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Effect of pre harvest foliar application of chemical treatments on physical quality of custard apple (*Annona squamosa* L.) cv. Balanagar

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Abstract
The investigation was carried out to study the effect of different pre harvest foliar application of chemical treatments on quality of custard apple (*Annona squamosa* L.) cv. Balanagar, during the year 2018-19 and 2019-20, at Instructional Cum Research Orchard Arid Zone Fruit Project and laboratory of Postharvest Technology, Department of Horticulture, MPKV., Rahuri, Dist. Ahmednagar (MS). The experiment was laid out in FRBD (Factorial Randomized Block Design) with two replications. The trees of custard apple sprayed with 1% and 2% $CaCl_2$, 1% and 2% $CaNo_3$ and 1% and 2% KNO_3 at 60, 90 and 60-90 days after fruit setting and control trees was spray with water. The maximum fruit weight (244.80 and 260.70 g), fruit volume (212.37 and 226.16 cc), fruit length (7.16 and 7.62 cm), fruit breadth (8.71 and 9.28 cm), fruit pulp (42.09 and 44.68%), fruit firmness (27.50 and 28.87 N), while minimum fruit rind (47.92 and 51.17%), fruit seed (5.16 and 5.49%) showed significant result with treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set).

Keywords: Custard apple, pre harvest, $CaCl_3$, $CaNo_3$, KNO_3, Balanagar, physical parameters

Introduction
Custard apple (*Annona squamosa* L.) is a semi deciduous, subtropical fruit, consumed in many countries throughout the world (Manica, 1994) [14]. The total area of custard apple fruit crop in India during 2018-2019 (42,000 ha with production 349,000 tonne) (Anon, 2019). The plants custard apple come up unattended in parts of Andhra Pradesh, Assam, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, and Tamil Nadu as a shrub or hedge plant. Bullock's heart is more commonly found in south India than in north India. The major area under this crop is scattered in submountain area like Beed, Aurangabad, Latur, Usmanabad, Jalna, Parbhani, Ahmednagar, Pune district.

The custard apple is used by indigenous as an insecticidal and antitumor agent, anti-diabetic, antioxidant, anti-lipidemic, and anti-inflammatory agent which may be characterized due to the presence of the cyclic peptides. (Singh *et al.*, 2019) [24]. The fruit is also being used in various recipes *viz*. jam, nectars, ice creams etc. (Singh *et al.*, 2006) [22].

Among various chemicals, potassium is one of the key elements which play an important role in determining yield and quality. Nutritional K-sprays are required to increase fruit yield as well quality attributes specially juice recovery percentage and ascorbic acid content. Potassium is needed for enzyme activation, cell division, photosynthesis, photosynthates transport and osmoregulations. Potassium is responsible for many important internal and external fruit characteristics including fruit size, rind thickness and colour. Calcium has received considerable attention in recent year due to its desirable effect in delaying ripening and senescence, increase in firmness, vitamin C and phenolic contents, reduce respiration, extending storage life and reducing the incidence of physiological disorder and storage rots. Calcium chloride treatment to fruits protects against post-harvest deterioration by binding with hydrolysis such as galacto-uronase and promote shelf life. Further, calcium has been shown to inhibit ethylene production and thus dealy ripening (Richardson and Al-Alani, 1982) [20]. Calcium delay softening and improve the fruit quality. The preharvest application of calcium salts has been used successfully in many fresh fruits to reduce loss of firmness and to slow down the ripening process. Potassium is important for cell growth due to its role in cell expansion and development of thick epidermal cell walls (Salisbury and Ross, 1992) [21]. The quality of fruits, especially colouration of the skin, size aroma and shelf life, is improved when adequate potassium.

