Efficacy of Prohexadione calcium and Paclobutrazol on Storage Life of Clapp’s Favorite Pear

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ABSTRACT

Present investigation was carried out to study the efficacy of growth retardants viz., prohexadione calcium and paclobutrazol on storage life of pear cv. ‘Clapp’s Favourite’ during the year 2015-2016. The experiment was laid out with thirteen treatments replicated thrice on 12-year-old-pear tree with uniform vigor and health under uniform cultural practices. The treatment comprises of single and double spray of growth retardants, i.e., prohexadione calcium (100 ppm, 200 ppm and 300 ppm) and paclobutrazol (100 ppm, 200 ppm and 300 ppm). The orchard soil was moderately deep with good fertility status.  Data was recorded on storage life of the pear at (7, 14, 21 and 28) day’s interval and results revealed that both the growth retardants prohexadione calcium and paclobutrazol had showed a significant influence on total sugars, TSS, acidity and physiological loss in weight. After 28 days of storage minimum physiological loss in weight (14.17 %) and acidity (0.20 %) was recorded with the application of prohexadione calcium @ 200 ppm sprayed twice closely followed by prohexadione calcium @ 200 ppm sprayed twice. Application of prohexadione calcium @ 200 ppm and paclobutrazol @ 200 ppm had also showed a significant influence on TSS (15.31 % and 15.17 %, respectively) and total sugars (13.48 % and 13.40 %). Minimum values for all the characters were observed in control. Results revealed that application of prohexadione calcium @ 200 ppm and 300 ppm sprayed twice will enhance the shelf life of Clapp’s Favourite pear.

Key words: Clapp’s Favourite, Growth retardants, Prohexadione-calcium, Paclobutrazol, Storage life

Introduction

Pear (Pyrus communis L.) occupies second place among temperate crops of India, both in respect of area and production. The acreage under the fruit crop has been steadily increasing because of its high yielding potential and economic returns. Because of hardy nature of pear and tolerance to wide range of soil, it needs less care and can be grown under different agro-climatic conditions. It is successfully grown in both temperate and sub-tropical regions of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and sub-tropical regions of Punjab, Assam and South India. Pear can tolerate as low as -26 ºC during dormant period and as high as 45 ºC growing period. Prohexadione calcium (Rademacher et al., 2006) and paclobutrazol (Arzani and Roosta, 2004) both are novel plant growth regu-
lators that emerged as important management tools that an orchardist has available to manage tree canopy volume. Prohexadione-Ca (Costa et al., 2006) is a plant bio-regulator that is primarily used to inhibit excessive vegetative growth in fruit trees and other crop plants. Furthermore, the compound may reduce abortion of fruitlets, thereby increasing fruit set. Prohexadione-Ca is relatively short-lived and possesses very favorable toxicological and eco-toxicological features. Prohexadione calcium foliar application @ 100 ppm during the month of April-May on ‘Willamette Raspberry’ increases the fruit quality, yield and anthocyanin content (Poledica et al., 2004). Apart from controlling excessive vegetative dormant growth and reducing summer pruning, the most important effects of prohexadione-calcium are to inhibit gibberellin metabolism and ethylene formation. Lowered levels of ethylene reduces fruit senescence process. It also increased calcium content in fruit and improved a good ratio between calcium and potassium and also damage of fruit in storage period was reduced. Prohexadione-Ca improved the fruit yield and quality and the fruit shelf life storage (Kupferman, 2008). Pear with improper maturity is more susceptible to internal browning disorder and has a shorter storage life.

Keeping in view the benefits of prohexadione calcium and paclobutrazol, the present study was conducted to determine the effects of growth retardants on storage life of Clapp’s Favorite pear.

Materials and Methods

Experimental site and material involved

The present study was conducted on 12 year old pear cv. Clapp’s Favourite grafted on seedling rootstock at private orchard during the year 2015-2016 near SKUAST-Kashmir, Shalimar, Srinagar (J&K). The experimental orchard was situated at an altitude of 1685 m amsl which is lying between 34°75’N latitude and 74°50’C longitude. The orchard had proper soil drainage and good fertility status. Trees of similar vigor and size were selected, marked and maintained under uniform cultural practices and trained as a modified leader system at a spacing of 5 × 5 meter. Most of the precipitation received from the month of October to April and rest is erratically distributed. Winters are severe extending from December to March and temperature often goes below freezing point during this period.

