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Study on different nitrogen regimes through neem coated urea and calcium sprays on physico-chemical attributes and maturity of peach fruits

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Abstract
An investigation was conducted at Krishi Vigyan Kendra (ICAR- VPKAS), Kafligair, Bageshwar (Uttarakhand) in randomized block design with three replications and ten treatments during the years 2016 and 2017 in peach cv. Red June. The treatments comprised three levels of nitrogen fertilization (375 g, 500 g, 625 g per tree through neem coated urea) along with three concentrations (0.5%, 1.0% and 1.5%) of calcium chloride for foliar spray, and a control (500 g N per tree through neem coated urea along with water spray). Thus there were ten treatments *viz*., 375 g N per tree + 0.5% Ca Cl_2 (T_1), 375 g N $tree^{-1}$ + 1.0% Ca Cl_2 (T_2), 375 g N $tree^{-1}$ + 1.5% Ca Cl_2 (T_3), 500 g N $tree^{-1}$ + 0.5% Ca Cl_2 (T_4), 500 g N $tree^{-1}$ + 1.0% Ca Cl_2 (T_5), 500 g N $tree^{-1}$ + 1.5% Ca Cl_2 (T_6), 625 g N $tree^{-1}$ + 0.5% Ca Cl_2 (T_7), 625 g N $tree^{-1}$ + 1.0% Ca Cl_2 (T_8), 625 g N $tree^{-1}$ + 1.5% Ca Cl_2 (T_9), 500g N $tree^{-1}$ + Water spray (T_{10} control). The experimental findings revealed that maximum polar diameter of fruits (60.49 mm in 2016 and 61.45 mm in 2017), fruit width (58.68 mm in 2016 and 59.38 mm in 2017), fruit weight (91.41 g in 2016 and 91.71 g in 2017) and fruit volume (96.32 ml and 96.93 ml in first and second year, respectively) of fruits were measured in T_5 while the minimum values for these attributes were recorded under T_7. In first year the maximum specific gravity of fruits was measured under T_2 and in second year under T_1, however in both the years it remained statistically at par among T_1, T_2 and T_3. The maximum TSS – Acid ratio (11.82 in 2016 and 11.45 in 2017) and ascorbic acid content (3.747 mg/100 g in 2016 and 3.700 mg/100 g in 2017) were recorded in treatment T_2. Treatments T_1, T_2 and T_3 took minimum days (65.33 in 2016 and 66.67 in 2017) from fruit set to give first harvest in both the years of experiment, but statistically these were *at par* to T_4, T_5, T_6 and T_{10}.

Keywords: neem coated urea, calcium chloride, maturity days, physical and chemical attributes of fruits

Introduction

Peach (*Prunus persica* (L.) Batsch) belongs to family Rosaceae, subfamily Prunoideae, genus *Prunus*, subgenus Amygadalus and has somatic chromosome number 2n= 16 (Chadha, 2011) [4]. It is an important temperate fruit of attractive appearance and quality. In India, it is cultivated mostly in Himalayan region starting from the Jammu and Kashmir, Himanchal Pradesh, Uttarakhand and extending up to North–Eastern hills. In India, peach is being cultivated in an area of 18.91 thousand hectare, with a production and productivity of 96.58 thousand MT and 5.11 MT/ha, respectively (Anonymous, 2015) [2]. Peach also has significant position in Uttarakhand hills. Here, it occupies an area of 9.34 thousand hectare with the production of 49.80 thousand MT. The productivity of this fruit crop in state is 5.33 MT/ha (Anonymous, 2015) [2].

For horticultural produce fruit quality is as important as yield and at some instances it becomes more significant. Fruit quality is influenced considerably by various factors such as cultivar, rootstock, horticultural practices and climatic conditions. Among them horticultural practices are of great value under the established orchards which may be amended for better quality attributes. Mineral nutrition of trees is an integral part of horticultural practices which plays a vital role in physico-chemical properties of fruits. It was noticed that management of nutrients, particularly nitrogen and calcium have an important relationship with the quality of fruits (Prasad and Spiers, 1991) [18]. Moreover, some of the researchers reported the influence of different nitrogen fertilization levels on fruit maturity period (Daane *et al.*, 1995 and Saenz *et al.* (1997) [7, 22].

Nitrogen levels standardized for peach under different agro climatic conditions show variation from region to region and project the variations in the nutrient status of the orchard soils (Singh and Singh, 2002) [24]. Moreover, the production system of peach in hills has been changed considerably with the adoption of high density planting.