Material and Methods

The experiment was conducted on ten year old custard apple plant orchard cv. Balanagar in mrig bahar at Instructional Cum Research Orchard Arid Zone Fruit Project and laboratory of Postharvest Technology, Department of Horticulture, MPKV., Rahuri, Dist. Ahmednagar (MS) during 2018-19 and 2019-20. A factorial randomized block design (FRBD) was use with 19 treatments and two replications, considering 36 trees per replication. The trees of custard apple sprayed with 1% and 2% $CaCl_2$, 1% and 2% $CaNo_3$ and 1% and 2% KNO_3 at 60, 90 and 60-90 days after fruit setting. Control trees was spray with water. Harvested fruits were sorted for uniform size, maturity and free from defect.

Table 1: Details of treatment combination

T_1	**C_1T_1**	**:**	**$CaCl_2$ 1% + 60 days after fruit set**
T_2	C_1T_2	:	$CaCl_2$ 1% + 90 days after fruit set
T_3	C_1T_3	:	$CaCl_2$ 1% + 60 and 90 days after fruit set
T_4	C_2T_1	:	$CaCl_2$ 2% + 60 days after fruit set
T_5	C_2T_2	:	$CaCl_2$ 2% + 90 days after fruit set
T_6	C_2T_3	:	$CaCl_2$ 2% + 60 and 90 days after fruit set
T_7	C_3T_1	:	$CaNo_3$ 1% + 60 days after fruit set
T_8	C_3T_2	:	$CaNo_3$ 1% + 90 days after fruit set
T_9	C_3T_3	:	$CaNo_3$ 1% + 60 and 90 days after fruit set
T_{10}	C_4T_1	:	$CaNo_3$ 2% + 60 days after fruit set
T_{11}	C_4T_2	:	$CaNo_3$ 2% + 90 days after fruit set
T_{12}	C_4T_3	:	$CaNo_3$ 2% + 60 and 90 days after fruit set
T_{13}	C_5T_1	:	KNO_3 1% + 60 days after fruit set
T_{14}	C_5T_2	:	KNO_3 1% + 90 days after fruit set
T_{15}	C_5T_3	:	KNO_3 1% + 60 and 90 days after fruit set
T_{16}	C_6T_1	:	KNO_3 2% + 60 days after fruit set
T_{17}	C_6T_2	:	KNO_3 2% + 90 days after fruit set
T_{18}	C_6T_3	:	KNO_3 2% + 60 and 90 days after fruit set
T_{19}	Control	:	Water spray at each spraying

Observations recorded

Physical parameters

Fruit weight (g)

Five fruits from each treatment combination tree were picked and weight of all fruits of each treatment was recorded separately on digital weighing balance. The average weight (g) of each treatment was computed by dividing the total weight of harvested fruits (g) by total number of fruits in each treatment.

Fruit volume (cubic centimeter)

The fruit volume of selected fruits was measured by water displacement method. Fruit was placed in measuring beaker of one liter capacity filled with full of water. The fruit was place in cylinder, the replace water was measured as volume and data were recorded as volume of fruit in cubic centimeter. Then average value was calculated.

Fruit length (cm)

The length of selected fruits were measured with the help of vernier calliper and after computing mean. It was recorded as average length of fruit in centimeter.

Fruit breadth (cm)

The breadth of selected fruits were measured with the help of vernier calliper and after computing mean. It was recorded as average breadth of fruit in centimeter.

Fruit pulp (%)

The pulp percentage was worked out by dividing the average weight of pulp per fruit by the average weight of fruit.

$$\text{Pulp Percentage} = \frac{\text{Average weight of pulp per fruit (g)}}{\text{Average weight of fruit (g)}} \times 100$$

Fruit rind (%)

The rind percentage was worked out by dividing the average weight of rind per fruit by the average weight of fruit.

$$\text{Rind Percentage} = \frac{\text{Average weight of rind per fruit (g)}}{\text{Average weight of fruit (g)}} \times 100$$

Fruit seed (%)

The seed percentage was worked out by dividing the weight of seeds per fruit by the weight of fruit.

$$\text{Seed Percentage} = \frac{\text{Average weight of seed per fruit (g)}}{\text{Average weight of fruit (g)}} \times 100$$

Fruit firmness (N)

