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# Studies on regulation of ripening of bael fruits bael [*Aegle marmelos* (L.) Correa] fruits

**Sanjay Kumar, SP Singh and Bhagwan Deen**

**Abstract**
Bael fruit [*Aegle marmelos* (L.) Correa] is one of the most important underutilized fruit in India having tremendous commercial potentialities. Due to its curative properties it is the most useful medicinal plants of India. It is utilized in day-to-day life in various forms. The fruit have excellent aroma which is not destroyed even during processing. The ripening regulation is an important aspect for long period availability of the fruit. Ethrel @1000ppm was most effective for minimizing the PLW in bael cultivars than CCC @2000ppm cultivar. The NB-4 was most responsive to treatments in reducing the PLW and 1000ppm ethrel was most effective treatment for NB-4 cultivar to reduce the PLW of fruits. The specific gravity showed decreasing trend in all the cultivars when treated with PGRs including control. The control fruits had higher specific gravity in comparison to PGRs treated fruits. The highest (34.78%) T.S.S. was recorded in the ethrel @1000ppm treated fruits and NB-9 cultivar contained maximum (34.59%) T.S.S. in all the cultivars. The acidity content was slightly decreased in treatments and cultivars during ripening. The minimum acidity content was recorded in NB-5. The fruits treated with ethrel @1000ppm retained maximum ascorbic acid content throughout the study period while maximum (34.50 mg/100g) ascorbic acid content was found in NB-7. The reducing, non-reducing and total sugars increased at initial period thereafter started decreasing and content was higher in ethrel @1000ppm treated fruits. The maximum (33.55 µg/100g) total carotenoids were retained in ethrel @1000ppm treated fruits. The maximum total phenols retention was recorded in ethrel @1000ppm and CCC @2000ppm treated fruits and NB-9 cultivars. The maximum highest organoleptic score was obtained in ethrel @1000ppm treated fruits with early ripening in comparison to other treatments. All the treatment except ethrel delayed ripening of bael fruits.

**Keywords:** Bael fruits, *Aegle marmelos*, fruit in India

## Introduction
The economic yield of pulp (base material for processing) from this novel fruit surpasses all other fruits due to high content of mucilage, gums and low moisture. However, judging the appropriate stage of ripening is one of crucial parameter for high pulp recovery, which is also influenced by size. Bael fruit [*Aegle marmelos* (L.) Correa] is one of the most important underutilized fruit in India having tremendous commercial potentialities. Bael is a very hardy tree and can be also grown well in swampy, alkaline or stony soils having $p^H$ range from 5 to 8 and up to an altitude of 1200 meters and it has also grown well and fruited on limestone of southern Florida (Orwa *et al.*, 2009). Although it is grown in almost all the states of India yet its cultivation has received great impetus in recent years in Northern part of India due to wide adoptability and ability to withstand drought, low cost of cultivation and high economic returns.

Green bael fruits are used for preparing preserve (murabba) and candy which are an important Ayurvedic medicinal products and generally prescribed in all types of digestive troubles. Other products like squash, R.T.S., dehydrated slices, toffee, slab, nector and bael powder can also be prepared from this fruit (Kaushik *et al*., 2000) [8]., The ripening regulation is an important aspect for long period availability of the fruit. Keeping these facts and lack of ripening information's on bael fruit in view the present investigation "Studies on regulation of ripening of bael [*Aegle marmelos* (L.) Correa] fruits" has been conducted.

## Material and methods
The present investigation "Studies on post harvest technology of Bael [*Aegle marmelos* (L.) Correa] fruits" was carried out at post-harvest technology laboratory of the Department of Horticulture, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during the year 2013-14. The 20 years old plants of the bael cultivars Narendra Bael-4 (NB-4), NB-5, NB- 7 and NB-9 (plate 1) having uniform vigour were selected randomly.

