Effect of different nitrogen regimes through *Azadirachta indica (neem)* coated urea and calcium sprays on post harvest attributes of peach[*Prunus persica* (L.) Batsch]

ABSTRACT

An investigation was conducted for two consecutive years in peach cv. Red June with varying nitrogen regimes through *Azadirachta indica* (neem) coated urea along with three sprays of calcium chloride. There were ten treatments i.e., 375g N per tree + 0.5% Ca Cl_2 (T_1), 375g N tree^{-1} + 1.0% Ca Cl_2 (T_2), 375g N tree^{-1} + 1.5% Ca Cl_2 (T_3), 500g N tree^{-1} + 0.5% Ca Cl_2 (T_4), 500g N tree^{-1} + 1.0% Ca Cl_2 (T_5), 500g N tree^{-1} + 1.5% Ca Cl_2 (T_6), 625g N tree^{-1} + 0.5% Ca Cl_2 (T_7), 625g N tree^{-1} + 1.0% Ca Cl_2 (T_8), 625g N tree^{-1} + 1.5% Ca Cl_2 (T_9), 500g N tree^{-1} + Water spray as control (T_{10}). The fruits were harvested at uniform maturity, stored at ambient condition and their post-harvest attributes were studied on 3rd, 6th and 8thday. The highest mean PLW was recorded under control (T_{10}). The maximum mean fruit firmness *viz*., 0.948 kg/mm^2 and 0.949 kg/mm^2 in first and second year, respectively was measured under T_2 and T_3. The maximum mean TSS during the course of storage was recorded under T_2 followed by T_3 and T_1. The maximum mean titratable acidity was estimated under T_{10}. The treatments under 375 g N per tree along with calcium chloride sprays (T_1, T_2 and T_3) possessed comparatively higher mean TSS - Acid ratio than other treatments. Treatment T_2 and T_3 consistently maintained higher organoleptic acceptability score with quality preference as excellent on 3rd day.

Key Words: *Azadirachta indica* (Neem) coated urea, Calcium chloride, Physiological loss in weight, Fruit firmness, Total soluble solids and Organoleptic acceptability.

INTRODUCTION

Peach (*Prunus persica* (L.) Batsch) belongs to family Rosaceae, subfamily Prunoideae, genus *Prunus*, subgenus Amygadalus and has somatic chromosome number 2n= 16. 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.

For horticultural produce post harvest attributes and shelf life are very important which play important role in marketing and consumer preference. These attributes are influenced considerably by various factors such as cultivar, rootstock, horticultural practices and climaticconditions. Among them horticultural practices are of great value under the established orchards which may be amended for better post-harvest attributes and shelf life. Mineral nutrition is reported to influence the shelf life of fruits also and management of nutrients, particularly nitrogen and calcium are important in relation to storage quality of fruits **[1]** Nitrogen is the nutrient having single greatest effect on post harvestfruit quality **[2]**. Besides, calcium is another nutrient that plays important role in maintaining shelf life of fruits because an inverse relation exist between fruit tissue calcium level and rate of respiration. It was reported that the calcium maintains the cell wall structure in fruits by interacting with pectins in the cell wall to form calcium pectate which assists molecular bonding between constituent of the cell wall **[3]**. Calcium also increases cell turgor pressure and stabilizes the cell membrane **[4].** Sprays with calcium have been reported to be effective in extending shelf life of fruits by maintaining firmness, minimizing respiration, tissue breakdown and thus, reducing the fruit loss **[5].** As far as the source of calcium for foliar application is concerned, salts with low Deliquescence Relative Humidity (DRH) are readily absorbed through leaves and fruits. 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 **[6]**. Calcium chloride is also less expensive as compared to other forms of calcium compounds such as chelated calcium. The use of calcium chloride is also emphasized because the nitrate form leads to more vigorous shoot growth and divert xylem calcium away from fruits.

Thus, it may be postulated that variation in nitrogen doses and spraying of calcium chloride may modulate the post harvest attributes of fruits. These attributes impart the shelf life and are of great importance. The fruits with better post harvest attributes and shelf life fetch the higher prices. Moreover, such fruits may be transported to distant places and provide an opportunity to the growers to widen their market destinations. However, the information with context of the effects of varying levels of nitrogen fertilization through *neem* coated urea which is now available in market in abundance and having less nitrification, volatization and leaching losses **[7]** along with sprays with different concentrations of calcium chloride on post harvest attributes are very meager for peach under the agro-climatic conditions of north-western Himalayas. Therefore, this investigation was conducted on peach cv. Red June with three nitrogen regimes through neem coated area and three concentration of calcium chloride applied as foliar spray and its methodology and results pertaining to post harvest attributes of peach are being presented vide infra.

MATERIALS AND METHODS

The presentstudy was conducted at Krishi Vigyan Kendra (ICAR- VPKAS, Almora) Kafligair-Bageshwar (Uttarakhand) in two consecutive years i.e., 2016 and 2017. The experimental siteis 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 on 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), 500g N tree^{-1} +

0.5% Ca Cl_2 (T_4), 500g N $tree^{-1}$ + 1.0% Ca Cl_2 (T_5), 500g 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 I^{st} spray and third at 25 days after II^{nd} 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.

