***Original Research Article***

# Effect of calcium chloride on fruit quality and shelf life of RedVelox apple .


Abstract

Jammu and Kashmir enjoys a vital place among temperate fruits due to its agro-climatic conditions. The only apple variety Ambri is indigenous to Kashmir while as all other varieties were introduced from outside. The famous Delicious varieties were introduced by Samuel Nicholar Stokes a resident of USA in 1918 at Kotgarth in Shimla hills. Calcium (Ca2+) has been extensively reviewed as both an essential element and its potential role in maintaining both pre and postharvest quality of fruit crops.Management of crop production which provides fruit at harvest with mineral nutrient levels sufficiently high and in balance that the fruit have a low risk of disorders and have optimal storage properties. Pre harvest spray at the highest concentration 0.3 % combined with dip at 8.0% of CaCl2 had a significant effect on fruit length, diameter which in turn significantly affected fruit weight and size in Red Velox apple.Foliar sprays of calcium(0.3%)in combination with fruit dip (8.0%) significantly increased TSS, fruit firmness and reduced weight loss during storage.The importance of calcium in apple fruit is its role in contributing to the maintenance of optimum quality during postharvest storage and fruit ripening. This role is seen directly in the prevention of specific disorders such as bitter pit, and in relationships between calcium and more general quality properties such as flesh firmness. Calcium application maintains cell turgor, membrane integrity, tissue firmness and delays membrane lipid catabolism, extending storage life of fresh fruits.



**Key words**: Apple, Red Velox, Fruit Size, Yield, Firmness, TSS.


**Introduction**:

The modern apple is believed to have been derived from south western Asia where the mix of native *Malus* species could have given fruits of good size and quality, attractive to man. Most of our domesticated cultivars derive from *M. pumila* Mill., the common apple of Europe. These large fruited derivatives have been under selection and improvement by man for thousands of years, so it is not possible to know their origin with certainty.The first attempt towards growing apple trees deliberatively may have begun in the middle east or south eastern Europe with technique being spread by Greeks and Romans (Beltitude,1983).. In India apple is grown in the states of Jammu and Kashmir, Himachal Pradesh, hills of Uttar Pradesh and North- eastern states. It is not known when the apple was introduced in cooler parts of India but evidence showed its presence in Agra in 1632.However, Jammu and Kashmir enjoys a vital place due to its agro-climatic conditions. The only apple variety Ambri is indigenous to Kashmir while as all other varieties were introduced from outside. The famous Delicious varieties were introduced by Samuel Nicholar Stokes a resident of USA in 1918 at Kotgarth in Shimla hills.By the end of the thirteenth century, many named cultivars were known, and since then we get the names of Pearmain and Costard. Apples in those days arose either as selected wildings from the hedgerow or were grown from seeds of selected apples. It was not until Thomas Andrew Knight (1759-

1835) began creating new apples by deliberate hybridization that fruit breeding on a scientific basis began. Knight was the first to apply the discovery of sex in plants to practical ends.

Apple fruits are commonly stored for long periods to fetch reasonable prices and circumvent the glut in the market. . Fruit quality and nutritional value decreases during storage. There are a number of factors that determine the quality of fruit both at harvest and during storage. Among the various factors nutrients play an important role in maintaining the quality of fruit.Calcium is considered as one of the most important minerals determining the quality of fruit since it is required for cell elongation and cell division (Rizzi and Abruzzese 1990). The storage disorders in fruits appear closely related to low calcium content in tissues (Shear 1975). Although, higher amounts of calcium in soils of apple growing regions have been reported due to calcareous nature of parent material and precipitation of lime in lower depths yet their availability to the plant is limited due low pH, drought condition and nutrient interaction. Therefore, foliar feeding provides best possibility to supplement the calcium requirement. In recent years, widespread deficiency of calcium has been observed in apple orchards and orchardists do not spray of calcium which seems to be one of the factors that result in deficiency of calcium in the fruits. Therefore, the present investigations were undertaken by using calcium chloride as pre harvest spray and post harvest dip in apple to assess its effect on growth, yield, fruit quality, and shelf-life of fruits during storage.