The 2 ml of appropriate solvents were used to prepare the desired concentration of the plant growth regulators into distilled water.

| | | | |
|---|---|---|---|
| (i) | Genotypes | - | 4 |
| (ii) | Treatments | - | 7 |
| | $T_1$ | - | Water (control) |
| | $T_2$ | - | 1000 ppm Ethrel |
| | $T_3$ | - | 2000 ppm Ethrel |
| | $T_4$ | - | 1000 ppm Alar |
| | $T_5$ | - | 2000 ppm Alar |
| | $T_6$ | - | 1000 ppm CCC |
| | $T_7$ | - | 2000 ppm CCC |
| (iii) | Temperature | - | Ambient |
| (iv) | Replications | - | 3 |
| (v) | Design | - | CRD factorial |
| (vi) | Treatments Stage | - | at maturity of fruits |
| (vii) | Observation interval | - | 10 days |

**Observations recorded**

| | |
|---|---|
| (i) | Physiological loss in weight (PLW) |
| (ii) | Titrable acidity |
| (iii) | Ascorbic acid |
| (iv) | Specific gravity |
| (v) | T.S.S. |
| (vi) | Non -reducing Sugars |
| (vii) | Reducing Sugar |
| (viii) | Total Sugars |
| (ix) | Total Phenols |
| (x) | Organoleptic quality |

## Result and Discussion

### Physiological loss in weight

Data furnished in Table 1 show that on 5th days after treatment (DAT) ethrel @1000ppm ($T_2$) was most effective in reducing the PLW to lowest extent (7.20%) followed by CCC @2000ppm ($T_7$) and the difference between $T_2$ and $T_1$ (control) was significant but $T_2$ was not significantly differed from $T_7$. Similarly on 10th, 15Th, 20th DAT also showed. On the basis of above findings it may be concluded that ethrel @1000ppm was most effective to minimize the PLW in bael cultivars followed by CCC @2000ppm and cultivar NB-4 was most responsive to treatments in reducing the PLW. The interaction effects show that 1000ppm ethrel was most effective treatment for NB-4 cultivar to reduce the PLW of fruits.

Treatment Ethrel @1000ppm ($T_2$) caused lowest PLW during entire period of study while minimum PLW was recorded in NB-4 cultivar in comparison to others cultivars. The results are supported by Mahajan (1996) in mango, Kulkarni *et al.* (2011) in banana, Madhvi *et al*. (2008) in acid lime and Chaudhary *et al*. (2003) [4] in sapota.

**Table 1:** Response of plant growth regulators and cultivars on changes in physiological loss in weight (PLW) during ripening regulation of bael fruits

| PGR treatments | Physiological loss in weight (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 05 DAT | | | | Mean | 10 DAT | | | | Mean |
| | NB-4 | NB-5 | NB-7 | NB-9 | | NB-4 | NB-5 | NB-7 | NB-9 | |
| Control ($T_1$) | 8.41 | 9.50 | 10.10 | 9.55 | 9.39 | 18.30 | 16.60 | 16.48 | 18.40 | 17.44 |
| Ethrel @1000ppm ($T_2$) | 5.10 | 7.08 | 8.40 | 8.20 | 7.20 | 12.50 | 12.32 | 12.46 | 13.98 | 12.81 |
| Ethrel @2000ppm ($T_3$) | 6.00 | 7.80 | 8.65 | 8.75 | 7.80 | 17.05 | 13.93 | 14.37 | 14.85 | 15.05 |
| Alar @1000ppm ($T_4$) | 6.80 | 7.90 | 8.80 | 8.37 | 7.97 | 15.38 | 12.44 | 13.95 | 15.91 | 15.91 |
| Alar @2000ppm ($T_5$) | 7.15 | 8.05 | 8.95 | 8.50 | 8.16 | 16.41 | 15.26 | 13.70 | 14.30 | 14.91 |
| CCC @1000ppm ($T_6$) | 6.30 | 6.50 | 8.75 | 8.55 | 7.52 | 13.43 | 13.90 | 15.35 | 16.90 | 14.90 |
| CCC @2000ppm ($T_7$) | 5.90 | 6.80 | 8.60 | 8.35 | 7.42 | 13.88 | 13.30 | 14.64 | 15.60 | 14.35 |
| Mean | 6.52 | 7.66 | 8.89 | 8.61 | | 15.27 | 13.96 | 14.42 | 15.71 | |

| | SEm± | C.D. at 5% | SEm± | C.D. at 5% |
|---|---|---|---|---|
| **Between PGR treatments (P)** | 0.085 | 0.241 | 0.161 | 0.457 |
| **Between cultivars (C)** | 0.064 | 0.182 | 0.122 | 0.345 |
| **Interaction PxC** | 0.170 | 0.483 | 0.323 | 0.914 |