Bruiseless fruits of almost same maturity from all trees were separately selected, packed in corrugated fiber boxes and stored at ambient temperature. Separate boxes were used for different storage periods. Provision of five fruit per replication per treatment was made to record various observations at each storage interval. Observations pertaining to shelf life *viz*., physiological loss in weight (PLW), fruit firmness, titratable acidity, TSS and TSS - Acids ratio were recorded at 3, 6 and 8 day of harvesting by using the following procedure in both the years;

(i) Change in physiological loss in weight (PLW %)

Initial weight of five fruits per replication per treatment was taken on an electronic balance (Model MX-7210A) for each storage period. Thereafter fruits were brought out from the boxes on stipulated days i.e., 3^{rd}, 6^{th} and 8^{th} day and again weighed. At each storage interval the physiological loss in weight was calculated by applying the following formula **[8]**.

$$\text{PLW (\%)} = \frac{\text{Initial weight of fruits} - \text{Weight of fruits on stipulated day}}{\text{Initial weight of fruits}} \times 100$$

(ii) Change in fruit firmness (kg/mm^2)

Fruit firmness at harvest and for each storage period was measured by texture analyser, (Taxt Plus)] having following setting configuration;

Test mode-Compression, Pre test speed- 1.50 mm/ sec., Test speed- 2.00 mm/sec., Post test speed- 10.00 mm/ sec., Distance- 10.00 mm, Trigger type- Auto (Force), Trigger force- 0.0050 kg, Break mode- Off, Stop plot at- Start position, Tare mode- Auto, Advanced option- On.

Three readings at three different positions were taken for each fruit and their mean was computed. Similarly, mean firmness of five fruits was calculated for every replication under each treatment.

(iii) Change in total soluble solids (TSS ^{0}Brix)

Change in total soluble solids of fruits at harvest and at different storage periods was observed by taking the reading on digital refractometer (Extech Instrument, MI 722-01). Before taking sample appraisal, zero was set with distilled water and then for each sample a drop of juice was put at the designated place on the refractometer to get the reading.

(iv) Change in titratable acidity (%)

Titratable acidity of fruits was recorded at harvest and on all three storage dates. The acidity of fruits was estimated by titrating the fruit pulp extract with 0.1N NaOH using phenophthaline as indicator by applying the established procedure **[9]**. 10 g fruit sample was blend with small amount of distil water and filter into 100 ml volumetric flask. Final volume was made upto mark. Take 10 ml aliquot and titrate against 0.1N NaOH by using phenolphthalein as indicator. Mathematically, the titratable acidity was determined by using the following formula and was expressed as percentage malic acid (predominant acid in peach).

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value x 0.1 x 100 x equivalent weight of acid x 100}}{\text{Volume of aliquot taken x Weight of sample x 1000}}$$

by following the procedure as cited under 3.6.3.2 (ii).

(v) Change in TSS - Acid ratio

TSS - Acid ratio at harvest and at various storage periods was calculated by dividing the fruit TSS content with its corresponding acidity.

(vi) Organoleptic acceptability

A panel of five judges ranked the overall acceptability of fruits for each treatment based on taste, aroma and texture at harvest as well as at all three storage durations. A five point scale indicating the following quality preferences was used for evaluation **[10]**.

List 1 : Rating of fruits

Sl. No.	Quality preference	Marks
1.	Excellent	5
2.	Very good	4
3.	Good	3
4.	Fair	2
5.	Poor	1

RESULTS AND DISCUSSION

(i) Physiological loss in weight:

The data presented in Table 1 shows that different treatments, storage periods and their interaction had significant effect on physiological loss in weight of peach fruits.In both the years, for different storage periods, the maximum mean physiological loss in weight was estimated on 8th day, followed by 6th and 3rd day. Among different treatments, the highest mean physiological loss in weight was recorded under T_{10} (10.588% in first year and 10.467 in second year), however, the lowest mean physiological loss in weight was estimated with T_3 (5.586% in first year and 5.478% in second year) that had non significant variation with T_2 (5.603% in first year and 5.478 in second year). The interaction between treatments and storage periods showed maximum physiological loss in weight i.e., 17.040% and 16.840% in first year and second year, respectively with T_{10} on 8^{th} day of storage, while the minimum of 2.140% in first year was obtained under T_3 and 2.103% under T_2 in second year on 3^{rd} day (excluding uniform initial values of zero day for all the treatments). Moreover, T_2 and T_3 remained statistically at par at all storage periods during both the years.

In general, higher physiological loss in weight was observed with increasing nitrogen regimes and calcium chloride sprayswere effective in reducing the physiological loss in weight. Specifically, fruits from the trees that received lowest nitrogen dose (325 g per tree) and calcium chloride sprays @ 1.0 per cent and 1.5 per cent i.e. T_2 and T_3 had minimum PLW at all three storage intervals. Weight loss is a consequence of fruit dehydration due to physiological processes like, respiration and transpiration. The cuticle acts as a barrier to water loss and it was found that the changes in anatomy of fruits with respect to cuticle and epidermis under varying levels of nitrogen fertilization **[11]**. It was also mentioned that the postharvest water loss was higher in peach fruits from highest leaf nitrogen content (3.6 per cent) than fruits from lowest leaf nitrogen content (2.6 per cent), which must be the consequence of varying doses of nitrogen fertilization and might explain the present finding **[2]**.

