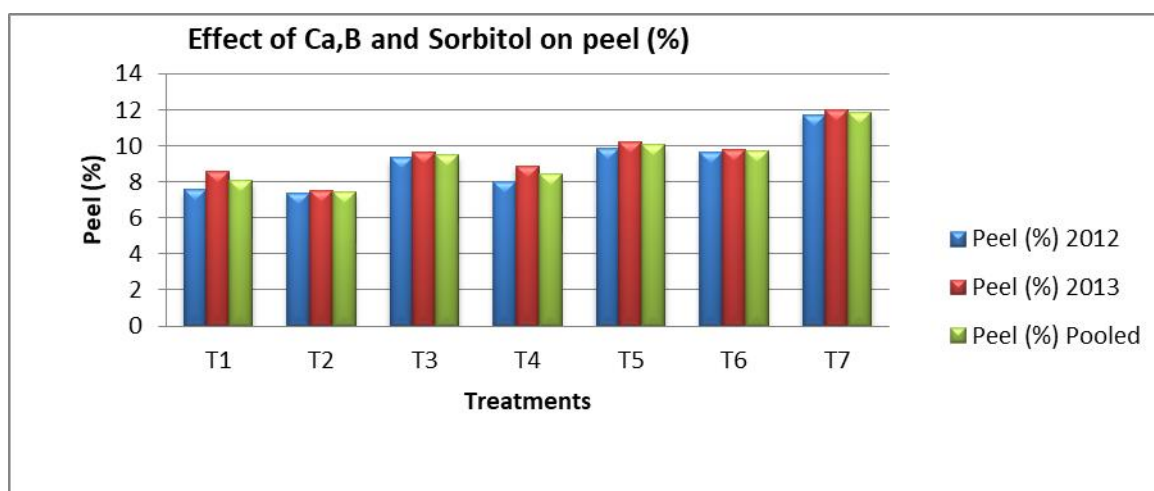
Treat.	Initial Fruit set per panicle			No.s of fruit /tree			Fruit wt (g)			Fruit yield (kg/tree)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1	117.25	117.25	281.75	181.25	643.75	412.50	271.00	343.50	307.25	49.15	220.85	135.00
T2	113.00	113.00	268.25	172.50	535.00	353.75	270.50	337.50	304.00	46.70	180.57	113.63
T3	108.25	108.25	249.00	161.00	457.25	309.13	255.25	326.50	290.88	41.11	149.49	95.30
T4	122.00	122.00	345.50	185.25	649.25	417.25	273.00	348.50	310.75	50.61	226.26	138.43
T5	103.50	103.50	219.25	157.00	401.25	279.13	254.50	327.00	290.75	39.99	131.15	85.57
T6	98.50	98.50	209.50	156.25	347.75	252.00	253.00	306.00	279.50	39.51	106.36	72.93
T7	92.00	92.00	196.75	132.25	300.00	216.13	236.00	291.25	263.63	31.17	87.23	59.20
SEm±	2.81	2.81	7.56	6.59	22.63	11.79	3.34	6.22	3.53	1.91	7.43	3.83
CD(P=0.05)	8.36	8.36	22.45	19.58	67.24	33.80	9.93	18.49	10.13	5.69	22.06	11.00
CV%	5.22	5.22	5.98	8.06	9.50	10.42	2.58	3.82	3.42	8.99	9.43	10.84

T1- Calcium nitrate (0.06%), T2-Boric acid (0.02%), T3-Sorbitol (2.0%), T4-Calcium nitrate @ 0.06% + boric acid @ 0.02%, T5- Calcium nitrate @ 0.06% + sorbitol @ 2.0% and T6-Boric acid @ 0.02% + sorbitol @ 2.0% and T7- Control (water spray)

