UNDER PEER REVIEW

Original Research Article

Effect of Pre-harvest Application of Paclobutrazol and Ethephon on Physico-chemical Characteristics of Winter Guava cv. Sardar

ABSTRACT

The investigation on effect of pre-harvest application of paclobutrazol and ethephon on physico-chemical characteristics of winter guava cv. Sardar was conducted in the well maintained guava orchard of Department of Agriculture, Khalsa College, Amritsar during 2016-2017. The experiment comprised of seven pre-harvest treatments viz. Paclobutrazol @ 250 ppm, 500 ppm, 750 ppm, Ethephon @ 250 ppm, 500 ppm, 750 ppm and control. The experiment was laid out in Randomized Block Design (RBD) with three replications. Results of the study revealed that marked variations were recorded among the pre-harvest treatments on physico- chemical characters of guava. Among all treatments, paclobutrazol 750 ppm treated fruits showed maximum fruit size (6.62 cm × 6.40 cm), fruit weight (155.43 g), pulp content (87.4 %) and fruit yield (37.85 Kg/plant). Whereas, the fruit bio-chemical characters were improved significantly with the use of ethephon 750 ppm (T_6). Maximum TSS (10.75 %), total sugars (7.89 %), reducing sugars (5.86 %) and ascorbic acid content (194.27 mg/100 g pulp) was observed under treatment T_6. Also the fruits harvested from trees under treatment T_6 attained excellent fruit colour with minimum seed count.

Keywords : Guava, Sardar, Physico-chemical characteristics, Paclobutrazol, Ethephon

1. INTRODUCTION

Guava (*Psidium guajava* L.) is native to central America and belongs to family Myrtaceae and order Myrtales [1]**.** It is a tropical fruit but also grows well under sub-tropical conditions. Guava is cultivated on commercial scale in Mexico, Peru, Egypt, India, South Africa, USA, Brazil and West Indies [2]. Guava fruit is very nutritious being rich in vitamin C (200-300 mg/100 g of pulp). It is also a good source of vitamin A, riboflavin, thiamine and minerals like Calcium, Phosphorus and Iron. The vitamin C content of guava fruit is four-five times higher than the citrus fruit. It is used for making juice, jam, jellies and various culinary purposes [3]. It is a rich source of potassium which is an important component of cell and body fluids that helps in controlling heart rate and blood pressure [2]. Guava trees do well to canopy modification with respect to vegetative and reproductive growth, modification of

UNDER PEER REVIEW

canopy through pruning and use of certain growth regulators may be required to enhance production efficiency [4]. Growth regulators like paclobutrazol and ethephon may be used for this purpose. Paclobutrazol blocks gibberellin biosynthesis and helps in reducing abscissic acid, ethylene and Indole-3 acetic acid while increasing cytokinin levels. Due to blockage of gibberellins, internodal growth is reduced to give stouter stems, increasing root growth and causing early fruit set and also improve fruit quality [5]. Whereas, ethephon acts as a ripening hormone and its mode of action on plants is similar to the influence of hormonal antiauxins and releases ethylene. Foliar application of ethephon has proved to be effective in retarding the vegetative growth and increases the fruit yield as well as quality also improved [6]. Ethephon enhances fruit ripening one week earlier than normal harvesting time. It also improves fruit quality in terms of TSS, total sugars and reducing sugars.

2. MATERIALS AND METHODS

The study was conducted in the well maintained guava orchard of Department of Agriculture, Khalsa College, Amritsar during 2016-2017. The trial was conducted on 6 years old uniform vigorous guava trees. The fruits were harvested at proper stage of maturity and the analysis was carried out in the laboratory of Department of Agriculture. The experiment was conducted in Randomized Block Design with three replications and seven treatments viz., T_1: Paclobutrazol 250 ppm, T_2: Paclobutrazol 500 ppm, T_3: 750 ppm, T_4: Ethephon 250 ppm, T_5: Ethephon 500 ppm, T_6: Ethephon 750 ppm and T_7: Control. The fruit length and breadth was measured with the help of Vernier's Caliper, fruit weight with electronic balance, pulp content by calculating pulp and peel weight separately, seeds were calculated by manually counting the seeds with fermentation method, yield per tree was calculated by multiplying the average fruit weight by total number of fruits obtained per tree and fruit colour was obtained with the help of scoring technique by panel of five judges. The TSS of fruits was determined with the help of hand refractometer. Sugars and acidity in fruits was calculated by the methods given by [7]. Ascorbic acid was estimated by indophenol dye method.

3. RESULTS AND DISCUSSION

The physical characters of guava fruits were significantly influenced by the pre-harvest application of paclobutrazol and ethephon. Maximum fruit size (6.62 cm × 6.40 cm) was obtained from the fruits treated with paclobutrazol 750 ppm and minimum was observed in control fruits (6.12 cm ×5.97 cm). Increase in fruit size and fruit weight with the application of paclobutrazol might be attributed to increased supply of nutrients and photosynthates to

UNDER PEER REVIEW

developing fruits at the expense of restricted vegetative growth. [8]. The present results are in accordance, [3] in guava and [9] in grapes.

