Effect of pruning time on bio-chemical parameters of guava (*Psidium guajava* L.) genotypes

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DOI: [https://doi.org/10.22271/chemi.2020.v8.i1aa.8537](https://doi.org/10.22271/chemi.2020.v8.i1aa.8537)

Abstract
The research was carried out at the Instructional-cum-Research Farm, Department of Horticulture, MPKV, Rahuri during the year 2016 and 2017. The present investigations were conducted on seven different genotypes namely RHR-Guv-58, RHR-Guv-60, RHR-Guv-14, RHR-Guv-16, RHR-Guv-3, RHR-Guv-6 and Sardar with five pruning time i.e. 15th May, 15th June, 15th July, 15th August, 15th Sept. and no pruning (control). The experiment was laid out in Factorial Randomized Block Design with forty two treatments and was replicated two times. The results revealed that the maximum TSS of fruit (12.33 °Brix) was observed in Sardar. The maximum total sugars (8.08 %), reducing sugars (5.07 %), sugar: acid ratio (22.33) with minimum acidity (0.36 %) were recorded in G6 (RHR-Guv-58) genotype. The maximum ascorbic acid of fruit (208.33 mg/100 g) and shelf life of fruit (9.75 days) was recorded in G1 (RHR-Guv-14) genotype. Fruit quality of genotypes was remained more or less similar irrespective to pruning time.

Keywords: Guava, pruning time, quality, genotypes, shelf-life

Introduction
Guava (*Psidium guajava* L.) is belonging to Myrtaceae family popularly known as “poor man’s fruit” or “apple of tropics” (Singh, 2013) [18]. It is native to tropical America stretching from Mexico to Peru and was introduced in India by the Portuguese during 17th century (Menzel, 1985) [8]. Guava is the fourth most important fruit crop in India after Mango, Banana and Citrus (Ray, 2002) [15] and is popular due to its round year availability, rich nutritional and medicinal value and affordable price, suitability for transportation, handling and consumer preference. It exceeds most other fruits in productivity, hardiness, adoptability and vitamin C content (Singh and Singh, 2001) [20].

Guava is often marketed as “super fruit”, being rich in vitamins ‘A’ and ‘C’ with seeds that are rich in omega-3, omega-6 polyunsaturated fatty acids and especially dietary fiber (Nimisha, et al., 2013) [10]. The development of colour, sweetness, aroma and vitamin C are dependent on low temperature and dry atmosphere, owing to this fact the quality of winter season fruits is better compared to that rainy and spring seasons. It is a popular fruit of India due to its delightful taste, flavour and easy availability. Guava is used for preparation of jams, jellies, juices, cakes, pies, ice-cream, milk shakes, sauces, butter, cheese, marmalade, chutney, relish, pickle, puree, beverages, ethanol, wine, animal feed, baby food, soft-drinks, as source of pectin, etc (Nagar et al., 2017) [9]. Guava trees bear terminally, that’s why pruning influences more sprouting of shoots, flowering, fruiting and consequently increase in the yield and quality of guava (Dubey et al., 2002) [4]. Keeping in a view the above facts, it is felt to undertake the research work on effect of pruning time on bio-chemical parameters of guava (*Psidium guajava* L.) genotypes.

Material and methods
An experiment was carried out with an objective to study quality of guava genotypes during the year 2016 and 2017 at the Instructional-cum-Research Farm, Department of Horticulture, present investigations were conducted on seven different genotypes namely Sardar (G1),

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Results and discussion

T.S.S. (°Brix) of fruit

The data on T.S.S. of fruit are displayed in Table 1. The maximum T.S.S. of fruit (11.43 °Brix) was recorded in P1 treatment, which was followed by P2 treatment (11.34 °Brix) and minimum in P3 treatment (11.16 °Brix) in pooled analysis of pruning time. Effect of various genotypes was found to be significant for the T.S.S. of fruit of pooled results. The significantly maximum T.S.S. of fruit (12.23 °Brix) was observed in G7 genotype and the minimum (11.04 °Brix) in G5 genotype. Result of conducted experiment showed that, time of pruning does not affect too much on T.S.S. but various genotypes get affected by pruning in that maximum T.S.S. was recorded in G1 (Sardar) as compared to others genotypes. This is due to the effect of pruning on plants, attributed to lower leaves/ fruit ratio and better availability of carbohydrates reserved in pruned shoots at a correct time and characteristics of the genotype. Similar results regarding the effect of pruning time on T.S.S of fruit were recorded by Sheikh and Hulmani (1996) [16], Singh and Dhaliwal (2004) [19] and Ali and Abdel-Hameed (2014) [1] in guava.