Calcium applications are effective in membrane functionality and integrity maintenance with lower losses of phospholipids and proteins and reduced ion leakage **[12]** thus, it could be responsible for lower loss in fruit weight. Our present findings are also in accordance to **[13]** and **[14].**

(ii) Change in fruit firmness:

The data pertaining to the influence of various treatments on fruit firmness during storage at ambient conditions are presented in Table 2 reveals that the maximum mean fruit firmness for different storage periods was estimated at harvest that reduced with time and the minimum was recorded on 8^{th} day of storage. The mean fruit firmness for applied treatments showed significant differences with maximum (0.948 kg/mm^2 in first year and 0.949kg/mm^2 in second year) under T_2 and T_3.It is also evident that the fruit firmness did not differ significantly for different treatments at harvest but with the progressive storage the variation became significant.The treatment T_2 and T_3 possessed significantly higher fruit firmness than all other treatments at each storage interval.

The presented data indicated progressive decrease in fruit firmness with the advancement of storage period. It might be due to the water and metabolite losses incurred during transpiration and respiration processes. The decline in firmness during storage is obvious due to the conversion of insoluble fraction into the soluble fractions, degradation processes occurring in the fruit because of respiration and changes in the cell wall polysaccharides. Less water and metabolite lost under superior treatments could possibly lead to retain comparatively higher fruit firmness. The thicker cuticle of fruits under low nitrogen fertilized nectarine trees resulted in less water loss **[11]**, which might explain the fruit firmness maintaining ability of treatments under the lowest nitrogen regime which reduced with increasing nitrogen levels.

The role of calcium in maintaining fruit firmness is very crucial because it is structural component of cell wall. It was reported that the calcium maintains the cell wall structure in fruits by interacting with pectins in the cell wall to form calcium pectate which assists molecular bonding between constituent of the cell wall **[3]**, this might elucidate the positive effects of calcium chloride sprays on maintaining the fruit firmness. The beneficial effects of foliar application of calcium chloride on retaining the fruit firmness during storage were also documented in nectarine **[10]**.

Table 1 Response of N regimes through neem coated urea and foliar application of calcium chloride on physiological loss in weight (PLW %) of fruits during storage at ambient condition in peach cv. Red June.

Treatment symbols	Physiological loss in fruit weight (PLW%), First year Storage period (Days)					Physiological loss in fruit weight (PLW%), Second year Storage period (Days				
	0	**3**	**6**	**8**	**Mean (Treatments)**	**0**	**3**	**6**	**8**	**Mean (Treatments)**
T_1	0.000 $^{a*D\#}$	2.723^{cC}	7.163 ^{dB}	11.440^{eA}	**7.109 $^{e\$}$**	0.000 $^{a*D\#}$	2.673^{bcC}	7.033^{eB}	11.227^{eA}	**6.978 $^{e\$}$**
T_2	0.000^{aD}	2.147^{dC}	5.647^{eB}	9.017^{fA}	**5.603 ^{f}**	0.000^{aD}	2.103^{cC}	5.530^{fB}	8.800^{fA}	**5.478 ^{f}**
T_3	0.000^{aD}	2.140^{dC}	5.630^{eB}	8.987^{fA}	**5.586 ^{f}**	0.000^{aD}	2.107^{cC}	5.540^{fB}	8.787^{fA}	**5.478 ^{f}**
T_4	0.000^{aD}	3.477^{bC}	9.143^{bB}	14.603^{cA}	**9.074 ^{c}**	0.000^{aD}	3.420^{bC}	8.993^{cB}	14.363^{cA}	**8.926 ^{c}**
T_5	0.000^{aD}	2.983^{bcC}	7.847^{cB}	12.530^{dA}	**7.787 ^{d}**	0.000^{aD}	2.933^{bC}	7.713 ^{dB}	12.320^{dA}	**7.656 ^{d}**
T_6	0.000^{aD}	2.950^{bcC}	7.757^{cB}	12.387^{dA}	**7.698 ^{d}**	0.000^{aD}	2.900^{bC}	7.627 ^{dB}	12.177^{dA}	**7.568 ^{d}**
T_7	0.000^{aD}	3.837^{abC}	10.090^{aB}	16.113^{bA}	**10.013 ^{b}**	0.000^{aD}	3.773^{abC}	9.927^{aB}	15.847^{bA}	**9.849 ^{b}**
T_8	0.000^{aD}	3.513^{abC}	9.240^{bB}	14.757^{cA}	**9.170 ^{c}**	0.000^{aD}	3.460^{abC}	9.100^{bcB}	14.530^{cA}	**9.030 ^{c}**
T_9	0.000^{aD}	3.493^{abC}	9.187^{bB}	14.670^{cA}	**9.117 ^{c}**	0.000^{aD}	3.453^{abC}	9.083^{bcB}	14.507^{cA}	**9.014 ^{c}**
T_{10}	0.000^{aD}	4.057^{aC}	10.667^{aB}	17.040^{aA}	**10.588 ^{a}**	0.000^{aD}	4.010^{aC}	10.550^{aB}	16.840^{aA}	**10.467 ^{a}**
Mean (Storage periods)	**0.000$^{d\Psi}$**	**3.132^{c}**	**8.237^{b}**	**13.154^{a}**		**0.000$^{d\Psi}$**	**3.083^{c}**	**8.110^{b}**	**12.940^{a}**	

	Treatment	Storage	Treatment x Storage	Treatment	Storage	Treatment x Storage
CD (0.05)	0.328	0.180	0.569	0.331	0.181	0.574
SE (m) ±	0.116	0.063	0.200	0.117	0.064	0.202

*Values within columns having common lowercase letter are statistically *at par*.
#Values within rows having common uppercase letter are statistically *at par*.
$Mean values of treatments having common bold lowercase letter are statistically *at par*.
ΨMean value of storage periods having common italic bold lowercase letter are statistically *at par*.