Traditionally the peaches were planted at 6m x 6m spacing, however now the spacing has reduced to 3m x 3m or 4m x 4m. Urea is the major nitrogen fertilizer in India and from January 2015, Government of India has made it mandatory for the domestic urea manufactures to produce "neem coated urea" up to a minimum of 75 per cent of their total production of subsidized urea from 35 per cent earlier and allowed them to go up to 100 per cent (http:/thehindubusinessline.com). The explanation for this decision is to inculcate the benefits of slow release nitrogenous fertilizers in Indian farming. Because, oil derived from neem seed possess melicians that is generally known as bitters of which epinimbin, deacetyl salanin and azadirachtin show dose dependent nitrification inhibition action (Thind *et al.*, 2010) [29]. In addition to controlled nitrification, neem coating of urea leads to less volatization and leaching losses. Although, adequate information has been generated with regard to neem coated urea for the use in field crops but a very meager work has been done for the fruit crops.

Calcium application through foliar spray is a standard practice to control fruit calcium levels in certain deciduous fruit trees (Yamane, 2014) [31]. As far as the source of calcium for foliar application is concerned, salts with low Deliquescence Relative Humidity (DRH) are readily absorbed through leaves. The threshold relative humidity above which the salt dissolves in water absorbed from the atmosphere is called Deliquescence Relative Humidity (DRH). Calcium chloride has low Deliquescence Relative Humidity, hence tends to remain in solution even if relative humidity is low and can thus be efficiently absorbed (Fallahi and Eichert, 2013) [9]. Calcium chloride is also less expensive as compared to other forms of calcium compounds such as chelated calcium. Although, adequate information for the application of calcium chloride in apple has been generated but a very meager research has been conducted in peach, especially under North-Western hill conditions.

Thus, different levels of nitrogen fertilization and calcium chloride sprays at varying concentrations were identified for the intervention to find out their effect on physico-chemical attributes and maturity duration of peach fruits.

Materials and Methods

The present study was conducted at Krishi Vigyan Kendra (ICAR-VPKAS, Almora) Kafligair- Bageshwar (Uttarakhand) in two consecutive years i.e., 2016 and 2017. The experimental site is situated in the mid Himalayas between 29º45'07" N latitude and 79º44'03" E longitude at an altitude of 1245 meters above the mean sea level which represents the humid sub- temperate climate with average annual rainfall of 1256 mm. The experiment was conducted peach cv. Red June trees, raised on seedling rootstocks and planted in 2010 with planting spacing of 3m x 3m. This self-fertile peach cultivar is extensively grown in Uttarakhand hills and is very popular among the farmers due to its attractive appearance, early maturity and consumer preference.

The experiment was conducted in randomized block design with three replications and ten treatments. The treatments comprised three levels of nitrogen fertilization (375 g, 500 g and 625 g per tree through neem coated urea) along with three concentrations (0.5%, 1.0% and 1.5%) of calcium chloride for foliar spray, and a control (500 g N per tree through neem coated urea along with water spray). Thus there were ten treatments *viz*., 375 g N per tree + 0.5% Ca Cl_2 (T_1), 375 g N tree^{-1} + 1.0% Ca Cl_2 (T_2), 375 g N tree^{-1} + 1.5% Ca Cl_2 (T_3), 500 g N tree^{-1} + 0.5% Ca Cl_2 (T_4), 500 g N tree^{-1} + 1.0% Ca Cl_2 (T_5), 500 g N tree^{-1} + 1.5% Ca Cl_2 (T_6), 625 g N tree^{-1} + 0.5% Ca Cl_2 (T_7), 625 g N tree^{-1} + 1.0% Ca Cl_2 (T_8), 625 g N tree^{-1} + 1.5% Ca Cl_2 (T_9), 500g N tree^{-1} + Water spray (T_{10} control). Foliar sprays of calcium chloride were given thrice, first at petal fall stage, second at 25 days after Ist spray and third at 25 days after IInd spray. Common doses of FYM (40 kg/tree), P_2O_5 (250 g/tree) and K_2O (500 g/tree) were also applied uniformly in each tree. Source of N, P_2O_5 and K_2O were neem coated urea, single super phosphate and muriate of potash, respectively. Whole quantity of FYM, P_2O_5 and K_2O were applied in December. Half of the N was applied in mid-February about three weeks before flowering and remaining half in last week of March after fruit set.

The observations were recorded by applying the following procedure

(1) Physico- chemical attributes of fruits

A representative sample of ten fruits per treatment per replication was taken randomly from all directions of the plant and various physical and bio-chemical attributes were recorded.