(b) Fruit development and pulp percentage

It is evident from Fig.-1, 2 and 3 that the foliar spray of various nutrients significantly enhanced the fruits growth and development. The fruit growth rate was more under treatment which was treated with the chemicals than the untreated ones. The application of Boric acid (0.02%) increased the pulp percentage of 78.98 percent was observed during years 2012, which was found at par with the treatment of Calcium nitrate (0.06%) with value of 78.47% of pulp and during the year 2013 and pooled data for both the year was recorded significantly superior than the rest treatments with having value of 78.22% and 78.60% respectively. While pooled data of both years exhibited the minimum of 7.45% peel percentage and 13.86% stone percentage by the effect of Boric acid (0.02%) which was found at par with the treatments Calcium nitrate (0.06%) with having value of 8.07% and 13.97% respectively. Whereas, higher value of peel and stone percentage and lower value pulp percentage of

pooled data of the both years were observed in control i.e. 11.86%, 15.35% and 72.92% respectively. Increase in fruit length, width and volume of fruit in the present study was probably due to increase in cell size and number. Hence, the process of cell elongation and cell division provides the basis of fruit growth. The division and enlargement of cell is a complicated process involving synthesis of many organic compounds such as protein, cellulose and nucleic acid in mango (Kumar *et al.*, 2009). Boric acid at 0.2 percent was most effective treatment in increasing pulp percentage of fruit. Increase in pulp percentage may be due to Boron, which facilitates sugar translocation within the plants. And it has also been reported that borate reacts with sugar to form sugar borate complex (more easily available to transverse membrane). Application of Boric acid at 0.02 percent increased the pulp percentage in the fruit of mango, which agrees with Negi *et al.* (2009) [13] and Kumari *et al.* (2017) [12].



CD (P=0.05): Peel (%):2012(0.69): 2013(0.68): Pooled (0.47)