**Contd….**

| PGR treatments | Physiological loss in weight (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAT | | | | Mean | 20 DAT | | | | Mean |
| | NB-4 | NB-5 | NB-7 | NB-9 | | NB-4 | NB-5 | NB-7 | NB-9 | |
| Control ($T_1$) | 18.93 | 19.30 | 21.21 | 19.30 | 19.68 | 20.50 | 21.80 | 23.36 | 22.71 | 22.09 |
| Ethrel @1000ppm ($T_2$) | 13.20 | 14.21 | 15.00 | 15.10 | 14.37 | 14.80 | 16.10 | 17.30 | 17.50 | 16.42 |
| Ethrel @2000ppm ($T_3$) | 17.80 | 17.92 | 15.20 | 16.70 | 16.90 | 19.10 | 19.70 | 19.10 | 19.80 | 19.43 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Alar @1000ppm ($T_4$) | 16.10 | 15.00 | 18.27 | 17.20 | 16.64 | 17.25 | 20.10 | 21.20 | 19.25 | 19.45 |
| Alar @2000ppm ($T_5$) | 17.35 | 16.15 | 18.04 | 17.50 | 17.26 | 19.10 | 19.00 | 20.20 | 18.70 | 19.25 |
| CCC @1000ppm ($T_6$) | 14.30 | 16.25 | 17.22 | 18.30 | 16.51 | 15.70 | 18.26 | 19.40 | 20.10 | 18.37 |
| CCC @2000ppm ($T_7$) | 14.20 | 14.72 | 16.37 | 16.21 | 15.37 | 15.40 | 17.15 | 18.50 | 18.40 | 17.36 |
| Mean | 15.98 | 16.22 | 17.33 | 17.18 | | 17.40 | 18.87 | 19.86 | 19.49 | |

| | SEm± | C.D. at 5% | SEm± | C.D. at 5% |
|---|---|---|---|---|
| **Between PGR treatments (P)** | 0.174 | 0.493 | 0.206 | 0.442 |
| **Between cultivars (C)** | 0.132 | 0.373 | 0.156 | 0.584 |
| **Interaction PxC** | 0.348 | 0.493 | 0.413 | 1.169 |

## Specific gravity

Data recorded on response of PGRs and cultivars and their interactions on changes in specific gravity during ripening regulation of bael fruits are presented in Table 2. Data reveal that 1000ppm ethrel ($T_2$) was recorded minimum (1.11) specific gravity followed by $T_6$ (1.12) however, there was no significant difference between $T_2$ and $T_6$ but both differed significantly from control ($T_1$). In comparison to other cultivars NB-5 was observed to be minimum in specific gravity. The interaction effects show that $T_2$ was effective treatment for NB-5 to minimize the specific gravity and at par value of specific gravity was recorded with $T_6$ (CCC 1000ppm) treatment in NB-4 cultivar on 5$^{th}$ DAT (Days after treatment). Similarly on 10$^{th}$, 15$^{Th}$, 20$^{th}$ DAT also showed. It may be concluded that specific gravity show decreasing trend in all the PGR treatments and cultivars during study period.

The specific gravity of bael fruits were recorded decreasing trend in all the treatments and cultivars during entire period of study. However, maximum specific gravity was observed in control in comparison to all treatments throughout the period of observation. These findings are supported by Singh *et al.* (2012) who stated that ethrel 750ppm showed better results in respect of specific gravity in mango fruits.

**Table 2:** Response of plant growth regulators and cultivars on changes in specific gravity during ripening regulation of bael fruits