(A) Physical Attributes

(i) Polar diameter of fruit (mm)

The distance between stalk end and distal end is known as polar diameter of fruit. It was measured by a digital Vernier's calliper (Absolute Digimatic, Mitutoyo, Model No. NOCD-6" CSX). Finally the mean polar diameter of ten fruits was calculated.

(ii) Fruit width (mm)

The fruit girth (cm) was measured at the widest point of the fruit by digital Vernier's caliper (Absolute Digimatic, Mitutoyo, Model No. NOCD- 6" CSX). The mean value of fruit girth of ten fruits was thus calculated.

(iii) Fruit weight (g)

Weight of ten fruits was taken on an electronic balance (Model MX-7210A) and average weight (g) was obtained by dividing the total weight of the fruits with the number of fruits.

(iv) Fruit volume (ml)

Fruit volume was recorded by using 'water displacement method'. Ten fruits were submerged in graduated cylinder, containing water and both initial and final volumes of water were recorded. The fruit volume was thus obtained by subtracting initial volume from final volume of water and, finally, the mean volume of ten fruits was computed.

(v) Specific gravity (g/ml)

Average fruit weight was divided by corresponding values of average fruit volume to calculate the specific gravity that was expressed in g/ml.

$$\text{Specific gravity (g/ml)} = \frac{\text{Average fruit weight (g)}}{\text{Average fruit volume (ml)}}$$

(B) Chemical attributes

(i) TSS - Acid Ratio

TSS - Acid ratio was calculated by dividing the fruit TSS content (measured by a digital refractometer, Extech Instrument, MI 722-01) with its corresponding acidity (estimated by titrating the fruit pulp extract with 0.1N NaOH using phenophthaline as indicator by applying the procedure described by Ranganna, 1986) [21], as mentioned below;

$$\text{T.S.S. - Acid ratio} = \frac{\text{T.S.S. } (^0\text{Brix})}{\text{Acidity } (\%)}$$

(ii) Ascorbic acid (mg/100 g)

The ascorbic acid content was estimated by reduction of 2,6-dichlorophenol indophenol dye expressed in terms of mg of ascorbic acid per 100 g of fruit pulp (Ranganna, 1986) [21].

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre value x Dye factor x Volume made up x 100}}{\text{Aliquot of extract taken x Weight of sample}}$$

2. Fruit maturity duration

The differences in days between fruit set and first pecking date were calculated to find out the fruit maturity duration.

Results and Discussion

(1) Physico- chemical Attributes of Fruits

(A) Physical attributes

(i) Polar diameter of fruit (mm)

The perusal of data presented in Table 1 clearly reveals that different nitrogen regimes significantly affected the polar diameter of fruit in both the years. During the two years study the maximum polar diameter of fruit was measured under T_5 (60.49 mm in 2016 and 61.45 mm in 2017) that was slightly higher and statistically *at par* to T_6, T_{10} and T_4. The minimum polar diameter of fruit was recorded under T_7 (56.07 mm in first year and 56.66 mm in second year) which was preceded and statistically *at par* to T_9 and T_8. The treatment T_1, T_2 and T_3 were statistically *at par* among themselves and contained intermediate values in both the years.

The possible reason for significant differences in polar diameter of fruit among three nitrogen regimes might be due to varying availability of nutrients, especially nitrogen that play important role in plant metabolism. The plants that received adequate nitrogen performed better, while high doses of nitrogen might cause nutrient and source to sink imbalance that led to minimum values of polar diameter of fruit. The present findings are in harmony with the earlier results of Singh and Chauhan (2002) [24] in peach and Saini *et al.* (2013) [23] in plum. Comparatively less decrease in polar diameter of fruit with lowest nitrogen regime is due to use of more efficient neem coated urea that has already proved its effectiveness in guava (Ram *et al.*, 1999) [20]. Non-significant differences among sprays with various calcium chloride concentrations as well as control are in agreement to the previous findings of Kirmani *et al.* (2013) [13] for plum, however contrary to Kumar *et al.* (2017) [14] in litchi.

Table 1: Response of different nitrogen regimes through neem coated urea and calcium sprays on physical attributes of peach fruits cv. Red June.