Maximum fruit weight (155.43 g) was registered in fruits harvested from the trees treated with paclobutrazol 750 ppm while the trees under control yielded fruits with minimum fruit weight (132.69 g). With the application of paclobutrazol, the vegetative growth was suppressed and the supply of nutrients and photosynthates to the fruits increased surprisingly, by which the fruit weight increased significantly [8]. The results obtained from the study also get support from the findings of [10] in peach, [8] in guava, [11] in mango and [9] in grapes.

The fruits obtained from the trees treated with ethephon 750 ppm attained excellent colour with scoring of 8.67 (pale yellow). The former treatment was found to be at par with treatment ethephon 500 ppm with similar coloured fruits (8.33). Fruit colour improvement in ethephon may be due to ripening enhancing properties of ethephon [8]. However the guava trees under control (6.33) gave light green coloured fruits. Similar results were obtained by the [12] in peach.

The trees under treatment of paclobutrazol 750 ppm produced fruits with significant pulp content (87.40 %). Ethephon 750 ppm yielded fruits with 86.80 per cent pulp content and found to be at par with treatment paclobutrazol 500 ppm (86.30 %). However the above treatments were found to be significantly superior to rest of the treatments. The increase in pulp content could be attributed to the fact that the growth regulators increased the fruit size as well as fruit weight which resulted in high proportion of pulp content. Present findings are in line with the results obtained by [8] in guava and [12] in peach.

The least number of seeds (219.33) were extracted from the fruits picked from trees sprayed with the ethephon 750 ppm whereas maximum number of seeds (312) were extracted from fruits picked from trees under control. The present results of the investigation are in conformity with the findings of [3] and [8] in guava.

The plants treated with paclobutrazol 750 ppm recorded the maximum fruit yield (37.85 Kg) which was followed by treatment Ethephon 750 ppm with fruit yield of 36.75 Kg. Minimum fruit yield (25.86 Kg) was noticed under the control treatment. Yield depends upon reserve food materials maintained by the plants. The trees treated with paclobutrazol and ethephon might have less gibberellins and higher photosynthates, while less energy was utilized for vegetative growth and having more energy for flower bud initiation, fruit setting, fruit size and weight which ultimately lead to increase in yield [6]. The present results are in line with

UNDER PEER REVIEW

the findings of [1], [4] in guava, [13] in pomegranate, [14] in litchi and [9] in grapes, [15], [16] in guava and [17] in peaches.

From the data it has been observed that total soluble solids in fruits increased significantly with the use of paclobutrazol and ethephon. Maximum TSS (10.75 %) was observed in fruits obtained from the trees treated with ethephon 750 ppm (T_6) which was followed by the treatments T_3 (Paclobutrazol 750 ppm) and T_5 (Ethephon 500 ppm) with TSS content of 10.58 and 10.50 per cent respectively. Increase in TSS by ethephon might be due to increase in sugar content by the activation of hydrolytic enzymes which are responsible for the conversion of starch into sugars [6]. Minimum TSS content (9.12 %) was noticed under the control (T_7) and found to be at par with treatments T_1 (Paclobutrazol 250 ppm) and T_4 (Ethephon 250 ppm) with TSS content of 9.31 per cent each. The results obtained from the present study are in conformation with findings of [6] in gooseberry, [9] in grapes, [18] and [8] in guava.

Acidic content in fruits was greatly influenced by the application of various concentrations of growth regulators. The fruits harvested from trees treated with ethephon 750 ppm contained minimum acidity i.e.0.46 per cent. The former treatment was found to be statistically at par with the treatments T_3 (Paclobutrazol 750 ppm) and T_5 (Ethephon 500 ppm) with acidic contents of 0.50 and 0.49 per cent respectively. Decrease in acidic content of fruits by the use of growth regulators might be due to the increasing rate of respiration which leads to the conversion of complex substances or acids into simple sugars [19]. While the trees under control produced significantly acidic fruits (0.59 %). These observations are also in agreement with the findings of [20] in papaya, [21] in strawberry, [8] in guava.

All the treatments significantly improved TSS: acid ratio over control. Significantly higher TSS: acid ratio (23.39) was found in fruits harvested from the trees treated with ethephon 750 ppm and it was followed by T_5 (Ethephon 500 ppm) and T_3 (Paclobutrazol 500 ppm) with TSS: acid ratio of 21.48 and 21.22 respectively. Ethephon 250 ppm recorded the TSS: acid ratio of (17.90) which was at par with paclobutrazol 250 ppm (17.59) and the lowest TSS: acid ratio was observed under the control treatment (15.46). Results of these findings are also confirmed by [22] in papaya, [9] and [23] in grapes.

Total sugars in fruits significantly improved with the use of growth regulators than control. Significantly higher total sugars (7.89 %) were found in fruits harvested from the trees treated with T_6 (Ethephon 750 ppm). Minimum total sugars (7.07 %) were found under the control

UNDER PEER REVIEW

which was found to be closely followed by the treatment T_1 (Paclobutrazol 250 ppm) with 7.12 per cent total sugar.