Firmness of fresh custard apple fruit was measured using an Instron Universal Testing Instrument (Make: Shimadzu, Japan; Model: AX-G). Different probe assemblies were used for different tests. Machine was connected to computer via software, this software coverts received signals, collects the data and converts it in graphical representation (texture profile) and prepare the reports of individual tests. The machine was fitted with1kN load cell and an 8-mm diameter compressive probe, adapting conditions from Ergun and Huber (2004) [5]. The probe was positioned at zero force contact with the surface of the custard apple fruit. Probe penetration was set at 10 mm at a crosshead speed of 20mm/min and readings were taken at 3 equidistant points on the equatorial region of the fruit. The force (N) required to penetrate the fruit surface up to a specific depth (mm) was recorded. The firmness were expressed as N (Newton).

Statistical Analysis

Various characters under study was statistically analysed by using analysis of variance techniques appropriate for factorial randomized block design (FRBD) as described by Panse and Sukhatme (1985) [16].

Result and Discussion

Fruit weight (g)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit weight of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 2. The (Chemicals X Time) interaction showed significant effect on fruit weight. During the first year of study (2018-19) the maximum weight of fruit (244.80 g) was observed in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (238.81 g) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (235.81 g). The minimum fruit weight (186.41 g) was recorded in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (190.20 g), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (190.82 g), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (193.10 g) and C_4T_2 ($CaNo_3$ 2% at 90 days after

fruit set) (196.12 g). In second year (2019-20) of study the maximum weight of fruit (260.70 g) was observed in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (256.10 g) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (249.91 g). The minimum fruit weight (203.21 g) was recorded in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (204.20 g), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (208.01 g), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (210.12 g) and C_4T_2 ($CaNo_3$ 2% at 90 days after fruit set) (214.30 g). Data regarding fruit weight was recorded maximum in treated (213.57 and 229.66 g). The minimum fruit weight was recorded in control (181.00 and 199.00 g).

Increase in fruit weight with potassium application might be due which lead to enhanced photosynthesis and thus facilitated greater supply of carbohydrates in consonance with increased rate of cell division and cell enlargement Meena *et al*. (2022) [15]. Another probable cause could be the greater mobility of assimilates by potassium to the developing fruits which acted as strong metabolic sink. The more pronounced effect of KNO_3 may be due to the additional supply of nitrogen which may further increase the efficiency of metabolic processes of plant and thus increases the growth of the plant and consequently increases the fruit weight in sweet orange Vijay *et al*., (2017) [25]. The increase in fruit weight with two sprays after 60 and 90 days after fruit set may be due to continuous supply of K to the developing fruit. The similar results were reported by Ramesh *et al*. (2016) [18] who reported KNO_3 (1.5%) 1st spray before flowering and 2nd at fruit set, recorded maximum fruit weight in custard apple. Gill and Bal (2010) reported that pre harvest spraying of KNO_3 (1.5%) significantly increased fruit weight in guava. Alebidi *et al.* (2021) [1] reported that spraying of potassium nitrate showed maximum fruit weight in date palm.

Fruit volume (cc)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit volume of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 2. The (Chemicals X Time) interaction showed significant effect on fruit volume. During the first year of study (2018-19) the maximum volume of fruit (212.37 cc) was registered in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (207.17 cc) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (204.57 cc). The minimum fruit volume (161.71 cc) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (165.00 cc), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (165.54 cc), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (167.52 cc) and C_4T_2 ($CaNo_3$ 2% at 90 days after fruit set) (170.13 cc). In second year (2019-20) of study the maximum volume of fruit (226.16 cc) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (222.17 cc) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (216.80 cc). The minimum fruit volume (176.29 cc) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (177.15 cc), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (180.45 cc) and C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (182.28 cc). Fruit volume was recorded maximum in treated (185.28 and 199.23 cc) while minimum fruit volume was recorded in control (157.02 and 172.64 cc).