Treatments	Treatment symbols	Polar diameter of fruit (mm)		Fruit width (mm)		Fruit weight (g)		Fruit volume (ml)		Specific gravity of fruits (g/ml)	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
375g N per tree + 0.5% Calcium chloride	T_1	58.31 ^{b*}	59.34 ^{b*}	55.91 ^{b*}	56.60 ^{b*}	89.46 ^{c*}	89.88 ^{c*}	93.57 ^{b*}	93.24 ^{b*}	0.956 ^{a*}	0.965 ^{a*}
375g N per tree + 1.0% Calcium chloride	T_2	58.56 ^{b}	59.48 ^{b}	56.14 ^{b}	56.88 ^{b}	89.65 ^{c}	89.96 ^{c}	93.67 ^{b}	93.30 ^{b}	0.957 ^{a}	0.964 ^{a}
375g N per tree + 1.5% Calcium chloride	T_3	58.43 ^{b}	59.44 ^{b}	56.01 ^{b}	56.77 ^{b}	89.67 ^{c}	89.99 ^{c}	93.97 ^{b}	93.40 ^{b}	0.954 ^{a}	0.963 ^{a}
500g N per tree + 0.5% Calcium chloride	T_4	60.08 ^{a}	61.14 ^{a}	58.24 ^{a}	59.04 ^{a}	91.12 ^{ab}	91.41 ^{ab}	96.17 ^{a}	96.77 ^{a}	0.948 ^{b}	0.944 ^{b}
500g N per tree + 1.0% Calcium chloride	T_5	60.49 ^{a}	61.45 ^{a}	58.68 ^{a}	59.38 ^{a}	91.41 ^{a}	91.71 ^{a}	96.32 ^{a}	96.93 ^{a}	0.949 ^{b}	0.946 ^{b}
500g N per tree + 1.5% Calcium chloride	T_6	60.32 ^{a}	61.42 ^{a}	58.52 ^{a}	59.27 ^{a}	91.39 ^{a}	91.67 ^{a}	96.30 ^{a}	96.90 ^{a}	0.949 ^{b}	0.946 ^{b}
625g N per tree + 0.5% Calcium chloride	T_7	56.07 ^{c}	56.66 ^{c}	54.85 ^{c}	55.88 ^{c}	85.13 ^{d}	85.70 ^{d}	91.63 ^{c}	92.17 ^{c}	0.929 ^{c}	0.930 ^{c}
625g N per tree + 1.0% Calcium chloride	T_8	56.30 ^{c}	56.73 ^{c}	55.26 ^{c}	56.05 ^{c}	85.33 ^{d}	85.73 ^{d}	92.03 ^{c}	92.57 ^{c}	0.927 ^{c}	0.926 ^{c}
625g N per tree + 1.5% Calcium chloride	T_9	56.23 ^{c}	56.68 ^{c}	55.06 ^{c}	55.94 ^{c}	85.44 ^{d}	85.95 ^{d}	91.53 ^{c}	92.00 ^{c}	0.933 ^{c}	0.934 ^{c}
500g N per tree + Water spray (Control)	T_{10}	60.11 ^{a}	61.24 ^{a}	58.26 ^{a}	59.05 ^{a}	90.88 ^{b}	91.33 ^{b}	96.13 ^{a}	96.67 ^{a}	0.946 ^{b}	0.945 ^{b}
CD (0.05)		0.97	1.01	0.63	0.74	0.33	0.33	0.66	0.64	0.006	0.007
SE (m) $\pm$		0.32	0.34	0.21	0.25	0.11	0.11	0.22	0.22	0.002	0.002

*Values within columns having common letter are statistically at par.

(ii) Fruit width

The critical examination of data presented in Table 1 reveals the significant influence of different nitrogen regimes on fruit width in first as well as in second year of the study. In first year of experiment the maximum fruit width was determined under T_5 (58.68 mm) that was statistically *at par* to T_6, T_{10} and T_4. The minimum fruit width in the same year was measured with T_7 (54.85 mm) that was slightly lower and statistically non-significant to T_8 and T_9. In second year also, the similar trends were observed with highest fruit width recorded under T_5 (59.38 mm) having non-significant differences with T_6, T_{10} and T_4. The treatments T_1, T_2 and T_3 showed non-significant differences among themselves and occupied almost mid position for fruit width. It is also evident from table 1 that foliar application of calcium chloride could not impart significant differences in fruit width during both the years.