Fig 1: Effect of chemicals on peel of mango cv. Lang

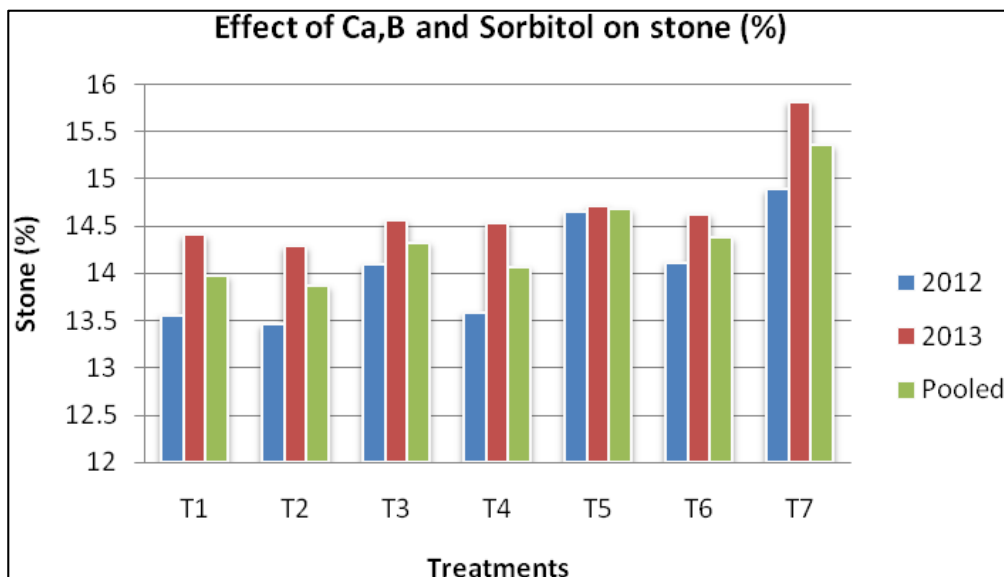


Fig 2: Effect of chemicals on stone of mango cv. Langra

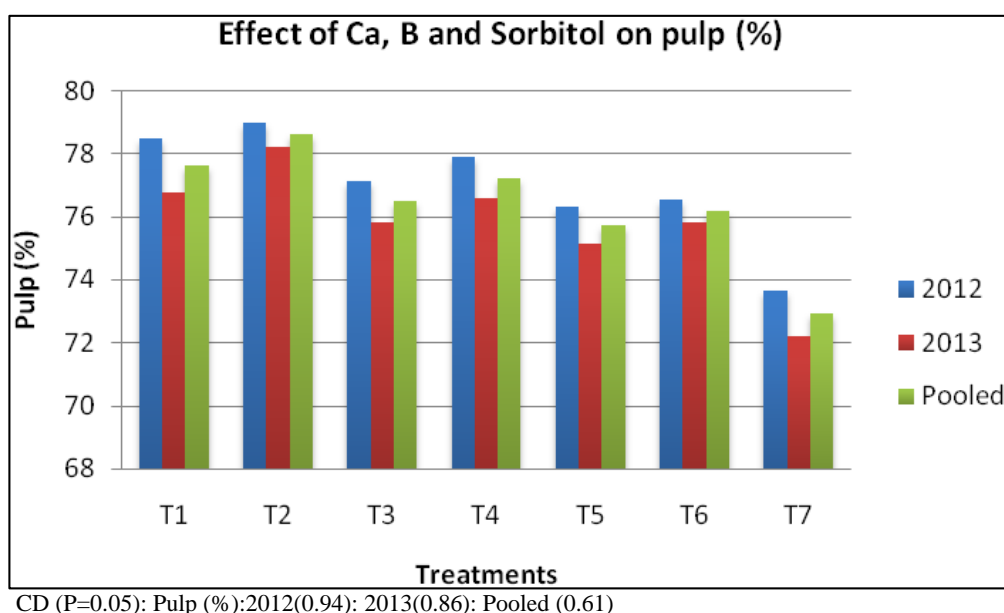


Fig 3: Effect of chemicals on pulp of mango cv. Langra

(c) Fruit quality characters

Table-3(a) showed the effect of different treatments on chemical properties of fruits. The result of the year 2012 and 2013 was recorded from the trees treated with Boric acid (0.02%) was produced the maximum TSS of 19.81 and 18.35⁰Brix respectively followed by Calcium nitrate (0.06%) with value of 19.32⁰Brix and 17.59⁰Brix respectively. The pooled data of both the years 2012 and 2013 also proved significantly superior result of 19.08% than the rest treatments including control (16.36⁰Brix) by the effect of foliar application Boric acid (0.02%). The increased TSS content in mango fruits due to involvement of Boron is known to increase transportation of sugar and forms complexes with sugar. This finding was supported by the result of Meena *et al.* (2006) [14], Nehete *et al.* (2011) [15], Sankar *et al.* (2013) [4] and Kumari *et al.* (2017) [12].

The data presented in Table-3(a) indicated that the total sugar in the year 2012 and 2013 and pooled data of both years was maximum of 11.37% and 11.77% respectively and pooled

result of 11.57% with the application of Boric acid (0.02%) in comparison to other treatments including the control (9.12%). Similar trend was followed in the findings of reducing sugar for the year 2012 and 2013 (2.55% and 2.82% respectively) and pooled data (2.68%) which was significantly higher than the remaining treatments including control (1.89%). This trend was also extended in the result of non-reducing sugar percentage in the year 2012 and 2013 (8.82 and 8.96% respectively) and pooled data also showed significantly superior result (8.89%) than the remaining treatments including control (7.23%). The increase in sugar and different fraction of sugars might be due to Boron probably augmented the conversion of starch to sugar and it has also been opined that boron increases transportation of sugars, hydrolysis of complex polysaccharides into simple sugars, synthesis of metabolites and rapid translocation of photosynthates and minerals from other parts of the plant to developing fruits. This finding agrees with those of Yamdagni *et al.* (1979) [16], Kumari *et al.* (2017) [12].

Table 3(a): Effect of chemical on fruit quality of mango cv. Langra.