All the treatments recorded a higher fruit volume compared to control. Increase in fruit volume with different concentrations of potassium could be due to the involvement of potassium in the synthesis of endogenous auxins, improved plant nutrient status which results in an increase in cell division and cell elongation in fruits and also due to an increase in the accumulation of food material in the fruit cells which results in an increase in the volume of fruits. Similar results were reported by Parauha and pandey (2019) [17] who reported that spray of GA_3 30 ppm + KNO_3 2% recorded maximum fruit volume in mango cv. Amrapali. Kaur and Dhillon (2006) [12] and Giriraj and Kacha (2014) [8] in guava.

Fruit length (cm)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit length of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 2.

The (Chemicals X Time) interaction showed significant effect on fruit length. During the first year of study (2018-19) the maximum length of fruit (7.16 cm) was obtained in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (6.98 cm) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (6.90 cm). The minimum fruit length (5.48 cm) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (5.56 cm), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (5.58 cm), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (5.65 cm) and C_4T_2 ($CaNo_3$ 2% at 90 days after fruit set) (5.74 cm). In second year (2019-20) of study the maximum length of fruit (7.62 cm) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (7.49 cm) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (7.31 cm). The minimum fruit length (5.94 cm) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (5.97 cm), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (6.08 cm) and C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (6.15 cm). Fruit length was recorded maximum in treated (6.25 and 6.72 cm), while minimum fruit length was recorded in control (5.29 and 5.82 cm).

The increased fruit size might be due to the role of potassium in cell wall construction as observed in grape fruit plants Boman and Hebb, (1998) [4]. The possible reasons for enhancement in fruit length with these nutrients might be due to higher synthesis of metabolites and enhanced mobilization of food and minerals from other parts of the plants towards the developing fruits as it is a well established fact that the fruit acts as extremely active metabolic sink. These results are in close proximity with foliar application of KNO_3 1st spray before flowering and 2nd at fruit set, recorded maximum fruit length in custard apple Ramesh *et al*. (2016) [18]. Hamza *et al.* (2012) [9] also observed that the treatment 8% KNO_3 (sprayed thrice) gave the best percentage of extra size class (57-63 mm) in citrus Clementine var. *Cadoux*. Gill and Bal (2009) [6] also reported a significant increase in fruit length with spray of KNO_3 in ber fruit.

Fruit breadth (cm)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit breadth of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 2. The (Chemicals X Time) interaction showed significant effect on fruit breadth. During the first year of study (2018-19) the maximum breadth of fruit (8.71 cm) was registered in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (8.50 cm) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (8.40 cm). The minimum fruit breadth (6.63 cm) was registered in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (6.77 cm), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (6.79 cm), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (6.87 cm) and C_4T_2 ($CaNo_3$ 2% at 90 days after fruit set) (6.98 cm). In second year (2019-20) of study the maximum breadth of fruit (9.28 cm) was observed in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (9.11 cm) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (8.89 cm). The minimum fruit breadth (7.23 cm) was recorded in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (7.27 cm), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (7.40 cm) and C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (7.48 cm). Fruit breadth was recorded maximum in treated (7.60 and 8.17 cm), while minimum fruit breadth was recorded in control (6.44 and 7.08 cm).

Increase in fruit breadth might be due to the foliar feeding of nutrients and consequently rapid fruit development caused by easy availability of nutrients plants as reported by Yadav *et al*. (2014) [27] in ber. The possible reasons for enhancement in fruit breadth with these nutrients might be due to higher synthesis of metabolites and enhanced mobilization of food and minerals from other parts of the plants towards the developing fruits as it is a well-established fact that the fruit acts as extremely active metabolic sink. It might have also been due to the involvement of these chemicals in cell division, cell expansion, increased volume of intercellular space in the mesocarpic cells and increased absorption of water and mobilization of sugars and minerals in the expanded cells and intercellular space of the mesocarp. These results are in close proximity with foliar application of KNO_3 1st spray before flowering and 2nd at fruit set, recorded maximum fruit length in custard apple Ramesh *et al*. (2016) [18]. Gill and Bal (2009) [6] also reported a significant increase in fruit length with spray of KNO_3 in ber fruit.