The minimum fruit width observed under highest nitrogen regime might be ascribed to plenty of nitrogen availability that possibly led to mobilization of metabolites towards luxuriant vegetative growth at the expense of metabolites meant for developing fruits. Our results regarding decrease in fruit width with increasing doses of nitrogen fertilization above a certain level, further elucidate the findings of Singh and Chauhan (2002) [24] in peach and Saini *et al.* (2013) [23] in plum. The medium position occupied by lowest nitrogen regime could be attributed to better utilization of nitrogen through neem coated urea. The insignificant influence of calcium chloride sprays on fruit width is in conformity to the upshots of Kirmani *et al.* (2013) [13] in plum, though disagree the findings of Kumar *et al.* (2017) [14] in litchi.

(iii) Fruit weight

The observations regarding the influence of various treatments on fruit weight are presented in Table 1. The maximum fruit weight in both the years was recorded under T_5 (91.41 g in 2016 and 91.71 g in 2017) that was immediately followed and statistically *at par* to T_6 andT_4. The minimum fruit weight in both the years was observed with T_7 (85.13 g and 85.70 g in first and second year, respectively). Treatment T_1, T_2 and T_3 attained the intermediate values for fruit weight and remained *at par* among themselves during both the years. Table 1 also reveals that under same nitrogen regime, various concentrations of calcium chloride did not impart significant differences in fruit weight. However, T_{10} that received same nitrogen dose with no calcium chloride sprays remained significantly lower than T_5 and T_6 during both the years. Nevertheless, T_{10} was statistically at par to T_4.

Mobilization and utilization of metabolites towards increasingly growing vegetative parts might be responsible for less fruit weight under highest nitrogen regimes. Singh and Chauhan (2002) [24] in peach and Saini *et al.* (2013) [23] in plum also observed increase in fruit weight upto 500 g N per tree and decrease thereafter. Intermediate values of fruit weight with lowest nitrogen regimes is proposed to be due to use of neem coated urea that might encountered less leaching and nitrification losses and provided adequate nitrogen during the whole fruiting season, as also suggested by Ram *et al.* (1999) [20] who reported effectiveness of neem coated urea on fruit weight in guava.

The significant influence of calcium chloride concentrations at same nitrogen regime though not evident, but significantly lower fruit weight was noticed under T_{10} than T_5 and T_6. This critical analysis of data suggests that calcium chloride sprays had some definite role in fruit weight; however, its applied concentrations remained *at par* among themselves under same nitrogen regime. It may also be extracted from the data that 0.5% calcium chloride was less effective as compared to 1.0% and 1.5%, because T_4 was statistically *at par* to T_{10}. Role of calcium in cell elongation and division implicates its influence on fruit weight. Beneficial effect of calcium chloride sprays on fruit weight was also reported by Ganal (2005) [10] in apple, Bakshi *et al.* (2013) [3] in strawberry and Kumar *et al.* (2017) [14] in litchi. However, Sotiropoulos *et al.* (2010) [28] reported that pre-harvest foliar application of calcium products on peach did not affect the mean fruit weight, significantly.

(iv) Fruit volume

A close perusal of data presented in Table 1 unveil that fruit volume responded to various nitrogen regimes significantly. The maximum fruit volume in first as well as in second year of experiment was recorded under T_5 (96.32 ml and 96.93ml in first and second year, respectively) that was a little higher and statistically *at par* to T_6, T_4 and T_{10}. These group of treatments were significantly higher than all other treatments and followed by T_3 (93.97 ml in 2016 and 93.40 ml in 2017), T_2 (93.67 ml in 2016 and 93.30 ml in 2017) and T_1 (93.57 ml in 2016 and 93.24 in 2017). Treatment T_1, T_2 and T_3 were non-significant among themselves. The minimum fruit volume was measured under T_9 (91.53 ml and 92.00 ml in 2016 and 2017, respectively) that remained statistically *at par* to T_7 and T_8.

Fruit volume is a collective expression of dimensions (polar diameter and width). Our present finding regarding fruit volume depicts analogy to previously discussed polar diameter of fruit and fruit width. Availability of adequate amount of metabolites and their proper mobilization towards developing fruits led to increased fruit volume in superior treatments. Similar pattern of fruit volume measurement with various nitrogen regimes was reported by some researchers in other horticultural crops (Costa *et al.*, 1997 and Aminifard *et al.*, 2012) [5, 1].