Treat.	Total Soluble Solids (^o Brix)			Total Sugars (%)			Reducing Sugars (%)			Non- Reducing Sugars (%)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1	19.32	17.50	18.41	11.24	11.36	11.30	2.44	2.77	2.61	8.80	8.59	8.70
T2	19.81	18.35	19.08	11.37	11.77	11.57	2.55	2.82	2.68	8.82	8.96	8.89
T3	18.33	17.20	17.77	10.87	11.20	11.03	2.23	2.61	2.42	8.64	8.59	8.61
T4	18.80	17.38	18.09	11.17	11.26	11.21	2.41	2.68	2.54	8.76	8.58	8.67
T5	17.24	16.18	16.71	10.05	10.10	10.07	2.16	2.37	2.26	7.89	7.73	7.81
T6	18.29	16.68	17.48	10.79	11.02	10.90	2.16	2.38	2.27	8.63	8.64	8.63
T7	16.79	15.93	16.36	9.15	9.10	9.12	1.93	1.86	1.89	7.22	7.25	7.23
SEm±	0.30	0.31	0.22	0.06	0.05	0.04	0.03	0.03	0.02	0.07	0.06	0.04
CD 5%	0.88	0.93	0.62	0.18	0.14	0.11	0.09	0.08	0.06	0.20	0.17	0.13
CV%	3.22	3.69	3.45	1.16	0.88	1.03	2.60	2.12	2.35	1.60	1.40	1.50

T1- Calcium nitrate (0.06%), T2-Boric acid (0.02%), T3-Sorbitol (2.0%), T4-Calcium nitrate @ 0.06% + boric acid @ 0.02%, T5- Calcium nitrate @ 0.06% + sorbitol @ 2.0% and T6-Boric acid @ 0.02% + sorbitol @ 2.0% and T7- Control (water spray)

It is evident from Table-3(b) that the foliar spray of Boric acid (0.02%) significantly produced lower titratable acidity percentage (0.31%) in comparison to control for the year 2012. Similar trend was also found in the year 2013 with value of 0.29%. When the data for both years were pooled the minimum titratable acidity content of 0.30% was estimated from the same treatments i.e. Boric acid (0.02%) and it was significantly lower than the remaining treatments including control (0.47%). This observation was supported by the finding of Singh *et al.* (2018) [17] in litchi. The lowest acidity by Boron was caused due to the role of Boron in conversion of acid into sugar and their derivatives by the reaction involving reversal of glycolytic pathway (Sankar *et al.*, 2013) [4]. The similar findings were reported by Hoggag *et al.* (1995) [18], Banik *et al.* (1997) [19] in mango and Meena *et al.* (2006) [14] in grapes.

In respect to maximum ascorbic acid content of 33.60 mg was observed in the fruits which were treated with Boric acid (0.02%) and it was found at par result with treatment Calcium nitrate (0.06%) with value of 33.58 mg and minimum of 30.14 mg in control in the year 2012. Whereas; in the year 2013 maximum ascorbic acid content of 33.91 mg was also noted in the fruits, which were treated with Boric acid (0.02%) followed by the treatment Calcium nitrate (0.06%) with value of 33.68 mg and minimum (30.28 mg) under control. When the data for both years were pooled the

maximum ascorbic acid content of 33.76 mg was obtained in the fruits, which were treated with Boric acid (0.02%) which was found significantly superior than the remaining treatments and it was minimum in control (30.21 mg). In general, it was noticed that the ascorbic acid content decreased during ripening of fruits with an increase in the storage period on account of oxidation of ascorbic acid (Badhe *et al.*, 2007) [20]. This might be due to higher level of sugars, which increased the content of ascorbic acid, since ascorbic acid is synthesized from sugar. Similar result was observed by Brahmchari *et al.* (1997) [21] in litchi who obtained higher ascorbic acid at sprayed of Boric acid at 0.02 percent on fruits and also supported the finding of Bhomik *et al.* (2012) [22] in Alphonso.