Treatment Details

The experiment was laid out in a completely randomized block design (RCBD) with three trees representing a treatment. There are thirty nine healthy trees grouped into three replications and thirteen treatments including a control (water spray) were marked as per the treatments. Three concentrations (100, 200, 300 ppm) each of prohexadione calcium and paclobutrazol with their active ingredients 10 and 23, respectively were sprayed (details given in Table 1). The first spray of these plant growth retardants was given at petal fall stage and second at four weeks after first spray.

Observations recorded and statistical analysis

The observations were recorded on storage life of pear. The physiological loss in weight was determined by labeling the fruits in each treatment and were weighed prior to storage and subsequently at each stage of analysis during storage. Reduction in weight was determined and loss in weight expressed on percentage basis.

\[
\text{PLW} (%) = \frac{\text{Initial weight of fruit} - \text{Final weight of fruit} \times 100}{\text{Initial weight of fruit}}
\]

Total soluble solids of fruits during storage were determined from fresh strained thoroughly stirred fruit juice on each sampling date with the help of a digital hand refractometer (AOAC, 2000). The acidity was determined by diluting the known volume of pear juice and titrating the same against 1N sodium hydroxide solution using the phenolphthalein as an indicator. It was expressed in terms of per cent malic acid. Total sugars were estimated by titrating boiling mixture containing 5 ml each of Fehling’s A and B solutions against a hydrolyzed aliquot using methylene blue dye as an indicator (AOAC, 2000). The data collected on various parameters were statistically analyzed.

Results and Discussion

Physiological loss in weight

Figure 1 depicts the effect of growth retardants on physiological loss in weight of pear cv. Clapp’s Favourite. Physiological loss in weight is the parameter that most obviously affected by prohexadione calcium and paclobutrazol applications. Minimum physiological loss in weight (PLW) was recorded in the treatment T_{wS_2} (2.87 %), i.e. prohexadione cal-
cium @ 300 ppm sprayed twice at 7th day’s after storage which was statistically at par with T₉S₂ (2.97%), i.e. prohexadione calcium @ 200 ppm sprayed twice and maximum PLW was noticed under control (6.17%), i.e. T₁S₀ treatment. However, it has been also noticed that minimum value for physiological loss in weight right from first day, i.e. harvesting day to 28th days after storage is recorded in plants treated with double spray of plant growth retardants. At 28th days after storage, it has been noticed that double spray of prohexadione calcium @ 300 ppm (T₁₀S₂) recorded 14.17 per cent physiological loss in weight which was statistically superior among all other treatments whereas, maximum value for physiological loss in weight was recorded in treatment T₉S₀ (18.22%), i.e. control. The reason attributed to this is that calcium is known to be effective in terms of membrane functionality and integrity maintenance, which resulted in minimum physiological loss in weight of fruit or may be due the reason that calcium delayed senescence and reduced the rate of transpiration and respiration (Mahajan and Dhatt, 2004).

**Total soluble solids**

Significant results of Prohexadione-Ca and paclobutrazol on total soluble solids of Clapp’s Favourite pear is presented in Table 2. Total soluble solids percentage of pear fruit was most obviously affected by Prohexadione-Ca and paclobutrazol applications. Maximum total soluble solids in freshly harvested fruits was recorded in treatment T₉S₂ i.e. prohexadione calcium @ 200 ppm sprayed twice which was statistically at par with T₉ₐS₀ (15.17%) and T₉₉S₂ (15.16%). Minimum total soluble solids were recorded in the treatment T₁S₀ (11.62%), i.e. control. Under treatment T₁S₀ i.e. control an increasing trend was recorded for total soluble solids with advancement in the storage period up to 21 days however, prolongation of storage to 28 days, total soluble solids declined only in treatment control. With the advancement in the storage period under treatment T₁S₀, i.e. control the total soluble solid content declined which might be due to the conversion of starch and other photosynthates into sugars (Stern et al., 2007).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total sugars (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>S₀</td>
<td>8.35</td>
</tr>
<tr>
<td>T₂S₁</td>
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</tr>
<tr>
<td>T₃S₁</td>
<td>8.98</td>
</tr>
<tr>
<td>T₄S₁</td>
<td>8.89</td>
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<tr>
<td>T₅S₁</td>
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</tr>
<tr>
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<td>T₈S₂</td>
<td>9.13</td>
</tr>
<tr>
<td>T₉S₂</td>
<td>10.23</td>
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<tr>
<td>T₁₀S₂</td>
<td>10.11</td>
</tr>
<tr>
<td>T₁₁S₂</td>
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<td>9.89</td>
</tr>
<tr>
<td>T₁₃S₂</td>
<td>9.67</td>
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**Table 1.** Treatment details:

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<tr>
<th>Treatments</th>
<th>Chemicals concentrations</th>
</tr>
</thead>
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<tr>
<td>T₁S₀</td>
<td>Water spray</td>
</tr>
<tr>
<td>T₁S₁</td>
<td>Prohexadione Ca 100 ppm</td>
</tr>
<tr>
<td>T₁S₂</td>
<td>Prohexadione Ca 200 ppm</td>
</tr>
<tr>
<td>T₁S₃</td>
<td>Prohexadione Ca 300 ppm</td>
</tr>
<tr>
<td>T₂S₁</td>
<td>Paclobutrazol 100 ppm</td>
</tr>
<tr>
<td>T₂S₂</td>
<td>Paclobutrazol 200 ppm</td>
</tr>
<tr>
<td>T₂S₃</td>
<td>Paclobutrazol 300 ppm</td>
</tr>
<tr>
<td>T₃S₁</td>
<td>Prohexadione Ca 200 ppm</td>
</tr>
<tr>
<td>T₃S₂</td>
<td>Prohexadione Ca 300 ppm</td>
</tr>
<tr>
<td>T₃S₃</td>
<td>Paclobutrazol 100 ppm</td>
</tr>
<tr>
<td>T₄S₁</td>
<td>Paclobutrazol 200 ppm</td>
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<tr>
<td>T₄S₂</td>
<td>Paclobutrazol 300 ppm</td>
</tr>
<tr>
<td>T₄S₃</td>
<td>Prohexadione Ca 200 ppm</td>
</tr>
<tr>
<td>T₅S₁</td>
<td>Prohexadione Ca 300 ppm</td>
</tr>
<tr>
<td>T₅S₂</td>
<td>Paclobutrazol 100 ppm</td>
</tr>
<tr>
<td>T₅S₃</td>
<td>Paclobutrazol 200 ppm</td>
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<tr>
<td>T₆S₁</td>
<td>Paclobutrazol 300 ppm</td>
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<tr>
<td>T₆S₂</td>
<td>Paclobutrazol 300 ppm</td>
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<td>Paclobutrazol 100 ppm</td>
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<tr>
<td>T₇S₃</td>
<td>Paclobutrazol 200 ppm</td>
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</tbody>
</table>
(2013) also obtained similar results in apple cv. ‘Golden Delicious’. Prohexadione calcium inhibits the late stage of gibberellic acid biosynthesis that resulted in reduction of vegetative growth and consequently facilitates more photosynthetic assimilates towards fruit, thus increase more starch and sucrose along with mineral level in fruits that further leads to increase in total soluble solids in the fruit (Mesa et al., 2012).

**Acidity**

Acidity recorded at different intervals decreased with an increase in storage period with the application of prohexadione calcium as well as paclobutrazol, however, results were significant only at 7 and 14 days of storage (Table 2). Minimum acidity in the freshly harvested fruits was recorded in the treatment T9S2, T10S2 and T12S2 i.e. 0.44 per cent and maximum under treatment T5S2 (0.52 %), however the results were non-significant among different treatments. After 7 and 14 days of storage, T9S2 recorded minimum acidity, i.e. 0.37 per cent and 0.36 per cent, respectively which was statistically at par with T6S1 and T12S2 treatments. After 28 days of storage, the results for acidity among treatments were non-significant and minimum acidity was recorded in T6S1 treatment, i.e. prohexadione calcium @ 300 ppm sprayed twice which was statistically at par with T13S2 (13.15 %) treatment, i.e. paclobutrazol @ 300 ppm sprayed twice.