(v) Specific gravity

A careful examination of data presented in Table 1 makes it evident that nitrogen regimes had significant role in specific gravity of fruits. The maximum specific gravity in the first year of study was estimated for T_2 (0.957 g/ml) that was statistically *at par* to T_1 (0.956 g/ml) and T_3 (0.954 g/ml). However, in second year, the maximum specific gravity was obtained under T_1 (0.965 g/ml) that had very minute and non-significant differences with T_2 (0.964 g/ml) and T_3 (0.963 g/ml). Treatment T_8 (0.927 g/ml in 2016 and 0.926 g/ml in 2017) turned out as the treatment having minimum specific gravity during both the year of experiment. Nevertheless, it remained statistically *at par* to T_7 and T_9. During two years experiment, treatment T_4, T_5, T_6 and T_{10} that received the medium nitrogen doses had *at par* specific gravity among themselves and showed intermediary values with respect to the highest and lowest nitrogen regimes. Two years average values indicate that highest specific gravity (0.961 g/ml) was noticed with T_1 and T_2 followed by T_3 (0.959 g/ml), while the minimum was observed under T_8 (0.927 g/ml) that were slightly lower than T_7 (0.930 g/ml) and T_9 (0.934 g/ml).

Specific gravity is the ratio of fruit weight and volume and expresses the compactness of the fruit. Excess nitrogen increases the tissues areas by enlarging cell volumes rather increasing the number of cells within the tissues (Milford and Watson, 1971) [15], resulting in less compact fruit growth. Reduction in specific gravity with increasing levels of nitrogen fertilization might be due to less rationale enlargement of fruits with respect to weight due to more availability of nitrogen. Comparison of the average results obtained for fruit weight, volume and specific gravity indicates that mere increase or decrease in fruit weight and volume does not warrant higher or lower specific gravity, but their appropriate ratio is important (Fig. 1 and Fig. 2).

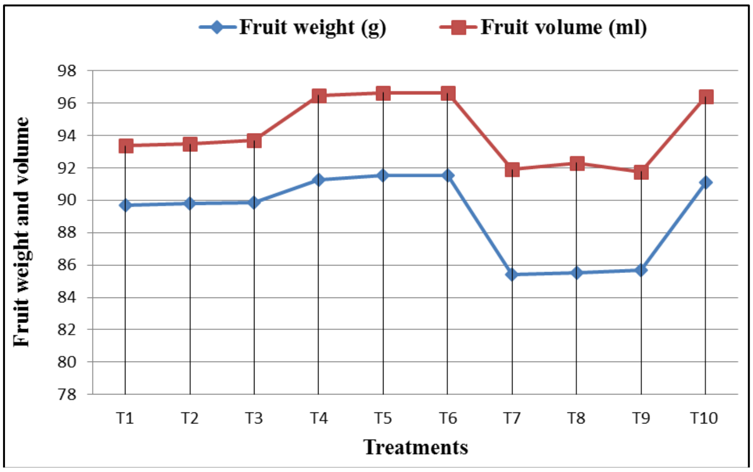

Fig 1: Response of N regimes through neem coated urea and foliar application of calcium chloride on (average of two years) fruit weight and volume in peach cv. Red June

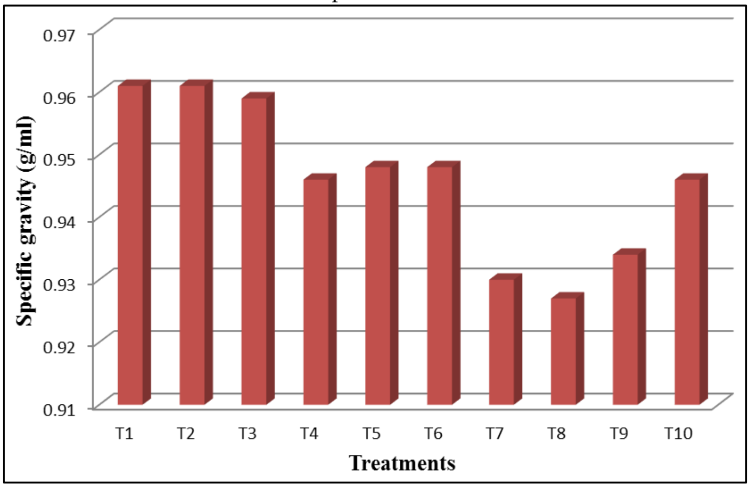

Fig 2: Response of N regimes through neem coated urea and foliar application of calcium chloride on (average of two years) specific gravity in peach cv. Red June

(B) Chemical Attributes

(iii) TSS - Acid ratio

The significant differences among various treatments during both the study years were observed for TSS - Acid ratio (Table 2). The maximum TSS - Acid ratio was computed for T_2 in both the study years (11.82 in 2016 and 11.45 in 2017) that were significantly higher than all other treatments. It was followed by T_3, T_1 and T_5 in first year and T_1, T_3 and T_5 in second year. At the same time, the minimum TSS - Acid ratio was recorded under T_{10} (9.57 in 2016 and 9.39 in 2017).