Table 1: Effect of pruning time and genotypes on T.S.S. (°Brix) of fruit

| Treatments | T.S.S. of fruit (Pooled data of 2 years- 2016 & 2017) |
|------------|------------------------------------------------------|
|           | Guava genotypes                                     |
|            | G1 G2 G3 G4 G5 G6 G7 Mean                           |
| P1         | 12.46 11.17 11.14 11.31 11.34 11.29 11.30 11.43    |
| P2         | 11.82 11.00 11.00 11.12 11.12 11.04 11.00 11.16    |
| P3         | 12.13 11.02 11.00 11.05 11.10 11.09 11.06 11.21    |
| P4         | 12.23 11.09 11.02 11.14 11.37 11.02 11.06 11.28    |
| P5         | 12.34 11.07 11.03 11.14 11.09 11.02 11.26 11.28    |
| P6 (Control)| 12.41 11.09 11.07 11.22 11.25 11.17 11.20 11.34    |
| Mean       | 12.23 11.07 11.04 11.16 11.21 11.10 11.14 11.28    |
| Year 2016 & 2017 | Pruning time Guava genotypes Interaction (P×G) | SE(m) ± 0.10 0.11 0.27 |
|             | CD% 0.16 0.18 0.30 NS | NS | NS |

Reducing sugars (% of fruit)
The data on reducing sugars of fruit have been presented in Table 3. Effect of different pruning time was found significant in pooled results, i.e. maximum (4.99 %) in P1 treatment and lowest (4.37 %) in P3 treatment. The highest reducing sugars of fruit (5.07 %) were recorded in G7 genotype and minimum (4.28 %) in G5 genotype. The data on reducing sugars of fruit was found to be non-significant for interaction effect of pruning time and various genotypes. However, highest reducing sugars of fruit (5.46 %) were noticed in P1G7 and minimum (4.02 %) in P3G1 treatment combinations in the pooled data. Results have been revealed that, improvement was observed in quality of guava fruit of pruned plants compared to control ones. This might be due to increase nutrient uptake by the trees and consequently more synthesis of carbohydrates and other metabolites and their translocation to the fruits. The results are found similar with Nikumbhe (2014) [13] and Raut et al., (2016) [14] reported that better quality of fruits observed in pruned guava plants compared to control plants.
Non-reducing sugars (%) of fruit
The data related to non-reducing sugars of guava fruit are displayed in Table 4. The maximum non-reducing sugars of fruit (3.24 %) were observed in P3 treatment and the minimum (3.05 %) in P1 treatment for pooled results. Effects of genotypes were found maximum (3.25 %) in G7 genotype and minimum (3.00 %) in G5 genotype. As regards interaction effects, the P2G1 treatment combination was noted maximum non-reducing sugars of fruit (3.36 %), whereas the minimum (2.92 %) in P1G3 treatment combination in pooled data. Overall considering the results indicated that, the maximum non-reducing sugars were recorded in P3 (15th September pruning time) treatment compared to other treatments. This might be due to the abundant availability of photosynthesis for limited number of fruits leads to increase in non-reducing sugars. The results coincided with findings of Nikumhbe (2014) [1] in guava.