| PGR treatments | Specific gravity | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5 DAT | | | | Mean | 10 DAT | | | | Mean |
| | NB-4 | NB-5 | NB-7 | NB-9 | | NB-4 | NB-5 | NB-7 | NB-9 | |
| Control ($T_1$) | 1.20 | 1.22 | 1.11 | 1.07 | 1.15 | 1.00 | 1.03 | 1.05 | 1.06 | 1.04 |
| Ethrel @1000ppm ($T_2$) | 1.20 | 1.01 | 1.12 | 1.12 | 1.11 | 0.93 | 1.01 | 1.04 | 1.08 | 1.02 |
| Ethrel @2000ppm ($T_3$) | 1.15 | 1.17 | 1.14 | 1.25 | 1.18 | 0.93 | 1.04 | 1.08 | 1.07 | 1.03 |
| Alar @1000ppm ($T_4$) | 1.08 | 1.08 | 1.08 | 1.20 | 1.11 | 0.92 | 1.06 | 1.06 | 1.03 | 1.02 |
| Alar @2000ppm ($T_5$) | 1.09 | 1.18 | 1.10 | 1.23 | 1.15 | 0.90 | 1.04 | 1.05 | 1.05 | 1.01 |
| CCC @1000ppm ($T_6$) | 1.01 | 1.08 | 1.14 | 1.23 | 1.12 | 0.90 | 1.01 | 1.06 | 1.08 | 1.01 |
| CCC @2000ppm ($T_7$) | 1.12 | 1.05 | 1.12 | 1.28 | 1.14 | 0.96 | 1.02 | 1.09 | 1.06 | 1.03 |
| Mean | 1.12 | 1.11 | 1.12 | 1.20 | | 0.93 | 1.03 | 1.06 | 1.06 | |

| | SEm± | C.D. at 5% | SEm± | C.D. at 5% |
|---|---|---|---|---|
| **Between PGR treatments (P)** | 0.012 | 0.035 | 0.008 | 0.023 |
| **Between cultivars (C)** | 0.009 | 0.026 | 0.008 | 0.030 |
| **Interaction PxC** | 0.025 | 0.070 | 0.021 | 0.060 |

**Contd….**

| PGR treatments | Specific gravity | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAT | | | | Mean | 20 DAT | | | | Mean |
| | NB-4 | NB-5 | NB-7 | NB-9 | | NB-4 | NB-5 | NB-7 | NB-9 | |
| Control ($T_1$) | 0.91 | 1.02 | 1.04 | 1.03 | 1.00 | 0.90 | 0.96 | 0.98 | 0.99 | 0.96 |
| Ethrel @1000ppm ($T_2$) | 0.92 | 0.95 | 0.95 | 0.93 | 0.94 | 0.91 | 0.93 | 0.93 | 0.90 | 0.92 |
| Ethrel @2000ppm ($T_3$) | 0.91 | 0.98 | 0.96 | 0.92 | 0.94 | 0.90 | 0.96 | 0.93 | 0.90 | 0.92 |
| Alar @1000ppm ($T_4$) | 0.90 | 1.03 | 0.94 | 1.02 | 0.97 | 0.89 | 0.95 | 0.92 | 0.93 | 0.92 |
| Alar @2000ppm ($T_5$) | 0.89 | 1.02 | 0.96 | 1.01 | 0.97 | 0.88 | 0.96 | 0.93 | 0.94 | 0.93 |
| CCC @1000ppm ($T_6$) | 0.88 | 1.01 | 0.95 | 1.02 | 0.97 | 0.87 | 0.94 | 0.92 | 0.94 | 0.92 |
| CCC @2000ppm ($T_7$) | 0.95 | 1.02 | 0.93 | 1.01 | 0.98 | 0.92 | 0.95 | 0.91 | 0.91 | 0.92 |
| Mean | 0.91 | 1.00 | 0.96 | 0.99 | | 0.90 | 0.95 | 0.93 | 0.93 | |

| | SEm± | C.D. at 5% | SEm± | C.D. at 5% |
|---|---|---|---|---|
| **Between PGR treatments (P)** | 0.010 | 0.029 | 0.007 | 0.024 |
| **Between cultivars (C)** | 0.008 | 0.022 | 0.007 | 0.018 |
| **Interaction PxC** | 0.021 | 0.058 | 0.017 | 0.049 |

## Total soluble solids

Data furnished in Table 3 show that on the 5$^{th}$ DAT, treatment $T_2$ was most effective in increasing (27.23%) the T.S.S. followed by $T_5$ (26.65%) but differences in these treatments regarding T.S.S. content was non-significant. The cultivar NB-4 (30.14%) was most responsive for T.S.S. content followed by NB-9 (25.37%) and difference between these two cultivars was significant.