## Materials and Methods:

The present investigation on "Shelf life studies of Red Velox" apple was executed at Faculty of Agriculture Wadura , SKUAST –K .The trees of cv. Red Velox having uniform growth and stature were selected for the study . The treatments comprised of preharvest spray of $CaCl_2$ (0.0, 0.2, 0.3%) sprayed twice at fifteen days interval commenced from the first week of July and post harvest dip (0.0, 4.0, 8.0 %) at the time of harvest and their combinations. The experiment was laid out in factorial Randomized Block Design and the treatments were replicated thrice. The fruit was harvested at optimum maturity and was analyzed for different parameters while as the fruit sample was also put to storage for a period of one and two months. The fruit length and diameter was recorded with the help of Vernier's calliper. The fruit firmness was measured with the help of Effegi model penetrometer FT3-27 with 11mm probe. The soluble solids content was determined with the help of Erina make Japan refractometer (0-32 % range). The total tritable acidity was determined by titrating the juice with N/10 NaOH using phenolphthalein as an indicator. The results were expressed as percentage of malic acid. The data on firmness ,TSS and physiological loss in weight was determined at harvest and one and two weeks after storage.

## Results and Discussion:

Preharvest spray of calcium chloride followed by post harvest dip was significant in increasing the fruit length ,diameter during both the years of investigation(Table 1). Preharvest spray at the highest concentration 0.3 % combined with dip at 8.0% of CaCl2 resulted in the maximum fruit length to the tune of 5.70 cm and 5.83 cmduring first and second year. Similarly, calcium chloride at 0.2 % plus 0.4% dip indicated fruit length of 5.69 cm and 5.77cm. At highest concentration of both pre and post harvest treatments the fruit attained maximum diameter of 5.95 cm and 5.97cm during first and second year. However, fruit length and fruit diameter was lowest under control. Results showed that preharvest spray and dipped fruits in Ca solution at different concentrations enhanced fruit weight and volume in comparison with control. Maximum fruit weightoccurred in treatments that received calcium chloride (0.3%) and fruit dip (8.0%) while as, lowest fruit weight was recorded in control (Table 1). Calcium applications at highest level combined with fruit dip also registered maximum fruit volume of

156.66 $cm^3$and 165.39 $cm^3$ in first and second year respectively. Kadir, (2005) also reported the improvement in fruit size, weight and appearance of apple fruits with foliar sprays of calcium chloride. It was further reported that increase in fruit weight and size was attributed to a linear increase in calcium concentrations of fruits and leaves due to calcium applications. Mursec, (2004) reported that foliar spray of calcium had a significant effect on the Ca content of the apple fruit, which in turn significantly affected fruit weight and size. In general, apple fruits recorded an increase in yield with the treatment of nutrient application compared to untreated fruits (Table -1).The results indicate that maximum fruit yield was noticed in 0.3 % Ca spray combined with fruit dip at 8.0% while minimum yield was recorded in control. Fruit yield of 12.83 kg/tree was observed in the first year followed by 12.91 kg/tree in the following year with 0.3% spray combined with fruit dipped in 8.0% CaCl2 .The lowest fruit yield of 9.45kg/tree and 9.85kg/tree was recorded under control during first and second year respectively. Calcium chloride had a beneficial effect on the improvement of fruit yield. These results are in agreement with those reported by Asgharzade et al., (2012) and Jafarpour and Poursakhi, (2011) who claimed that foliar sprays of calcium concentration increased fruit yield in apple.

The results depicted in table -2 revealed that fruit firmness increased with increasing the calcium chloride content and maximum firmness of 13.63 and 13.68 $kg/cm^2$ was noticed under 0.3% calcium chloride combined with 8.0% dip. However, lowest firmness of 10.77 $kg/cm^2$ and 10.91$kg/cm^2$ was attained when no calcium chloride was applied. Similarly, calcium chloride gave firmness of 12.36 $kg/cm^2$ followed by 12.50 $kg/cm^2$ with 0.2 per cent spray as preharvest and 4.0 per cent dip and was the next best treatment in Increasing the firmness of Red Velox. The similar trend was obtained in treatments during storage period of 30 and 60 days. Calcium chloride was effective in retaining the firmness of fruit as compared to control during two months storage period. The fruit firmness has direct relation with calcium pectate as calcium interact with pectic polymers of cell wall and act as cementing agent which gives strength to the cell wall (Dey and Brinson 1984). These results are in agreement with those obtained by Casero et al. (2004). They reported that that dipped fruits in Ca solution at different concentration increased apple firmness percentages.