The spraying of Boric acid @ 0.02 percent significantly increased the carotenoids content (8.36mg and 8.88 mg) in the year 2012 and 2013 respectively as compared to control (4.63mg and 4.62 mg respectively). When the data for both the years were pooled, maximum carotene content of fruits (8.62 mgs) was noted from the plants treated with Boric acid (0.02%) and it was significantly higher than the carotene content of the fruits of remaining treatments including control (4.62 mg). This might be due to Boron which enhanced the ripening could be attributed to their accelerated biosynthesis during ripening process as reported by Badhe *et al.* (2007) [20] in mango.

Table 3(b): Effect of chemicals on fruit quality of mango cv.Langra.

Treat.	Titratable Acidity (%)			Ascorbic Acid (mg/100gfw)			Carotenoids (mg/100gfw)			TSS/Acid ratio		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T1	0.35	0.34	0.35	33.58	33.68	33.63	8.35	8.87	8.61	55.52	51.47	53.50
T2	0.31	0.29	0.30	33.60	33.91	33.76	8.36	8.88	8.62	64.77	63.87	64.32
T3	0.39	0.39	0.39	30.20	30.70	30.45	6.70	6.58	6.64	48.02	43.63	45.83
T4	0.36	0.38	0.37	32.85	32.68	32.77	6.88	6.74	6.81	52.47	46.37	49.42
T5	0.41	0.41	0.41	31.86	32.13	31.99	5.62	5.68	5.65	42.35	39.87	41.11
T6	0.39	0.40	0.40	31.92	32.20	32.06	5.77	5.90	5.83	47.43	41.41	44.42
T7	0.49	0.46	0.47	30.14	30.28	30.21	4.63	4.62	4.62	34.86	34.59	34.73
SEm±	0.01	0.02	0.01	0.03	0.04	0.02	0.06	0.10	0.06	2.12	2.39	1.60
CD(P=0.05)	0.04	0.05	0.03	0.09	0.11	0.07	0.17	0.30	0.16	6.31	7.10	4.58
CV%	7.21	8.78	8.03	0.20	0.23	0.21	1.69	2.96	2.42	8.60	10.42	9.49

T1- Calcium nitrate (0.06%), T2-Boric acid (0.02%), T3-Sorbitol (2.0%), T4-Calcium nitrate @ 0.06% + boric acid @ 0.02%, T5- Calcium nitrate @ 0.06% + sorbitol @ 2.0% and T6-Boric acid @ 0.02% + sorbitol @ 2.0% and T7- Control (water spray)

Transformation of organic acids to sugars is one of the reasons for decrease in acidity during fruit maturity and ripening (Badhe *et al.*, 2007) [20]. Fruit quality was mainly judged by the balance between total sugars and acidity present in the fruit. Therefore, TSS:acid ratio plays an important role in determining the quality of the fruit (Gayon, 1968) [23].

The foliar application of various micronutrients and Sorbitol significantly affected the TSS: acid ratio when compared with control in both years (Table-4, b). The maximum TSS: acid ratio during both the years (2012 & 2013) was recorded from the trees treated with Boric acid (0.02%) with having value of 64.77 and 63.87 respectively, whereas; control showed the lowest of 34.86 and 34.59, respectively. The similar trend was

followed when the data for both the years were pooled. This might be due to accumulation and translocation of sugars that increased the TSS and acidity was on lower side in the fruit. Similar observations were obtained by Singh and Kaur (2016)^[24] in litchi, Singh *et al.* (2018)^[17] in litchi.

Conclusion

The above findings clearly showed that the spraying of Calcium nitrate @ 0.06% + Boric acid @ 0.02% had a positive effect on minimum fruit drop (91.19%), fruit weight (310.75 g), yield (138.43 kg per tree). On the other hand, the used materials increased pulp (78.60%), TSS content (19.08°Brix), total sugar (11.57%), ascorbic acid (33.76mg) and carotene content (8.62mg) with lower acidity (0.30%) of mango cv. Langra trees especially when the fruits were treated with foliar spray of Boric acid @ 0.02% performed better in comparison to rest of the treatments including control.

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