Fruit rind (%)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit rind of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 3. The (Chemicals X Time) interaction showed non significant effect on fruit rind per cent. During the first year of study (2018-19) the minimum rind per cent of fruit (47.92%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set). The maximum fruit rind per cent (55.92%) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). In second year (2019-20) of study the minimum rind per cent of fruit (50.76%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set). The maximum fruit rind per cent (60.55%) was recorded in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). In pooled data minimum rind per cent of fruit (49.54%) was observed in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set). The maximum fruit rind per cent (58.23%) was noted in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). Fruit rind per cent was recorded minimum in treated (51.81 and 55.68%), while maximum fruit rind per cent was observed in control (55.54 and 61.89%).

The results are in close conformity with the findings of Ramesh *et al*. (2016) [18] who reported KNO_3 (1.5%) 1st spray before flowering and 2nd at fruit set, recorded minimum rind per cent in custard apple.

Fruit pulp (%)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit pulp of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 3. The (Chemicals X Time) interaction showed significant effect on fruit pulp per cent. During the first year of study (2018-19) the maximum pulp per cent of fruit (42.09%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (41.06%) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (40.53%). The minimum fruit pulp per cent (33.23%) was noted in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (34.34%), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (34.42%), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (34.93%) and C_4T_2 ($CaNo_3$ 2% at 90 days after fruit set) (34.99%). In second year (2019-20) of study the maximum pulp per cent of fruit (44.68%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (44.15%) and C_4T_3 ($CaNo_3$ 2% at 60 and 90 days after fruit set) (43.22%). The minimum fruit pulp per cent (36.58%) was noted in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (36.77%), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (37.64%), C_3T_2 ($CaNo_3$ 1% at 90 days after fruit set) (37.80%) and C_4T_2 ($CaNo_3$ 2% at 90 days after fruit set) (38.18%). Fruit pulp per cent was recorded maximum in treated (37.72 and 40.60%) while minimum fruit pulp per cent was recorded in control (32.02 and 33.71%).

The possible reasons for enhancement in fruit pulp with these chemicals might be due to higher synthesis of metabolites and enhanced mobilization of food and minerals from other parts of the plants towards the developing fruits as it is a well-established fact that the fruit acts as extremely active metabolic sink. It might have also been due to the involvement of these chemicals in cell division, cell expansion, increased volume of intercellular space in the mesocarpic cells and increased absorption of water and mobilization of sugars and minerals in the expanded cells and intercellular space of the mesocarp. These results are in close proximity with the findings of Ramesh *et al*. (2016) [18] who reported KNO_3 (1.5%) 1st spray before flowering and 2nd at fruit set, recorded maximum pulp weight in custard apple, Parauha and pandey (2019) [17] who reported that spray of NAA 50 ppm + KNO_3 2% recorded maximum pulp weight in mango cv. Amrapali, Kale *et al*. (2000) [11], Singh and Randhawa (2001) [23] and Rathore and Chandra (2002) [19] in ber, and Bhatia *et al*. (2001) [3] in guava.

Fruit seed (%)

The data on effect of pre harvest foliar spray of chemicals and time of application on fruit seed percentage of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 3. The (Chemicals X Time) interaction showed non significant effect on fruit seed per cent. During the first year of study (2018-19) the minimum seed per cent of fruit (5.16%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set). The maximum fruit seed per cent (8.77%) was noted in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). In second year (2019-20) of study the minimum seed per cent of fruit (5.39%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set). The maximum fruit seed per cent (9.23%) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). In pooled data minimum seed per cent of fruit (5.33%) was noted in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set). The maximum fruit seed per cent (9.00%) was noted in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). Fruit seed per cent was recorded minimum in treated (6.98 and 7.27%), while maximum fruit seed per cent was recorded in control (8.72 and 9.42%).

The lowest seed per cent was recorded in fruits harvested from the plants sprayed with KNO_3 2% at 60 and 90 days after fruit set might be due to an increase in pulp content by an increase in accumulation of starch in the inter cellular spaces of fruit cells which results in decrease in the number of seeds per fruit. The results are in close conformity with the findings of Ramesh *et al*. (2016) [18] who reported KNO_3 (1.5%) 1st spray before flowering and 2nd at fruit set, recorded minimum seed per cent in custard apple.