TSS-Acid ratio is a mathematical expression that play important role in taste and flavor of the fruits and consequently influences the consumer preference. Treatments under lowest nitrogen regime (375 g N per tree) had maximum TSS - Acid ratio due to higher TSS and lower acidity. Positive influence of calcium chloride sprays were also realized over control and 1.0% concentration was found to be the best. It was due to higher TSS and lower acidity under calcium chloride sprays. Decrease in TSS - Acid ratio with increase in nitrogen fertilization levels was also reported by Dhillon *et al.* (1992) [8] in grapes. Similar to our findings, the positive effect of calcium chloride sprays on TSS - Acid ratio was also documented by Bakshi *et al.* (2013) [3] in strawberry, who found significantly higher TSS- Acid ratio for all the calcium chloride treatments over control though there were differences among concentrations.

Table 2: Response of different nitrogen regimes through neem coated urea and calcium sprays on chemical attributes of peach fruits cv. Red June.

Treatments	Treatment symbols	TSS - Acid ratio		Ascorbic acid (mg/100 g)	
		2016	2017	2016	2017
375g N per tree + 0.5% Calcium chloride	T_1	11.31 ^{bc*}	11.10 ^{b*}	3.483 ^{c*}	3.413 ^{c*}
375g N per tree + 1.0% Calcium chloride	T_2	11.82 ^{a}	11.45 ^{a}	3.747 ^{a}	3.700 ^{a}
375g N per tree + 1.5% Calcium chloride	T_3	11.40 ^{b}	11.07 ^{b}	3.680 ^{b}	3.620 ^{b}
500g N per tree + 0.5% Calcium chloride	T_4	10.43 ^{e}	9.88 ^{de}	3.000 ^{f}	2.953 ^{f}
500g N per tree + 1.0% Calcium chloride	T_5	11.14 ^{c}	10.90 ^{b}	3.280 ^{d}	3.223 ^{d}
500g N per tree + 1.5% Calcium chloride	T_6	10.85 ^{d}	10.33 ^{c}	3.220 ^{e}	3.160 ^{e}
625g N per tree + 0.5% Calcium chloride	T_7	9.84 ^{f}	9.81 ^{de}	2.743 ^{h}	2.703 ^{i}
625g N per tree + 1.0% Calcium chloride	T_8	10.23 ^{e}	10.04 ^{d}	2.913 ^{g}	2.863 ^{g}
625g N per tree + 1.5% Calcium chloride	T_9	9.91 ^{f}	9.69 ^{e}	2.860 ^{g}	2.807 ^{h}
500g N per tree + Water spray (Control)	T_{10}	9.57 ^{g}	9.39 ^{f}	2.460 ^{i}	2.403 ^{j}
CD (0.05)		0.22	0.28	0.057	0.053
SE (m) $\pm$		0.07	0.09	0.019	0.018

*Values within columns having common letter are statistically *at par*.

Table 3: Response of different nitrogen regimes through neem coated urea and calcium sprays on first picking duration of peach cv. Red June.

Treatments	Treatment symbols	Days from fruit set to first harvest	
		2016	2017
375g N per tree + 0.5% Calcium chloride	T_1	65.33 [b*]	66.67 [b*]
375g N per tree + 1.0% Calcium chloride	T_2	65.33 [b]	66.67 [b]
375g N per tree + 1.5% Calcium chloride	T_3	65.33 [b]	66.67 [b]
500g N per tree + 0.5% Calcium chloride	T_4	65.67 [b]	67.33 [b]
500g N per tree + 1.0% Calcium chloride	T_5	65.67 [b]	67.33 [b]
500g N per tree + 1.5% Calcium chloride	T_6	65.67 [b]	67.33 [b]
625g N per tree + 0.5% Calcium chloride	T_7	67.67 [a]	69.67 [a]
625g N per tree + 1.0% Calcium chloride	T_8	67.67 [a]	69.67 [a]
625g N per tree + 1.5% Calcium chloride	T_9	67.67 [a]	69.67 [a]
500g N per tree + Water spray (Control)	T_{10}	65.67 [b]	67.33 [b]
CD (0.05)		1.20	1.45
SE (m) $\pm$		0.40	0.48

*Values within columns having common letter are statistically *at par*.