Ethrel @1000ppm ($T_2$) was found most effective for maximum retention of T.S.S. content in bael fruits among the various treatments. The T.S.S. content was found in increasing trend up to 20$^{th}$ DAT in all the treatments and cultivars except ethrel treatments and NB4 cultivars. This might be due to hydrolysis of polysaccharides into sugars and enhance in transpiration of fruits. The results are similar to findings of Ghosh and Mitra (2004) [6] in bael.

**Table 3:** Response of plant growth regulators and cultivars on changes in total soluble solids (T.S.S.) during ripening regulation of bael fruits

| PGR treatments | T.S.S. (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5 DAT | | | | Mean | 10 DAT | | | | Mean |
| | NB-4 | NB-5 | NB-7 | NB-9 | | NB-4 | NB-5 | NB-7 | NB-9 | |
| Control ($T_1$) | 30.10 | 25.20 | 24.20 | 26.10 | 26.40 | 32.20 | 29.10 | 25.10 | 31.20 | 29.40 |
| Ethrel @1000ppm ($T_2$) | 31.20 | 20.20 | 25.20 | 24.30 | 27.23 | 36.10 | 31.20 | 29.20 | 32.30 | 32.20 |
| Ethrel @2000ppm ($T_3$) | 31.10 | 23.20 | 26.20 | 25.10 | 26.40 | 35.10 | 30.10 | 28.10 | 31.20 | 31.13 |
| Alar @1000ppm ($T_4$) | 29.20 | 25.10 | 25.30 | 26.20 | 26.45 | 34.20 | 28.20 | 26.20 | 30.20 | 29.70 |
| Alar @2000ppm ($T_5$) | 30.10 | 26.10 | 25.10 | 25.30 | 26.65 | 33.20 | 28.30 | 27.10 | 29.10 | 29.43 |
| CCC @1000ppm ($T_6$) | 30.20 | 24.10 | 26.10 | 25.20 | 26.40 | 34.10 | 30.10 | 28.20 | 28.20 | 30.15 |
| CCC @2000ppm ($T_7$) | 29.10 | 25.20 | 24.10 | 25.40 | 26.49 | 33.20 | 29.30 | 29.10 | 29.10 | 30.18 |
| Mean | 30.14 | 24.15 | 25.17 | 25.37 | | 34.01 | 29.47 | 27.57 | 30.19 | |

| | SEm± | C.D. at 5% | SEm± | C.D. at 5% |
|---|---|---|---|---|
| **Between PGR treatments (P)** | 0.292 | 0.827 | 0.334 | 0.947 |
| **Between cultivars (C)** | 0.221 | 0.625 | 0.253 | 0.716 |
| **Interaction PxC** | 0.584 | 1.654 | 0.669 | 1.895 |

**Contd….**

| PGR treatments | T.S.S. (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAT | | | | Mean | 20 DAT | | | | Mean |
| | NB-4 | NB-5 | NB-7 | NB-9 | | NB-4 | NB-5 | NB-7 | NB-9 | |
| Control ($T_1$) | 34.10 | 30.10 | 27.10 | 33.10 | 31.10 | 33.30 | 32.30 | 30.20 | 33.60 | 32.35 |
| Ethrel @1000ppm ($T_2$) | 36.00 | 35.10 | 32.20 | 35.80 | 34.78 | 35.10 | 35.00 | 32.00 | 35.75 | 34.46 |
| Ethrel @2000ppm ($T_3$) | 35.00 | 34.20 | 32.40 | 34.20 | 33.95 | 34.20 | 34.10 | 30.30 | 34.10 | 33.18 |
| Alar @1000ppm ($T_4$) | 34.10 | 32.30 | 29.10 | 33.10 | 32.15 | 33.40 | 34.20 | 29.00 | 35.30 | 32.98 |
| Alar @2000ppm ($T_5$) | 33.10 | 33.20 | 30.20 | 31.20 | 31.93 | 32.80 | 35.10 | 30.10 | 35.10 | 33.28 |
| CCC @1000ppm ($T_6$) | 34.00 | 31.40 | 29.10 | 30.30 | 31.20 | 33.20 | 34.20 | 29.00 | 33.20 | 32.40 |
| CCC @2000ppm ($T_7$) | 33.20 | 32.10 | 30.20 | 32.20 | 31.90 | 32.10 | 33.30 | 30.10 | 35.10 | 32.65 |
| Mean | 34.20 | 32.63 | 30.04 | 32.84 | | 33.44 | 34.03 | 30.10 | 34.59 | |

| | SEm± | C.D. at 5% | SEm± | C.D. at 5% |
|---|---|---|---|---|
| **Between PGR treatments (P)** | 0.341 | 0.965 | 0.352 | 0.999 |
| **Between cultivars (C)** | 0.257 | 0.729 | 0.266 | 0.755 |
| **Interaction PxC** | 0.681 | 1.930 | 0.705 | NS |