Fruit firmness (N)

The data on effect of pre harvest foliar application of chemicals and time of application on fruit seed of custard apple cv. Balanagar for the year 2018-19, 2019-20 are presented in Table 3. The (Chemicals X Time) interaction showed significant effect on fruit firmness. During the first year of study (2018-19) the maximum firmness of fruit (27.50 N) was observed in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) and which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (26.76. N).The minimum fruit firmness (23.67 N) was noted in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (23.95 g), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (24.02 N), C_3T_2 ($CaNO_3$ 1% at 90 days after fruit set) (24.19 N) and C_4T_2 ($CaNO_3$ 2% at 90 days after fruit set) (24.44 g). In second year (2019-20) of study the maximum firmness of fruit (28.87 N) was recorded in treatment combination C_6T_3 (KNO_3 2% at 60 and 90 days after fruit set) and which was at par with C_5T_3 (KNO_3 1% at 60 and 90 days after fruit set) (28.13 N).The minimum fruit firmness (25.03 N) was observed in C_1T_2 ($CaCl_2$ 1% at 90 days after fruit set). It was at par with C_2T_1 ($CaCl_2$ 2% at 60 days after fruit set) (25.32 g), C_1T_1 ($CaCl_2$ 1% at 60 days after fruit set) (25.39 N), C_3T_2 ($CaNO_3$ 1% at 90 days after fruit set) (25.56 N) and C_4T_2 ($CaNO_3$ 2% at 90 days after fruit set) (25.81 N). Fruit firmness was recorded maximum in treated (25.18 and 26.51 N). The minimum fruit firmness was recorded in control (23.54 and 24.91 N).

The fruit pressure is an index for fruit ripening by judging hardness or softness. The fruits maintained optimum hardness with potassium nitrate treatments compared to control. Generally too soft fruits have shorter shelf life after harvesting. The reduction in fruit pressure gives softness to the fruits which might be linked with the activation of enzyme responsible for cell wall hydrolysis or biosynthesis of ripening hormone. Potassium might help in the formation of cell wall hydrolysing enzymes thereby contributing to an increase in fruit firmness of fruit. This is in agreement with the results of Kaur and Dhillon (2006) [12] in guava and Walid *et al.* (2015) [26] in apple. Foliar feeding of potassium increases fruit firmness, which might be related to an increase in fruit tissue pressure potential Lester *et al*. (2006) [13] as well as enhanced phloem transport of calcium to fruits following potassium applications.

Table 2: Effect of pre harvest foliar spray of chemicals and time of application on weight (g), volume (cc), length (cm) and breadth (cm) of custard apple cv. Balanagar fruit.

Treatments	Fruit weight (g)		Fruit volume (cc)		Fruit length (cm)		Fruit breadth (cm)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Interaction (C x T)								
C_1T_1	190.82	208.01	165.54	180.45	5.58	6.08	6.79	7.40
C_1T_2	186.41	203.21	161.71	176.29	5.48	5.94	6.63	7.23
C_1T_3	225.61	239.31	195.72	207.60	6.60	7.00	8.03	8.52
C_2T_1	190.20	204.20	165.00	177.15	5.56	5.97	6.77	7.27
C_2T_2	200.69	216.70	174.10	187.99	5.87	6.34	7.14	7.71
C_2T_3	232.30	246.20	201.52	213.58	6.79	7.20	8.27	8.76
C_3T_1	213.19	228.80	184.95	198.49	6.24	6.69	7.59	8.14
C_3T_2	193.10	210.12	167.52	182.28	5.65	6.15	6.87	7.48
C_3T_3	204.81	220.80	177.68	191.55	5.99	6.46	7.29	7.86
C_4T_1	222.10	241.70	192.67	209.68	6.50	7.07	7.90	8.60
C_4T_2	196.12	214.30	170.13	185.91	5.74	6.27	6.98	7.63
C_4T_3	235.81	249.91	204.57	216.80	6.90	7.31	8.40	8.89
C_5T_1	215.52	231.02	186.96	200.41	6.30	6.76	7.67	8.22
C_5T_2	217.61	233.20	188.78	202.30	6.36	6.82	7.75	8.30
C_5T_3	238.81	256.10	207.17	222.17	6.98	7.49	8.50	9.11
C_6T_1	229.51	245.00	199.10	212.54	6.71	7.17	8.17	8.72
C_6T_2	206.90	224.61	179.49	194.85	6.05	6.57	7.36	7.99
C_6T_3	244.80	260.70	212.37	226.16	7.16	7.62	8.71	9.28
S.Em±	3.76	3.73	3.06	3.24	0.12	0.11	0.15	0.13