In general, apple fruits recorded an increase in total soluble solids (TSS) content with the treatment of nutrient application compared to unsprayed fruits (Table 2). The highest increase in TSS of 13.55 and 13.59 per cent was noticed with 0.3 per cent calcium chloride spray and 8.0% dip during first and second year of study respectively. Comparison of preharvest spray andpost harvest dip treatment revealed that TSS recorded a significant increase at highest level of calcium chloride as compared to control during both the years. The minimum TSS observed was found to be 10.65 and 10.68 per cent under control during first and second year of research trial. Similarly, the highest increase in TSS was recorded with 0.3 per cent calcium chloride spray and 8.0% dip during storage period of 30 and 60 days in first and second year of study . Increase in TSS content with the calcium chloride has also been reported by Raese and Drake (1993) in apple and pear fruits and Robson et al., (1989) in peach. Similarly, Randhawa et al., (1980) and Banday (1996) recorded higher TSS in Le Conte pears with 6 and 8 percent calcium chloride respectively.

The maximum physiological weight loss of fruits was recorded under control and minimum weight loss was recorded with increased concentration of calcium chloride.(Table-3). High concentration of CaCl2 consistently reduced the weight loss (2.78% and 2.80%) under 30 days and (4.14% and 4.11% )under 60 days storage condition during first and second year of study.These observations are supported by the finding of Rabiei et al., (2011) who stated that calcium treatments influenced peroxidise and catalase enzyme in the apple fruits which delayed breakdown of cells and hence maintained the higher firmness and reduced weight loss percentage during storage. Farag and Nagy, (2012) also reported that the improvement of reduction in physiological weight loss during storage with application of calcium formulation might be attributed to their influence on maintaining the integrity of the plasma membrane.

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**Table1: Effect of pre and post harvest application of $CaCl_2$ on yield attributes of apple.**

| Treatments | Fruit Diameter (cm) | | Fruit length(cm) | | Fruit Volume($cm^3$) | | Fruit Weight (g) | | Fruit Yield(kg/tree) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year |
| T1 | 5.77 | 5.80 | 5.42 | 5.48 | 136.64 | 138.68 | 125.26 | 126.13 | 11.65 | 12.24 |
| T2 | 5.90 | 5.94 | 5.59 | 5.60 | 150.85 | 152.22 | 134.16 | 135.43 | 12.19 | 12.75 |
| T3 | 5.48 | 5.50 | 5.11 | 5.18 | 128.66 | 135.03 | 119.00 | 119.55 | 9.99 | 9.94 |
| T4 | 5.48 | 5.50 | 5.13 | 5.20 | 130.93 | 136.51 | 120.13 | 120.83 | 9.80 | 10.03 |
| T5 | 5.81 | 5.83 | 5.48 | 5.55 | 145.78 | 148.45 | 131.06 | 132.78 | 11.73 | 12.52 |
| T6 | 5.85 | 5.87 | 5.51 | 5.57 | 147.17 | 149.62 | 136.73 | 136.45 | 11.84 | 12.59 |
| T7 | 5.91 | 5.95 | 5.69 | 5.77 | 155.14 | 160.83 | 141.13 | 147.70 | 12.75 | 12.68 |
| T8 | 5.95 | 5.97 | 5.70 | 5.83 | 156.66 | 165.39 | 141.83 | 144.47 | 12.83 | 12.91 |
| T9 | 5.47 | 5.49 | 5.10 | 5.17 | 127.66 | 134.06 | 118.46 | 119.09 | 9.45 | 9.85 |
| CD | 0.154 | 0.152 | 0.103 | 0.087 | 5.511 | 4.221 | 3.898 | 4.142 | 0.503 | 0.265 |
| SE(M) | 0.052 | 0.050 | 0.034 | 0.029 | 1.823 | 1.396 | 1.289 | 1.370 | 0.166 | 0.088 |
| CV | 1.567 | 0.071 | 1.076 | 0.912 | 2.220 | 1.647 | 1.721 | 1.801 | 2.534 | 1.296 |

**Treatment symbols:**

$T_1$–Preharvest application of $CaCl_2$@0.2%
$T_2$-Preharvest application of $CaCl_2$@0.3%
$T_3$-post harvest dip of $CaCl_2$@4.0%
$T_4$-post harvest dip of $CaCl_2$@8.0%
$T_5$-$T_1$+$T_3$
$T_6$-$T_1$+$T_4$
$T_7$-$T_2$+$T_3$
$T_8$-$T_2$+$T_4$
$T_9$-Conrol