(v) Ascorbic acid

A close examination of the data presented in Table 2 reveals that different nitrogen regimes through neem coated urea and calcium chloride sprays significantly affected the ascorbic acid content of peach fruits during both the study years. In first year of the experiment i.e., 2016, the values of ascorbic acid content ranged from 2.460 mg/100 g to 3.747 mg/100 g with maximum under T_2 and minimum under T_{10}. Treatment T_2 remained significantly higher than all other treatments and followed by T_3 (3.680 mg/100 g), T_1 (3.483 mg/100 g) and T_5 (3.280 mg/100 g). Likewise, in second year (2017), the maximum ascorbic acid content was estimated under T_2 (3.700 mg/100 g) followed by T_3 (3.620 mg/100 g), T_1 (3.413 mg/100 g) and T_5 (3.223 mg/100 g). In this year also the lowest value of ascorbic acid content i.e., 2.403 mg/100 g was recorded with T_{10} that was immediately preceded.

High levels of nitrogen fertilizers seem to decrease the concentration of ascorbic acid (Vitamin C) in several fruits and vegetables (Mozafar, 1993) [16]. Garhwal *et al.* (2014) [11] also reported maximum ascorbic acid content at a certain nitrogen fertilization level in Kinnow mandarin that reduced thereafter and attributed to the catalytic activity of several enzymes which participate in the biosynthesis of ascorbic acid and its precursor. Similarly, Rai *et al.* (2002) [19] in litchi also found the maximum ascorbic acid with a particular nitrogen regime that showed decline with increase in nitrogen levels. The synergistic effect of calcium chloride sprays on ascorbic acid content might be due to the uninterrupted synthesis of its precursor (Glucose -6- phosphate) during conversion of starch into sugars and low rate of oxidation. Increase in ascorbic acid content with calcium chloride sprays substantiated with the previous results of Ganal (2005) [10] in apple, Bakshi *et al.* (2013) [3] in strawberry, Wahab *et al.* (2016) [30] in peach, and Patel *et al.* (2017) [17] in sapota. However, contrary to the our present findings, non-significant effect of calcium chloride sprays on ascorbic acid content in peach fruits was reported by Singh and Sharma (2009) [26].

2. Fruit maturity duration

The differences in days between fruit set and first picking date were calculated (Table 3) which showed that T_1, T_2 and T_3 took minimum days (65.33 in 2016 and 66.67 in 2017) from fruit set to give first harvest in both the years of experiment. They were statistically *at par* to treatment T_4, T_5, T_6 and T_{10} that gave first harvest in 65.67 and 67.33 days from fruit set during 2016 and 2017, respectively. Treatment T_7, T_8 and T_9 acquired more days to come in first picking (67.67 in 2016 and 69.67 in 2017) and remained significantly different to all other treatments during both the years.

The delayed first harvest with highest nitrogen fertilization level is supposed to be due to added vegetative growth (data not shown) that led to increased shade inside and beneath the tree canopy. Therefore, the fruits under T_7, T_8 and T_9 might receive less sunlight that caused delay in colour development and consequently the first picking took some more days to happen. Crisosto and Costa (2008) [6] cited that higher nitrogen delays fruit maturity in peach due to poor visual red colour development and inhibits ground colour change from green to yellow. Daane *et al.* (1995) [7] and Saenz *et al.* (1997) [22] also reported delayed harvest with nitrogen increments in nectarine and peach, respectively. Calcium sprays could not exert any noticeable influence on first picking duration and the findings are in line of Singh (2000) [25].

Conclusion

An array of discussion made vide supra elucidate that different nitrogen regimes had significant role on physical fruit characteristics. Maximum values of all the physical fruit parameters except specific gravity were found with medium nitrogen doses (500 g per tree). However, maximum specific gravity of the fruits was measured with lowest nitrogen regime (375 g per tree) which showed more fruit compactness and may consequently possess better shelf life. Moreover, better chemical attributes of fruits in terms of TSS- Acid ratio and ascorbic acid content were also realized with this lowest nitrogen regime and these were most pronounced when calcium chloride sprays were given @ 1.0%. However, the fruits under 375 g N per tree through neem coated urea along with three sprays of 1% calcium chloride treatment T_2 were a bit smaller than 500 g N per tree, but considering the better response of this treatment (T_2) for consumer preferable attribute (TSS- Acid ratio), nutritive value (ascorbic acid), fruit compactness (specific gravity) and market opportunity (early maturity), the same may be recommended for peach under Uttarakhand hill conditions where most of the peach orchards are managed under closer spacing.

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