**Total sugars**

Total sugars of Clapp’s Favourite pear were also influenced by the prohexadione calcium and paclobutrazol applications (Table 3). Maximum total sugars (10.23 %) in the freshly harvested fruits was recorded in the treatment T9S2 when prohexadione calcium was sprayed twice @ 200 ppm and this treatment was statistically at par with treatment T10S2 (10.11 %) and T12S2 (9.89 %), however minimum total sugar was recorded in T1S0 (8.35 %) treatment. An increasing trend was noticed for total sugar during the storage period under ambient conditions and same trend was continued even after 28 days of storage among the treatments, where maximum total sugars was recorded in T9S2 (13.48 %) treatment, i.e. prohexadione calcium @ 200 ppm sprayed twice which was statistically at par with T12S2 (13.40 %) treatment, i.e. paclobutrazol @ 200 ppm sprayed twice, T10S2 (13.19 %) treatment, i.e. prohexadione calcium @ 300 ppm sprayed twice and T13S2 (13.15 %) treatment, i.e. paclobutrazol @

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total soluble solids (%)</th>
<th>Acidity (%)</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>T1S0</td>
<td>9.72</td>
<td>10.83</td>
</tr>
<tr>
<td>T2S1</td>
<td>11.12</td>
<td>11.43</td>
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<td>T4S1</td>
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<td>T5S1</td>
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<td>T7S1</td>
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</tr>
<tr>
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<td>13.21</td>
<td>13.76</td>
</tr>
<tr>
<td>T10S2</td>
<td>13.06</td>
<td>13.33</td>
</tr>
<tr>
<td>T11S2</td>
<td>11.73</td>
<td>12.20</td>
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<td>T12S2</td>
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<tr>
<td>T13S2</td>
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<td>13.10</td>
</tr>
<tr>
<td>CD0.05</td>
<td>0.34</td>
<td>0.43</td>
</tr>
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</table>
300 ppm sprayed twice. However, minimum value for total sugars was registered in treatment T_{10S0}(10.23%). An increased in percent of total sugar was attributed to the reason that increased sucrose, starch and sugar levels due to reduction in vegetative growth and thus absence of other potentially competitive actively growing sinks, which resulted in more nutrients portioning toward fruits (Guak, 2013).

TSS/acid ratio

Significant results were obtained with the application of prohexadione Calcium and paclobutrazol for TSS/acid ratio (Fig.1). Maximum TSS/acid ratio was recorded in the treatment T_{9S2}(30.02), i.e. prohexadione Calcium @ 200 ppm sprayed twice which was statistically at par with T_{10S2}(29.68) and T_{12S2}(29.36), however minimum TSS/acid ratio was recorded under control (18.69), i.e. treatment T_{1S0}. Treatment T_{9S2} recorded maximum values for TSS/acid ratio after 7 days (37.19), 14 days (40.86), 21 days (57.92) and 28 days (76.55) of storage. After 7 days and 28 days of storage treatment T_{9S2} was statistically higher among all other treatment whereas T_{S0} treatment was statistically at par with treatment T_{10S2} and T_{12S2} after 14 days and 21 days of storage. Minimum TSS/acid ratio was noticed in Treatment T_{1S0}, i.e. control with the increasing trend of storage periods. These differences in TSS/acid ratio may be due to differences in total soluble solid and acidity as TSS/acid ratio is directly influenced by these two attributes (Drake et al., 2004).

Conclusion

From the present study it is concluded that foliar spray of prohexadione calcium @ 200 ppm and 300 ppm at two times (first at petal fall stage and second at four weeks after first spray) resulted in increase in total soluble solids (TSS), total sugars and decreased acidity as well as physiological loss in weight percentage as photosynthetic assimilates are save (due to reduction in vegetative growth) and translocated more towards fruit of Clapp’s Favourite pear.

References


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![Fig. 1. Effect of prohexadione calcium and paclobutrazol on physiological loss in weight (%) of pear under ambient storage conditions](image1)

![Fig. 2. Effect of prohexadione calcium and paclobutrazol on TSS/acid ratio of pear under ambient storage conditions](image2)