Table 4 Effect of pruning time and genotypes on non-reducing sugars (%) of fruit

| Treatments | Non-reducing sugars of fruit (Pooled data of 2 years- 2016 & 2017) |
|------------|---------------------------------------------------------------|
|            | Guava genotypes                                              |
|            | Pruning time | G1 | G2 | G3 | G4 | G5 | G6 | G7 | Mean |
| P1         | 3.25        | 2.98 | 2.92 | 2.95 | 3.08 | 3.00 | 3.21 | 3.05 |
| P2         | 3.17        | 3.05 | 2.95 | 3.00 | 3.07 | 3.11 | 3.23 | 3.08 |
| P3         | 3.17        | 3.24 | 3.08 | 3.21 | 3.21 | 2.98 | 3.17 | 3.15 |
| P4         | 3.28        | 3.27 | 3.01 | 3.25 | 3.21 | 3.00 | 3.27 | 3.18 |
| P5 (Control) | 3.29       | 3.31 | 3.14 | 3.27 | 3.16 | 3.13 | 3.36 | 3.24 |
| Mean       | 3.23        | 3.17 | 3.00 | 3.13 | 3.16 | 3.03 | 3.25 | 3.14 |
| Year 2016 & 2017 Pruning time | Guava genotypes | Interaction (P×G) |
| SE(m) ±     | 0.05        | 0.05 | 0.12 | NS |   |   |   |
| CD 5%       | 0.14        | NS |   |   |   |   |   |

Acidity (%) of fruit
The data in Table 5 related to the acidity of guava fruit was significantly influenced due to genotypes. This is very important biochemical parameter decides taste blend of guava. The pooled data of pruning time indicated that the minimum acidity of fruit (0.37 %) was noticed in P2 treatment, while the maximum (0.46 %) in P3 treatment. The data regarding effect of different genotypes on acidity of fruit was observed minimum acidity of fruit (0.36 %) in G1 genotype, which was at par with G2, G6 and G7 genotypes (0.37 %), while the maximum (0.46 %) in G1 genotype.

Table 5 Effect of pruning time and genotypes on acidity (%) of fruit

| Treatments | Acidity of fruit (Pooled data of 2 years- 2016 & 2017) |
|------------|---------------------------------------------------------------|
|            | Guava genotypes                                              |
|            | Pruning time | G1 | G2 | G3 | G4 | G5 | G6 | G7 | Mean |
| P1         | 0.47        | 0.36 | 0.39 | 0.40 | 0.36 | 0.36 | 0.39 |
| P2         | 0.43        | 0.34 | 0.34 | 0.38 | 0.35 | 0.34 | 0.37 |
| P3         | 0.46        | 0.36 | 0.37 | 0.39 | 0.37 | 0.37 | 0.39 |
| P4         | 0.47        | 0.38 | 0.38 | 0.40 | 0.40 | 0.39 | 0.40 |
| P5         | 0.48        | 0.39 | 0.38 | 0.41 | 0.40 | 0.39 | 0.40 |
| P6 (Control) | 0.46       | 0.37 | 0.33 | 0.38 | 0.39 | 0.35 | 0.38 |
| Mean       | 0.46        | 0.37 | 0.36 | 0.39 | 0.37 | 0.37 | 0.39 |
| Year 2016 & 2017 Pruning time | Guava genotypes | Interaction (P×G) |
| SE(m) ±     | 0.00        | 0.01 | 0.01 |   |   |   |   |
| CD 5%       | NS          | 0.01 | NS |   |   |   |   |

As regards, the data on interaction effect of treatment combinations indicated that, the maximum acidity of fruit (0.48 %) was noticed in P6G1 and minimum acidity in P2G3, P2G6 and P2G7 (0.34 %) treatment combinations in pooled data. The present results observed that the pruning time does not affect too much on acidity but genotypes differ in acidity. It might be due to the independent characteristic of genotype along with pruning effect and also might be due to the abundant availability of photosynthesis for limited number of fruits leads to increase in acidity. Chandra and Govind (1995) [3] reported similar results in guava that better quality of fruits observed in fruits of pruned guava plants compared to control.

Ascorbic acid (mg/100 g) of fruit
The data related to ascorbic acid of fruit are given in Table 6. Effect of pruning time reported that, the P2 treatment was recorded maximum ascorbic acid of fruit (207.68 mg/100 g) and the minimum (190.84 mg/100 g) was recorded in P3 treatment. As regarding effect of genotypes, significantly maximum ascorbic acid of fruit (208.33 mg/100 g) was observed in G4 genotype, which was superior over rest of genotypes and minimum (188.29 mg/100 g) in G1 genotype.