Table 2 Response of N regimes through neem coated urea and foliar application of calcium chloride on fruit firmness (kg/mm^2) during storage at ambient condition in peach cv. Red June.

Treatment symbols	Fruit firmness (kg/mm^2), First year Storage period (Days)					Fruit firmness (kg/mm^2), Second year Storage period (Days				
	0	**3**	**6**	**8**	**Mean (Treatments)**	**0**	**3**	**6**	**8**	**Mean (Treatments)**
T_1	1.166$^{a*A\#}$	1.085^{bB}	0.759^{bC}	0.460^{bD}	**0.868$^{b\$}$**	1.167$^{a*A\#}$	1.086^{bB}	0.760^{bC}	0.461^{bD}	**0.869$^{b\$}$**
T_2	1.178^{aA}	1.139^{aB}	0.855^{aC}	0.619^{aD}	**0.948^{a}**	1.179^{aA}	1.140^{aB}	0.856^{aC}	0.620^{aD}	**0.949^{a}**
T_3	1.176^{aA}	1.140^{aB}	0.855^{aC}	0.620^{aD}	**0.948^{a}**	1.177^{aA}	1.141^{aB}	0.856^{aC}	0.621^{aD}	**0.949^{a}**
T_4	1.169^{aA}	0.823^{dB}	0.535^{cC}	0.348^{cD}	**0.719^{d}**	1.170^{aA}	0.825^{dB}	0.537^{cC}	0.350^{cD}	**0.721^{d}**
T_5	1.178^{aA}	0.999^{cB}	0.749^{bC}	0.443^{bD}	**0.842^{c}**	1.179^{aA}	1.000^{cB}	0.751^{bC}	0.444^{bD}	**0.844^{c}**
T_6	1.170^{aA}	1.000^{cB}	0.750^{bC}	0.454^{bD}	**0.844^{c}**	1.169^{aA}	1.001^{cB}	0.752^{bC}	0.455^{bD}	**0.844^{c}**
T_7	1.165^{aA}	0.725^{eB}	0.471^{dC}	0.188^{dD}	**0.637^{e}**	1.165^{aA}	0.730^{eB}	0.473^{dC}	0.189^{dD}	**0.639^{e}**
T_8	1.164^{aA}	0.813^{dB}	0.529^{cC}	0.331^{cD}	**0.709^{d}**	1.163^{aA}	0.815^{dB}	0.531^{cC}	0.332^{cD}	**0.710^{d}**
T_9	1.167^{aA}	0.818^{dB}	0.532^{cC}	0.345^{cD}	**0.716^{d}**	1.166^{aA}	0.819^{dB}	0.533^{cC}	0.346^{cD}	**0.716^{d}**
T_{10}	1.170^{aA}	0.688^{fB}	0.447^{eC}	0.108^{eD}	**0.603^{f}**	1.172^{aA}	0.689^{fB}	0.448^{dC}	0.109^{eD}	**0.605^{f}**
Mean (Storage periods)	**1.170$^{a\Psi}$**	**0.923^{b}**	**0.648^{c}**	**0.392^{d}**		**1.171$^{a\Psi}$**	**0.924^{b}**	**0.650^{c}**	**0.393^{d}**	

	Treatment	Storage	Treatment x Storage	Treatment	Storage	Treatment x Storage
CD (0.05)	0.012	0.007	0.023	0.012	0.007	0.023
SE (m) ±	0.004	0.003	0.008	0.004	0.003	0.008

*Values within columns having common lowercase letter are statistically *at par*.
#Values within rows having common uppercase letter are statistically *at par*.
$Mean values of treatments having common bold lowercase letter are statistically *at par*.
ΨMean value of storage periods having common italic bold lowercase letter are statistically *at par*.

(iii) Change in total soluble solids:

The data presented in table 3 elucidate that the applied treatments, storage periods and their interaction significantly influenced the TSS content during storage in first year and second year. The minimum mean TSS for storage periods was recorded at harvest i.e., 0 day (10.747^{0}B in first year and 10.637 ^{0}B in second year) which increased progressively till 6th day of storage (11.813^{0}B and11.643 ^{0}B in first year and second year, respectively) and partially declined thereafter. The maximum mean TSS for treatments was observed under T_2 (12.025^{0}B in first year and11.900 ^{0}B in second year) followed by T_3 and T_1, whereas, the minimum was estimated with T_{10}(10.950^{0}B in first year and10.775 ^{0}B in second year).The interaction of treatments and storage periods for first as well as second yearof experiment(table 3) demonstrated that the maximum TSS was found under T_2 on 8th day of storage(12.533 ^{0}B in first year and 12.433 ^{0}B in second year), while the minimum was recorded with T_{10} at harvest. The maximum TSS at harvest (0 day) was measured under T_2 that was statistically *at par* with T_3.