CD at 5%	11.18	11.08	9.08	9.62	0.35	0.32	0.43	0.39
Treated Vs Control								
Treated	213.57	229.66	185.28	199.23	6.25	6.72	7.60	8.17
Control	181.00	199.00	157.02	172.64	5.29	5.82	6.44	7.08
S.Em±	3.87	3.83	3.14	3.33	0.14	0.17	0.17	0.15
CD at 5%	11.60	11.49	9.42	9.99	0.42	0.51	0.50	0.45

Table 3: Effect of pre harvest foliar application of chemicals on rind (%), pulp (%), seed (%) and firmness (N) of custard apple cv. Balanagar fruit

Treatments	Fruit rind (%)		Fruit pulp (%)		Fruit seed (%)		Fruit firmness (N)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Interaction (C x T)								
C_1T_1	54.24	60.03	34.42	37.64	8.30	8.88	24.02	25.39
C_1T_2	55.92	60.55	33.23	36.58	8.77	9.23	23.67	25.03
C_1T_3	50.47	54.14	39.78	42.05	5.93	6.22	25.52	26.89
C_2T_1	54.56	60.33	34.34	36.77	8.60	9.27	23.95	25.32
C_2T_2	53.19	56.89	36.12	39.01	7.98	8.26	24.59	25.96
C_2T_3	50.16	53.15	39.85	42.62	5.81	5.91	26.16	27.53
C_3T_1	52.00	54.91	38.16	40.71	7.35	7.37	24.86	26.23
C_3T_2	54.38	57.93	34.93	37.80	8.42	8.44	24.19	25.56
C_3T_3	52.11	56.38	36.66	39.56	7.35	8.03	24.77	26.14
C_4T_1	50.57	54.23	39.72	42.04	5.95	6.17	25.13	26.50
C_4T_2	53.74	59.76	34.99	38.18	7.93	8.69	24.44	25.81
C_4T_3	48.49	52.79	40.53	43.22	5.58	5.87	26.39	27.76
C_5T_1	51.54	54.48	38.27	41.19	6.68	6.81	25.00	26.37
C_5T_2	51.12	55.43	38.70	41.42	6.69	7.06	25.93	26.46
C_5T_3	48.85	50.76	41.06	44.15	5.62	5.39	26.76	28.13
C_6T_1	50.16	53.09	39.37	42.81	5.78	5.96	25.69	27.06
C_6T_2	53.14	56.27	36.77	40.26	7.77	7.83	24.80	26.17
C_6T_3	47.92	51.17	42.09	44.68	5.16	5.49	27.50	28.87
S.Em±	0.65	0.72	0.75	0.54	0.22	0.29	0.29	0.32
CD at 5%	NS	NS	2.23	1.62	NS	NS	0.87	0.94
Treated Vs Control								
Treated	51.81	55.68	37.72	40.60	6.98	7.27	25.18	26.51
Control	55.54	61.89	32.02	33.71	8.72	9.42	23.54	24.91
S.Em±	0.67	0.74	0.77	0.56	0.22	0.29	0.30	0.33
CD at 5%	NS	NS	2.31	1.68	NS	NS	0.98	0.96

Conclusion

Pre harvest foliar application of potassium nitrate 2% (KNO_3 2%) followed by potassium nitrate 1% (KNO_3 1%) at 60 and 90 days after fruit set proved to be the best treatment for physical parameters.

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