## Acidity

Data recorded on response of PGR treatments and cultivars in acidity content during ripening regulation of bael fruits are presented. Data show that significantly lowest (0.37%) acidity content was recorded with $T_2$ treatments followed by $T_3$ (0.39%) and differences between these two treatments was significant. NB-9 cultivar was recorded significantly lowest (0.33%) acidity among the cultivars. Similarly on 10$^{th}$, 15$^{Th}$, 20$^{th}$ DAT also showed. Based on the interaction it was observed that $T_2$ was most effective treatment to minimize (0.29%) the acidity content in NB-9 followed by $T_7$ in same cultivar.

The minimum acidity content was found in Ethrel @1000ppm among the treatments while NB-5 cultivars was follow same trend. The acidity content was slightly increased up to 10$^{th}$ DAT and thereafter decreased considerable in all the treatments and cultivars during study period. These results supported by the findings of Dutta *et al*. (2008) [5] in mango.

## Reducing sugars

Data recorded on response of PGR and cultivars and their interaction on changes in reducing sugars during ripening regulation of bael fruits are recorded. Data show that treatment $T_2$ (4.60%) was recorded maximum reducing sugars followed by $T_6$ (4.35%) and difference between these two treatments was significant as well as significantly higher in comparison to $T_1$ (4.03%). The cultivar NB-9 (4.51%) was significantly higher in reducing sugars followed by other cultivars. Based on the interaction it was observed that $T_2$ (5.00%) was most effective with NB-4 in maximum retention of reducing sugars followed by $T_2$ with NB-9 (4.80%) but differences was non-significant. Similarly on 10$^{th}$, 15$^{Th}$, 20$^{th}$ DAT also showed.

The interaction effects showed that $T_2$ was most effective treatment with NB-5 (5.40%) for maximum retention of reducing sugars content followed by $T_6$ (5.30%) with same cultivar.

## Non-reducing sugars

Data recorded on the 5$^{th}$ DAT, treatment $T_2$ was most effective in respect of maximum (13.85%) content of non-reducing sugars followed $T_4$ (13.50%) but difference between these two treatments was non-significant whereas both differed significantly from $T_1$ (12.68%). Among the cultivars NB-9 (14.28%) was significantly higher in non-reducing sugars content followed by NB-4 (13.19%). The interaction effects show that $T_2$ was most effective with NB-9 (15.45%) followed by $T_4$ with same cultivar (15.40%). Similarly on 10$^{th}$, 15$^{Th}$, 20$^{th}$ DAT also showed. On the basis of above results it may be concluded that non-reducing sugars was recorded in decreasing trend in all the treatments and cultivars and their interactions. The treatment $T_2$ was most effective on cultivar NB-9. The interaction between $T_2$ and NB-9 was found to be most effective in comparison to others in respect of non-reducing sugars content in bael fruits.

## Total sugars

Data recorded on 5$^{th}$ DAT, treatment $T_2$ (18.45%) was most effective in respect of total sugars content followed by $T_4$ (17.83%) but difference was non-significant. Among the cultivars NB-9 (18.79%) was significantly higher in total sugars content in comparison to others cultivars except NB-5 (18.28%). The interaction effects show that $T_2$ with NB-9 (20.25%) was recorded maximum total sugars content

followed by $T_4$ (19.90%) but difference between these interactions was non-significant. Similarly on 10th, 15Th, 20th DAT also showed.

Treatment ethrel @1000ppm was most responsive for maximum retention of reducing sugars throughout the study period among the treatments.

The non-reducing sugars content was recorded in decreasing trend in all the treatments and cultivars during entire period of observations.

The decreasing trend in non-reducing sugars might be due to continuous respiration and less availability of starch to hydrolyze into sugars. The findings are supported by Lee and Toshiaki (1991) in persimmon.