The increase in TSS content during storage might be due to the breakdown of complex polymers into simple substances by hydrolytic enzymes during ripening. The decrease in TSS content beyond 6th day of storage indicates the utilization of sugars in respiration and other metabolic activities. However, T_1, T_2 and T_3 which were under lowest nitrogen regime and received calcium chloride sprays at different concentrations did not show this declining trend and increase in TSS content was observed on 8th day of storage, probably due to the availability of adequate sugar and other metabolites and reduced rate of respiration. Higher nitrogen fertilization led to elevated respiration rate and ethylene production during storage **[15]**, this possibly exhausted the metabolites and comparatively less TSS content was recorded under increased levels of nitrogen fertilization. Thus, it may be implicated that lower rate of physiological processes and availability of sugar and other metabolites in treatments under lowest nitrogen regime with calcium chloride sprays especially @ 1.0 and 1.5 per cent manifested in better TSS content during the course of storage. Similar benefits of foliar calcium application were also observed **[14]**.

(iv) Change in titratable acidity:

The effects of various treatments on change in titratable acidity during storage at ambient conditions are presented in Table 4. In both of the years significant effects of applied treatments, storage periods and their interaction were observed on titratable acidity. During both the years of experiment, the maximum mean titratable acidity for storage periods was estimated at harvest i.e., 0 day (1.012% in first year and 1.029% in second year) which reduced significantly with the advancement of storage period and the minimum of 0.792% and 0.803%was recorded on 8th day in first year and second year, respectively. The maximum mean titratable acidity for treatments was observed under T_{10} (0.983% in first year and 0.993% in second year) followed by T_9 and, while the minimum was found with T_3. The interaction between treatment and storage period showed that all the treatments possessed significantly higher titratable acidity at harvest (0 day) with maximum under T_{10} (1.080% and 1.090% in first year and second year, respectively) and minimum under T_2, which decreased significantly for each storage period. Treatment T_{10} retained maximum titratable acidity during whole storage period, while the minimum was observed with T_3 on 3rd and 6th day of storage.

Table 3Response of N regimes through neem coated urea and foliar application of calcium chloride on total soluble solids ^{0}Brix (TSS ^{0}B) during storage at ambient condition in peach cv. Red June in.

Treat ment symbols	Total soluble solids ^{0}Brix (TSS ^{0}B), First year, Storage period (Days)					Total soluble solids ^{0}Brix (TSS ^{0}B), Second year, Storage period (Days				
	0	**3**	**6**	**8**	**Mean (Treatments)**	**0**	**3**	**6**	**8**	**Mean (Treatments)**
T_1	$11.067^{b*D\#}$	11.633^{bC}	11.867^{cdB}	12.033^{cA}	$\mathbf{11.650^{c\$}}$	$10.933^{b*C\#}$	11.433^{cB}	11.767^{cA}	11.867^{cA}	$\mathbf{11.500^{c\$}}$
T_2	11.267^{aC}	11.867^{aB}	12.433^{aA}	12.533^{aA}	$\mathbf{12.025^{a}}$	11.100^{aD}	11.767^{aC}	12.300^{aB}	12.433^{aA}	$\mathbf{11.900^{a}}$
T_3	11.167^{aD}	11.800^{aC}	12.133^{bB}	12.333^{bA}	$\mathbf{11.858^{b}}$	11.000^{abD}	11.633^{bC}	11.933^{bB}	12.200^{bA}	$\mathbf{11.692^{b}}$
T_4	10.533^{dD}	11.233^{dC}	11.733^{dA}	11.467^{eB}	$\mathbf{11.242^{f}}$	10.433^{eC}	11.000^{eB}	11.467^{dA}	11.367^{eA}	$\mathbf{11.067^{f}}$
T_5	10.900^{cC}	11.500^{cB}	12.067^{bA}	11.567^{eB}	$\mathbf{11.509^{d}}$	10.800^{cC}	11.333^{cB}	11.867^{bcA}	11.433^{deB}	$\mathbf{11.358^{d}}$
T_6	10.700^{dD}	11.300^{dC}	11.967^{cA}	11.700^{dB}	$\mathbf{11.417^{e}}$	10.600^{dD}	11.167^{dC}	11.767^{cA}	11.533^{dB}	$\mathbf{11.267^{e}}$
T_7	10.367^{eD}	11.000^{efC}	11.433^{fA}	11.233^{gB}	$\mathbf{11.008^{h}}$	10.300^{fD}	10.867^{fC}	11.333^{eA}	11.067^{gB}	$\mathbf{10.892^{g}}$
T_8	10.600^{dD}	11.067^{eC}	11.567^{dA}	11.333^{fgB}	$\mathbf{11.142^{g}}$	10.500^{dD}	10.967^{eC}	11.433^{deA}	11.233^{fB}	$\mathbf{11.033^{f}}$
T_9	10.533^{dD}	11.067^{eC}	11.600^{dA}	11.367^{fB}	$\mathbf{11.142^{g}}$	10.467^{dD}	10.900^{eC}	11.467^{dA}	11.233^{fB}	$\mathbf{11.017^{f}}$
T_{10}	10.333^{eD}	10.933^{fC}	11.333^{fA}	11.200^{gB}	$\mathbf{10.950^{i}}$	10.233^{fC}	10.733^{gB}	11.100^{fA}	11.033^{gA}	$\mathbf{10.775^{h}}$
Mean (Storage periods)	$\mathbf{10.747^{d\text{ɏ}}}$	$\mathbf{11.340^{c}}$	$\mathbf{11.813^{a}}$	$\mathbf{11.677^{b}}$		$\mathbf{10.637^{d\text{ɏ}}}$	$\mathbf{11.180^{c}}$	$\mathbf{11.643^{a}}$	$\mathbf{11.540^{b}}$	

	Treatment	Storage	Treatment x Storage	Treatment	Storage	Treatment x Storage
CD (0.05)	0.060	0.038	0.120	0.062	0.039	0.123
SE (m) ±	0.021	0.013	0.043	0.022	0.014	0.044

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ɏMean value of storage periods having common italic bold lowercase letter are statistically *at par*.