Table 6 Effect of pruning time and genotypes on ascorbic acid (mg /100 g) of fruit

| Treatments | Ascorbic acid of fruit (Pooled data of 2 years- 2016 & 2017) |
|------------|---------------------------------------------------------------|
|            | Guava genotypes                                              |
|            | Pruning time | G1 | G2 | G3 | G4 | G5 | G6 | G7 | Mean |
| P1         | 200.16       | 198.25 | 201.25 | 202.25 | 203.50 | 204.50 | 205.25 | 206.63 |
| P2         | 203.00       | 201.63 | 203.25 | 204.50 | 205.75 | 206.25 | 207.50 | 208.75 |
| P3         | 209.75       | 206.00 | 207.25 | 208.50 | 209.75 | 209.25 | 209.75 | 210.25 |
| P4         | 222.50       | 219.63 | 221.00 | 222.25 | 223.50 | 224.75 | 225.00 | 226.25 |
| P5         | 232.25       | 228.75 | 230.00 | 231.25 | 232.50 | 233.75 | 234.00 | 235.25 |
| P6 (Control) | 238.75     | 235.63 | 237.00 | 238.25 | 239.50 | 240.75 | 241.00 | 242.25 |
| Mean       | 238.75       | 236.00 | 237.25 | 238.50 | 239.75 | 240.25 | 241.00 | 242.25 |
| Year 2016 & 2017 Pruning time | Guava genotypes | Interaction (P×G) |
| SE(m) ±     | 0.81         | 0.87 | 2.14 |   |   |   |   |
| CD 5%       | 2.24         | 2.42 | 5.93 |   |   |   |   |
noticed in P2G4 and minimum (177.00 mg/100 g) in P2G1 treatment combinations. The results indicated that the maximum ascorbic acid content in fruit increased with pruning as compared to control ones. This might be due to the abundant availability of photosynthesis for limited number of fruits leads to increase in ascorbic acid. As well as prevalence of low temperature increases ascorbic acid in fruit. The results are similar findings of Dubey et al. (2002) [9], Prakash et al. (2012) [13] and Mali et al. (2016) who registered the highest ascorbic acid content in fruits produced by trees subjected to severe pruning, also observed improved ascorbic acid content in fruits of guava after pruning.

Sugar: acid ratio of fruit

The data in respect to sugar: acid ratio of fruit is presented in Table 7. Significant differences in sugar: ratio of fruit was recorded due to effect of pruning time and genotypes. In pooled results, the maximum sugar: acid ratio of fruit (21.71) was noted in P2 treatment and minimum (18.99) in P3 treatment in pooled data. Data in respect to effect of different genotypes revealed that, significantly maximum sugar: acid ratio (22.33) was recorded in G6 genotype and minimum (16.38) in G1 genotype. The effect of various interactions between different pruning time and genotypes were found maximum sugar: acid ratio of fruit (24.17) in P2G3 treatment combination and minimum sugar: acid ratio (15.38) in P3G1 treatment combination.

Table 7: Effect of pruning time and genotypes on sugar: acid ratio of fruit

| Treatments | Sugar: Acid ratio of fruit (Pooled data of 2 years- 2016 & 2017) | Guava genotypes |
|------------|-----------------------------------------------------------------|-----------------|
|            | Pooled data of 2016 & 2017                                      |                 |
| Pruning     | G1                  | G2                  | G3                  | G4                  | G5                  | G6                  | G7                  | Mean |
| time        |                     |                     |                     |                     |                     |                     |                     |       |
| P1          | 16.71               | 21.82               | 23.34               | 20.57               | 20.10               | 23.20               | 22.29               | 21.15 |
| P2          | 17.76               | 22.37               | 24.17               | 20.72               | 20.50               | 23.49               | 22.98               | 21.71 |
| P3          | 16.07               | 20.81               | 21.41               | 20.01               | 19.48               | 21.25               | 19.58               | 19.80 |
| P4          | 15.88               | 20.44               | 20.77               | 19.42               | 19.32               | 19.97               | 18.97               | 19.25 |
| P5          | 15.38               | 19.76               | 21.04               | 19.13               | 18.89               | 19.71               | 19.05               | 18.99 |
| P6 (Control)| 16.48               | 21.09               | 23.24               | 20.54               | 20.15               | 23.35               | 20.88               | 20.82 |
| Mean        | 16.38               | 21.05               | 22.33               | 20.07               | 19.74               | 21.83               | 20.62               | 20.29 |
| Year 2016 & 2017 | Pruning time | Guava genotypes | Interaction (P×G) |
|               |                     |                     |                     |                     |                     |                     |                     |       |
| SE(m) ±     | 0.32                | 0.34                | 0.34                | 0.84                |                     |                     |                     |       |
| CD 5%       | 0.88                | 0.95                | 0.95                | NS                  |                     |                     |                     |       |