**Table2: Effect of pre and post harvest application of $CaCl_2$ on quality during storage period of apple.**

| Treatments | Firmness at harvest(Kg/cm$^2$) | | Firmness (Kg/cm$^2$) 30days storage | | Firmness(Kg/cm$^2$) 60 days storage | | TSS ($^0$Brix)at harvest | | TSS($^0$ Brix) 30days storage | | TSS($^0$ Brix) 60days storage | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year | 1st Year | 2nd year |
| T1 | 11.35 | 11.38 | 10.13 | 10.15 | 10.00 | 10.04 | 11.11 | 11.20 | 11.13 | 11.23 | 11.56 | 11.66 |
| T2 | 11.51 | 11.52 | 10.57 | 10.62 | 10.24 | 10.14 | 12.27 | 12.30 | 12.32 | 12.32 | 12.76 | 12.86 |
| T3 | 10.94 | 10.97 | 10.65 | 10.52 | 10.14 | 10.47 | 10.71 | 10.91 | 11.37 | 11.39 | 11.88 | 11.88 |
| T4 | 11.01 | 11.12 | 10.84 | 10.88 | 10.20 | 10.02 | 10.70 | 10.92 | 11.44 | 11.46 | 11.97 | 11.97 |
| T5 | 12.36 | 12.50 | 11.18 | 11.26 | 11.08 | 11.16 | 12.65 | 12.67 | 13.19 | 12.38 | 13.4 | 13.62 |
| T6 | 12.84 | 12.86 | 11.88 | 12.01 | 11.72 | 11.17 | 12.82 | 12.82 | 13.37 | 13.42 | 13.93 | 13.93 |
| T7 | 12.96 | 13.15 | 11.51 | 12.01 | 11.31 | 11.87 | 13.18 | 13.22 | 13.33 | 12.98 | 13.88 | 13.92 |
| T8 | 13.63 | 13.68 | 12.01 | 12.11 | 11.79 | 11.90 | 13.55 | 13.59 | 13.74 | 13.84 | 14.21 | 14.27 |
| T9 | 10.77 | 10.91 | 9.88 | 9.84 | 9.40 | 9.35 | 10.65 | 10.68 | 10.87 | 11.07 | 11.34 | 11.41 |
| CD | 0.344 | 0.393 | 0.517 | 0.463 | 0.390 | 0.404 | 0.133 | 0.111 | 0.293 | 0.545 | 0.511 | 0.490 |
| SE(M) | 0.114 | 0.130 | 0.171 | 0.153 | 0.129 | 0.134 | 0.044 | 0.037 | 0.097 | 0.180 | 0.169 | 0.162 |
| Cv | 1.652 | 1.876 | 2.702 | 2.398 | 2.097 | 2.166 | 0.638 | 0.529 | 1.363 | 2.553 | 2.291 | 2.188 |

**Treatment symbols:**

$T_1$–Preharvest application of $CaCl_2$@0.2%

$T_2$-Preharvest application of $CaCl_2$@0.3%

$T_3$-post harvest dip of $CaCl_2$@4.0%

$T_4$-post harvest dip of $CaCl_2$@8.0%

$T_5$-$T_1$+$T_3$

$T_6$-$T_1$+$T_4$

$T_7$-$T_2$+$T_3$

$T_8$-$T_2$+$T_4$

$T_9$-Conrol

**Table3: Effect of pre and post harvest application of $CaCl_2$ on physiological loss in weight during storage period of apple.**

| Treatments | PLW (%) at 30 days | | PLW (%) at 60 days | |
|---|---|---|---|---|
| | 1st Year | 2nd year | 1st Year | 2nd year |
| **T1** | 3.62 | 3.68 | 5.38 | 5.40 |
| **T2** | 3.51 | 3.50 | 5.13 | 5.36 |
| **T3** | 3.51 | 3.40 | 5.34 | 5.31 |
| **T4** | 3.41 | 3.38 | 5.31 | 5.28 |
| **T5** | 3.38 | 2.92 | 4.98 | 4.96 |
| **T6** | 2.76 | 2.81 | 4.68 | 4.31 |
| **T7** | 2.87 | 2.91 | 4.91 | 4.91 |
| **T8** | 2.71 | 2.80 | 4.14 | 4.11 |
| **T9** | 3.98 | 3.95 | 5.52 | 5.49 |
| **CD** | 0.103 | 0.120 | 0.191 | 0.290 |
| **SE(M)** | 0.034 | 0.040 | 0.063 | 0.096 |
| **CV** | 1.777 | 2.108 | 2.156 | 3.304 |

**Treatment symbols:**

$T_1$–Preharvest application of $CaCl_2$@0.2%
$T_2$-Preharvest application of $CaCl_2$@0.3%
$T_3$-post harvest dip of $CaCl_2$@4.0%
$T_4$-post harvest dip of $CaCl_2$@8.0%
$T_5$-$T_1$+$T_3$
$T_6$-$T_1$+$T_4$
$T_7$-$T_2$+$T_3$
$T_8$-$T_2$+$T_4$
$T_9$-Conrol