Table 4 Response of N regimes through neem coated urea and foliar application of calcium chloride on titratable acidity (%) during storage at ambient condition in peach cv. Red June.

Treatment symbols	Titratable acidity (%), First year Storage period (Days) 0	3	6	8	Mean (Treatments)	Titratable acidity (%), Second year Storage period (Days 0	3	6	8	Mean (Treatments)
T_{1}	0.980$^{ef*A\#}$	0.890^{fB}	0.760^{eC}	0.713^{eD}	**0.836 $^{h\$}$**	0.993 $^{d*A\#}$	0.940^{deB}	0.803^{cC}	0.763^{cD}	**0.875 $^{e\$}$**
T_{2}	0.953^{fA}	0.923^{eB}	0.783^{dC}	0.747^{dD}	**0.852 ^{g}**	0.970^{eA}	0.900^{fB}	0.770^{dC}	0.723^{dD}	**0.841 ^{f}**
T_{3}	0.963^{fA}	0.857^{gB}	0.743^{fC}	0.723^{eD}	**0.823 ^{i}**	0.973^{eA}	0.867^{gB}	0.753^{eC}	0.733^{dD}	**0.832 ^{f}**
T_{4}	0.993^{eA}	0.983^{cB}	0.830^{bC}	0.807^{bD}	**0.903 ^{d}**	1.027^{cA}	0.927^{eB}	0.787^{dC}	0.757^{cD}	**0.875 ^{e}**
T_{5}	0.987^{eA}	0.930^{eB}	0.793^{cC}	0.753^{cdD}	**0.866 ^{f}**	1.003^{dA}	0.950 ^{dB}	0.813^{cC}	0.773^{cD}	**0.885 ^{e}**
T_{6}	1.017^{dA}	0.940^{deB}	0.803^{cC}	0.763^{cD}	**0.881 ^{e}**	1.063^{abA}	0.960 ^{dB}	0.853^{bC}	0.823^{bD}	**0.925 ^{d}**
T_{7}	1.063^{bA}	1.003^{bB}	0.843^{bC}	0.820^{bD}	**0.932 ^{c}**	1.077^{aA}	1.013^{bB}	0.847^{bC}	0.830^{bC}	**0.942 ^{c}**
T_{8}	1.030^{cA}	0.950 ^{dB}	0.843^{bC}	0.810^{bD}	**0.908 ^{d}**	1.043^{bcA}	0.987^{cB}	0.920^{aC}	0.897^{aD}	**0.962 ^{b}**
T_{9}	1.053^{bA}	1.017^{abB}	0.910^{aC}	0.887^{aD}	**0.967 ^{b}**	1.050^{bA}	1.027^{aB}	0.840^{bC}	0.817^{bD}	**0.934 ^{cd}**
T_{10}	1.080^{aA}	1.030^{aB}	0.923^{aC}	0.900^{aD}	**0.983 ^{a}**	1.090^{aA}	1.040^{aB}	0.933^{aC}	0.910^{aD}	**0.993 ^{a}**
Mean (Storage periods)	**1.012$^{a\psi}$**	**0.952^{b}**	**0.823 ^{c}**	**0.792^{d}**		**1.029 $^{a\psi}$**	**0.961^{b}**	**0.832^{c}**	**0.803^{d}**	

	Treatment	Storage	Treatment x Storage	Treatment	Storage	Treatment x Storage
CD (0.05)	0.009	0.005	0.017	0.010	0.007	0.021
SE (m) ±	0.003	0.002	0.006	0.004	0.002	0.007

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$^{\psi}$Mean value of storage periods having common italic bold lowercase letter are statistically *at par*.

The decrease in titratable acidity in all the treatments with the advancement of storage period is accompanied by the ripening and respiration processes, might be due to the utilization of organic acids in respiration. Our present findings showing the minimum titratable acidity under lowest nitrogen doses that increased with further increment in nitrogen levels are in agreement with the previous reports **[16]**. The increase in fruit acidity with higher doses of nitrogen was due to increased synthesis and translocation of organic acids in the fruits **[17]**. The calcium chloride sprays especially under lowest nitrogen regime resulted in less titratable acidity at all storage intervals and it might be due to the low respiration rate that perhaps reduced the possibility of utilization of organic acids in respiration and some acids might change in sugars.