Overall considering the results revealed that, maximum sugar: acid ratio was noticed in pruned plants as compared to control plants of guava. This might be due to healthy shoot canopy, better sun light distribution in canopy, better sun light utilization and better photosynthetic rate in pruned plants. Shirsath (2013) [17] and Nikumbhe (2014) [11] reported similar results that maximum sugar: acid ratio was recorded in pruned plants compared to control plants in guava.

Shelf life of fruit (days)

The data on shelf life of fruit are displayed in Table 8. The effect of pruning times and genotypes was found to be significant during both the years and pooled results for shelf life of fruit. Effect of pruning time indicated that, the maximum shelf life of fruit (8.44 days) was recorded in P1 treatment, which was at par with P2 treatment (8.30 days) and the minimum (7.13 days) in P3 treatment. Effect of genotypes revealed that, the G6 genotype was recorded significantly maximum shelf life of fruit (9.20 days), which was at par with G3 genotype (9.11 days) and G6 genotype (9.09 days) while the minimum (3.57 days) in G1 genotype.

Table 8: Effect of pruning time and genotypes on shelf life of fruit (days)

| Treatments | Shelf life of fruit (Pooled data of 2 years- 2016 & 2017) | Guava genotypes |
|------------|----------------------------------------------------------|-----------------|
|            |                                                           |                 |
| Pruning     | G1                  | G2                  | G3                  | G4                  | G5                  | G6                  | G7                  | Mean |
| time        |                     |                     |                     |                     |                     |                     |                     |       |
| P1          | 3.70                | 8.86                | 9.60                | 9.75                | 8.75                | 9.56                | 8.88                | 8.44 |
| P2          | 3.60                | 8.72                | 9.53                | 9.63                | 8.58                | 9.51                | 8.55                | 8.30 |
| P3          | 3.63                | 8.47                | 8.99                | 9.11                | 8.42                | 9.15                | 8.53                | 8.04 |
| P4          | 3.53                | 8.11                | 9.01                | 9.08                | 8.19                | 9.01                | 8.14                | 7.87 |
| P5          | 3.28                | 7.36                | 8.12                | 8.11                | 7.41                | 7.84                | 7.80                | 7.13 |
| P6 (Control)| 3.70                | 8.39                | 9.39                | 9.50                | 8.50                | 9.51                | 8.83                | 8.26 |
| Mean        | 3.57                | 8.32                | 9.11                | 9.20                | 8.31                | 9.09                | 8.45                | 8.01 |

Regarding interactions effect of pruning time and genotypes, the P1G4 treatment was recorded maximum shelf life of fruit (9.75 days), which was at par with P1G6 (9.63 days), P1G3 (9.60 days), P1G6 (9.56 days), P1G1 (9.53 days), P1G6 (9.51 days), P1G5 (9.51 days), P1G6 (9.50 days) and P1G1 (9.39 days) treatment combinations and minimum in P1G6 (3.28 days) treatment combination. The results indicated that maximum shelf life of fruit was recorded in the pruning time of 15th May (P6) but later it was decreased from June to September pruning treatments and control. It might be due to slow rate of respiration of fruit due to which slow degradation of fruit taking place in low temperature. Nikumbhe (2014) [11] reported that maximum shelf life of fruit was recorded in 15th May compared to other treatments in guava.

Conclusion

The results of present research it can be concluded that, the genotype RHR-Guv-60 is better in quality parameters like lustrous fruit, crispy pulp texture, maximum total sugars, reducing sugars and sugar acid ratio with minimum acidity thus it can be evaluated for cultivation as mirig bhar crop.

Acknowledgement

The authors are sincerely thankful to Department of Science & Technology, Ministry of Science & Technology, Govt. of India, New Delhi for financial assistance during Ph.D. Program research.

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