The total sugars content in bael fruits were increasing continuously up to end of study period in all the treatments and cultivars. The treatment $T_2$ was most effective in respect of total sugars content retention during entire period and NB-9 was recorded maximum total sugars content. The results are similar to Roy *et al.* (1972) [17].

**Ascorbic acid content**

Data furnished on the 5th DAT, treatment $T_2$ (29.87 mg/100g) was most effective in maximum retention of ascorbic acid followed by $T_3$ (29.50 mg/100g) but difference between these two treatments was non-significant. Among the cultivars NB-4 (31.02 mg/100g) was most responsive in respect of ascorbic acid content followed by NB-9 (29.15 mg/100g) and difference between these two cultivars was significant. The interaction effects show that the treatment $T_2$ was most effective with NB-4 (33.80 mg/100g) followed by $T_3$ (31.40 mg/100g) in respect of maximum retention of ascorbic acid content. Similarly on 10th, 15Th, 20th DAT also showed.

Treatment ethrel @1000ppm was most effective for maximum retention of ascorbic acid among the all treatments and NB-7 cultivar was contained maximum (34.50 mg/100g) ascorbic acid in comparison to other cultivars. The increasing trend was found in all the treatments and cultivars up to 30th DAT then decreasing trend was observed in ascorbic acid content.

**Total carotenoids**

Data recorded on the 5th DAT, maximum carotenoids was retained in $T_2$ (28.74 µg/100g) followed by $T_3$ (28.34 µg/100g) in comparison to all other treatments. All the treatments was superior in respect of total carotenoids content except control ($T_1$). However, among the cultivars, NB-4 (29.22 µg/100g) was recorded maximum total carotenoids followed by NB-5 (29.08 µg/100g) but difference between these cultivars was non-significant. Non-significant interaction was recorded between treatments and cultivars. Ethrel @1000ppm ($T_2$) was most effective for maximum retention of total carotenoids content in all the treatments while NB-9 cultivars was recorded maximum in total carotenoids content in comparison to others cultivars.

Treatment $T_2$ had retained the maximum total carotenoids content than other treatments during entire period of observation while the NB-5 cultivar was higher in total carotenoids content among the cultivars.

**Total phenols**

Data furnished on 5th DAT, treatment $T_6$ was significantly higher (26.56 mg/100g) in total phenols content as compared to control (25.15 mg/100g) however, there was no significant difference among the treatments. The minimum (25.90 mg/100g) total phenols content was recorded in $T_3$ followed by $T_2$ (26.11 mg/100g) but difference was non-significant between these treatments. On the basis of above results it may be concluded that total phenols content was recorded in decreasing trends in all the treatments and cultivars during regulation of ripening of bael fruits. On 5th DAT and 15th DAT, treatment $T_6$ & $T_7$ were superior, respectively but on 10th DAT and 20th DAT, treatment $T_2$ was most effective for retaining total phenols content. The difference in total phenols content in bael fruits was non-significant in different treatments and content continued to decrease during entire period of observation in all the treatments. The cultivar NB-9 was recorded maximum total phenols content among the cultivars.

**Organoleptic quality**

Changes in organoleptic scores which indicate edible quality of fruits during ripening regulation. The 7 or above organoleptic score indicated that fruits were still possessing edible qualities. On 5th DAT, all the treated fruit were not edible and organoleptic score were obtained below 6. All the cultivars did not remain edible at 5th DAT and NB-4 was obtained maximum (6.27) organoleptic score in comparison to other cultivars.

Loss in organoleptic quality and storage ability of product after certain period is obvious. Organoleptic score initially increased and then declined after securing highest acceptable value. The treatment $T_2$ was obtained maximum organoleptic score among the treatments and NB-9 cultivar was proving better in comparison to other cultivars. An increase in organoleptic score was recorded in all the treatments and cultivars except ethrel treatments and NB-4 and NB-7 during entire period of observation. The results are in consonance with the findings of Singh and Pal (2006) [18] in apple.

**Summary and conclusion**

Out of all the PGR treatments, the ethrel @1000ppm was found to be most effective for early ripening of bael fruits with minimum PLW and highest retention of ascorbic acid, total carotenoids, minimum acidity and alar and CCC delayed ripening of bael fruits. The cultivar NB-4 was most responsive for early ripening while NB-9 delayed ripening in comparison to other cultivars.

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