(v) Change in TSS - Acid ratio:

The first as well as second year observations revealed significant change in TSS - Acid ratio for storage periods, treatments and their interaction (Table 5). The minimum mean TSS- Acid ratio (10.650 in first year and 10.365 in second year) for storage periods was noted at harvest (0 day) which increased significantly at each storage interval and reached at maximum on 8^{th} day of storage with the value of 14.877 and 14.511 in first year and second year, respectively. In first year, the maximum value of mean TSS - Acid ratio for treatments was recorded under T_3 (14.682) followed by T_1 (14.251) and T_2 (14.067) and in second year it was maximum under T_2 (14.440) followed by T_3 (13.886) and T_1 (13.589). The interaction of treatment and storage showed that in first year the maximum TSS - Acid ratio was recorded with T_3 (17.610) on 8^{th} day of storage and in second year, it was maximum under T_2 (17.223), while, during both the years the minimum was estimated at harvest (0 day) under T_{10} (9.570 in first year and 9.393 in second year).

TSS- Acid ratio is calculated by dividing the TSS content with corresponding values of titratable acidity and its higher score leads better organoleptic preferences. The increase in TSS - Acid ratio with the advancement of storage period was also reported in peach **[12]**, which might be because of the increase in TSS and decrease in titratable acidity during storage. The elevated TSS - Acid ratio found under the treatments at lowest nitrogen regime (375 g N per tree) with calcium chloride sprays (especially at 1.0 and 1.5%

Table 5 Response of N regimes through neem coated urea and foliar application of calcium chloride on TSS- Acid ratio during storage at ambient condition in peach cv. Red June in.

Treat ment symbols	TSS - Acid ratio, First year Storage period (Days) 0	3	6	8	Mean (Treatments)	TSS - Acid ratio, Second year Storage period (Days 0	3	6	8	Mean (Treatments)
T_1	11.313$^{b*C\#}$	13.433^{aB}	16.250^{aA}	16.007^{bcA}	**14.251$^{b\$}$**	11.097$^{ab*D\#}$	12.383^{bC}	14.873^{bB}	16.003^{bA}	**13.589$^{c\$}$**
T_2	11.820^{aD}	12.733^{bC}	15.320^{bB}	16.393^{bA}	**14.067^{b}**	11.447^{aD}	13.087^{aC}	16.003^{aB}	17.223^{aA}	**14.440^{a}**
T_3	11.397^{abD}	13.343^{aC}	16.377^{aB}	17.610^{aA}	**14.682^{a}**	11.073^{abC}	13.087^{aB}	15.780^{aA}	15.603^{bcA}	**13.886^{b}**
T_4	10.427^{cdC}	11.533^{dB}	14.150^{dA}	14.240^{dA}	**12.588^{d}**	9.877^{cdC}	11.423^{cB}	13.410^{dA}	13.660^{dA}	**12.093^{e}**
T_5	11.143^{bcD}	12.380^{bC}	14.797^{cB}	15.780^{cA}	**13.525^{c}**	10.897^{bD}	12.040^{bC}	14.480^{cB}	15.360^{cA}	**13.194^{d}**
T_6	10.850^{cC}	12.240^{cB}	15.290^{bA}	15.697^{cA}	**13.519^{c}**	10.327^{cC}	12.057^{bB}	14.980^{bA}	15.267^{cA}	**13.158^{d}**
T_7	9.843^{eC}	10.853^{gB}	12.573^{fA}	12.693^{eA}	**11.491^{f}**	9.810^{dC}	10.757^{dB}	13.560^{dA}	13.543^{dA}	**11.918^{f}**
T_8	10.233^{dC}	11.687^{eB}	13.730^{eA}	14.007^{dA}	**12.414^{d}**	10.037^{cC}	11.153^{cdB}	13.660^{dA}	13.947^{dA}	**12.199^{e}**
T_9	9.907^{eC}	11.063^{fB}	13.767^{eA}	13.883^{dA}	**12.155^{e}**	9.690^{dC}	10.583^{dB}	12.330^{eA}	12.363^{eA}	**11.242^{g}**
T_{10}	9.570^{eC}	10.683^{gB}	12.287^{fA}	12.463^{eA}	**11.251^{g}**	9.393^{dC}	10.320^{dB}	11.903^{eA}	12.140^{eA}	**10.939^{h}**
Mean (Storage periods)	**10.650$^{d\Psi}$**	**11.995^{c}**	**14.454^{b}**	**14.877^{a}**		**10.365$^{d\Psi}$**	**11.689^{c}**	**14.098^{b}**	**14.511^{a}**	

	Treatment	Storage	Treatment x Storage	Treatment	Storage	Treatment x Storage
CD (0.05)	0.216	0.136	0.431	0.233	0.147	0.465
SE (m) ±	0.076	0.048	0.153	0.082	0.052	0.165

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ΨMean value of storage periods having common italic bold lowercase letter are statistically *at par*.

Table 6 Response of N regimes through neem coated urea and foliar application of calcium chloride on organoleptic acceptability during storage at ambient condition in peach cv. Red June.

Treatment symbols	Organoleptic acceptability (Scale of 1-5), First year – Storage period (Days) 0	3	6	8	Mean (Treatments)	Organoleptic acceptability (Scale of 1-5), Second year – Storage period (Days 0	3	6	8	Mean (Treatments)
T_1	4.333 $^{a*AB\#}$	4.667^{abA}	3.667^{bB}	2.667^{bC}	**3.833$^{bc\$}$**	4.000 $^{a*A\#}$	4.333^{aA}	3.333^{bB}	2.333^{cC}	**3.500 $^{b\$}$**
T_2	4.333^{aAB}	5.000^{aA}	4.667^{aAB}	4.000^{aB}	**4.500 ^{a}**	4.000^{aB}	4.667^{aA}	4.333^{aAB}	3.667^{aB}	**4.167 ^{a}**
T_3	4.333^{aAB}	5.000^{aA}	4.667^{aAB}	4.000^{aB}	**4.500 ^{a}**	4.333^{aA}	4.667^{aA}	4.333^{aA}	3.667^{aB}	**4.250 ^{a}**
T_4	4.333^{aA}	4.000^{bcA}	3.667^{bA}	2.333^{bB}	**3.583 ^{c}**	4.000^{aA}	3.667^{bAB}	3.333^{bB}	2.000^{cC}	**3.250 ^{c}**
T_5	4.333^{aA}	4.667^{abA}	4.000^{abAB}	3.333^{abB}	**4.083 ^{b}**	4.000^{aA}	4.333^{aA}	3.667^{bB}	3.000^{bC}	**3.750 ^{b}**
T_6	4.333^{aAB}	4.667^{abA}	3.667^{bB}	3.333^{abB}	**4.000 ^{b}**	4.000^{aA}	4.333^{aA}	3.333^{bB}	3.000^{bB}	**3.667 ^{b}**
T_7	4.000^{aA}	3.333^{cAB}	2.667^{cB}	1.000^{cC}	**2.750 ^{d}**	3.667^{aA}	3.000^{cB}	2.333^{cC}	1.333^{dD}	**2.583 ^{d}**
T_8	4.000^{aA}	3.667^{cAB}	3.000^{bcB}	1.333^{cC}	**3.000 ^{d}**	3.667^{aA}	3.333^{bcA}	2.667^{cB}	1.333^{dC}	**2.750 ^{d}**
T_9	4.000^{aA}	3.667^{cAB}	3.000^{bcB}	1.333^{cC}	**3.000 ^{d}**	3.667^{aA}	3.333^{bcA}	2.667^{cB}	1.333^{dC}	**2.750 ^{d}**
T_{10}	4.000^{aA}	2.667 ^{dB}	1.333^{dC}	1.000^{cC}	**2.250 ^{e}**	3.667^{aA}	2.333 ^{dB}	1.333^{dC}	1.000^{dC}	**2.083 ^{e}**
Mean (Storage periods)	**4.200$^{a\psi}$**	**4.133^{a}**	**3.434^{b}**	**2.433^{c}**		**3.900$^{a\psi}$**	**3.800^{a}**	**3.133^{b}**	**2.267 ^{c}**	

	First year: Treatment	Storage	Treatment x Storage	Second year: Treatment	Storage	Treatment x Storage
CD (0.05)	0.356	0.225	0.713	0.313	0.198	0.626
SE (m) ±	0.126	0.080	0.253	0.111	0.070	0.222

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ᵠMean value of storage periods having common italic bold lowercase letter are statistically *at par*.

concentration) was due to prevailing higher TSS and lower titratable acidity during storage at ambient conditions in these treatments.Similar to our findings, the positive effect of calcium chloride sprays on TSS - Acid ratio was also documented **[17]**.

(vi) Organoleptic acceptability:

The first as well as second year study (Table 6) showed that the maximum mean organoleptic acceptability for storage periods was observed at zero day with a score of 4.200 in first year and 3.900 in second year. It reduced non significantly at 3rd day but thereafter the differences became significant and the minimum score was recorded on 8th day. In first year, the maximum mean organoleptic acceptability for treatments with 4.500 score was found under T_2 and T_3 both and in second year it was maximum under T_3 (4.250) that varied non significantly from T_2 (4.167). The interaction of treatments and storage periods showed the maximum organoleptic acceptability on 3rd day under T_2 and T_3 with a score of 5.000 in first year and 4.667 in second year, whereas the minimum was found under T_{10} on 8th day (1.000) during both the years.

It was also observed that all the treatments on zero day possessed statistically *at par* organoleptic acceptability and the differences became significantly visible during storage. Treatment T_2 and T_3 consistently maintained higher organoleptic acceptability score during each storage interval with quality preference as excellent on 3rd day, above very good on 6th day and very good on 8th day, while T_{10} ranked last on similar days of storage. However, on 8th day of storage the minimum score of T_{10} was found to be statistically *at par* with T_7, T_8 and T_9.

The organoleptic acceptability data indicate that the lowest nitrogen regime resulted in better organoleptic acceptability during storage and increase in nitrogen levels led to inferior quality preference. Moreover, sprays of calcium chloride above 0.5 per cent concentration imparted better storage quality. The organoleptic acceptability is the manifestation of compiled quality attributes estimated during the course of storage. Therefore, the observations recorded and discussed above might possibly explain the findings for organoleptic acceptability. Our results are also in accordance with the findings of previous authors **[10]**.

Conclusion:

An array of discussion made vide supra suggests that the post harvest attributes of peach may be amended with different nitrogen regimes and calcium chloride sprays. The better efficiency and durable availability of nitrogen through *neem* coated urea resulted in lowering the nitrogen fertilization dosesfrom present recommendation of 500 g per tree to 375 g per tree to get best post harvest attributes and maximum shelf life at ambient conditions. Moreover, at this nitrogen regime of 375 g per tree, three sprays of calcium chloride @ 1.0% and 1.5% were further improved the shelf life of peach fruits. An increase in the concentration of calcium chloride led to increase the input cost. Hence, it will be judicious to apply calcium chloride @ 1.0%.

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