Paclobutrazol and ethephon exerted a significant influence on reducing sugars in guava fruits. Highest percentage (5.86 %) of reducing sugars were recorded in the fruits treated with ethephon 750 ppm (T_6) while it was closely followed by treatments T_5 (Ethephon 500 ppm) and T_3 (Paclobutrazol 750 ppm) with reducing sugars of 5.81 and 5.61 per cent respectively. Minimum reducing sugars (4.90 %) were observed in treatment T_1 (Paclobutrazol 250 ppm) and was found to be statistically at par with the treatments T_7 (5.14 %) and T_4 (5.18 %).

It can be seen from the data that treatments had non-significant effect on non-reducing sugars in fruits. Maximum non reducing sugars (2.26 %) were observed in the fruits obtained from trees treated with treatment T_4 (Ethephon 250 ppm). However minimum non reducing sugars (1.81 %) were noticed under treatment T_5. From the given data, it is evident that sugar content of guava fruits was significantly improved with the use of growth regulators than control. It seems that paclobutrazol and ethephon might have caused an increase in hydrolytic activities in fruits which resulted in increased sugars content in the fruits treated with these treatments. The observations are also in agreement with the findings of [18] in guava, [6] in gooseberry, [24] in phalsa, [20] in papaya [15].

Ascorbic acid content was significantly influenced by the application of growth regulators. Significant ascorbic acid content (194.27 mg/100 g pulp) was recorded in fruits obtained from trees treated with treatment T_6 (Ethephon 750 ppm). The increase in ascorbic acid content might be due to the catalytic influence of the growth substances on the biosynthesis of ascorbic acid from sugars. Inhibited activity of oxidative enzyme and enhanced photo-phosphorylation prolonged the photo synthesizing ability of chlorophylous leaves and fruits, probably caused by paclobutrazol and ethephon which might have helped in increasing the ascorbic acid content [6]. However minimum ascorbic acid content (178.99 mg/100 g pulp) was recorded under the control. The present observations are also in agreement with the findings of [8] and [18] in guava.

Table 1 : Effect of pre-harvest application of paclobutrazol and ethephon on fruit physical characteristics of winter guava cv. Sardar

Treatments	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Fruit colour	Pulp content (%)	Seed count per	Yield per tree

UNDER PEER REVIEW

						fruit	(Kg)
T_1 - Paclobutrazol 250 ppm	6.37	6.21	148.25	6.67	85.00	278.33	30.17
T_2 - Paclobutrazol 500 ppm	6.53	6.32	150.64	7.33	86.30	247.67	34.06
T_3 - Paclobutrazol 750 ppm	6.62	6.40	155.43	7.67	87.40	238.97	37.85
T_4 - Ethephon 250 ppm	6.26	6.07	138.73	8.00	84.89	230.67	32.75
T_5 - Ethephon 500 ppm	6.42	6.13	142.21	8.33	85.31	234.00	34.80
T_6 - Ethephon 750 ppm	6.39	6.22	145.32	8.67	86.80	219.33	36.75
T_7 - Control	6.12	5.97	132.69	6.33	84.60	312.00	25.86
Mean	6.39	6.19	144.75	7.57	85.76	251.57	33.18
CD (P=0.05 %)	0.11	0.17	6.05	0.61	0.73	NS	1.52

Table 2 : Effect of various concentrations of paclobutrazol and ethephon on total soluble solids , titratable acidity and TSS: acid ratio in fruits of guava cv. Sardar.

Treatments	**Total soluble solids (%)**	**Titratable acidity (%)**	**TSS: acid ratio**
T_1 – Paclobutrazol 250 ppm	9.31	0.53	17.59
T_2 – Paclobutrazol 500 ppm	10.22	0.51	20.07
T_3 – Paclobutrazol 750 ppm	10.58	0.50	21.22
T_4 – Ethephon 250 ppm	9.31	0.52	17.90
T_5 – Ethephon 500 ppm	10.50	0.49	21.48
T_6 – Ethephon 750 ppm	10.75	0.46	23.39
T_7 – Control	9.12	0.59	15.46
Mean	9.97	0.51	19.59
CD (P = 0.05%)	0.39	0.04	1.27

Table 3 : Effect of various concentrations of paclobutrazol and ethephon on sugars and ascorbic acid content of guava cv. Sardar.

Treatments	**Total sugars (%)**	**Reducing sugars (%)**	**Non reducing sugars (%)**	**Ascorbic acid (mg/100 g pulp)**

UNDER PEER REVIEW

T_1- Paclobutrazol 250 ppm	7.12	4.90	2.22	181.24
T_2 – Paclobutrazol 500 ppm	7.50	5.53	1.98	184.65
T_3- Paclobutrazol 750 ppm	7.51	5.61	1.90	187.42
T_4- Ethephon 250 ppm	7.44	5.18	2.26	187.14
T_5-Ethephon 500 ppm	7.62	5.81	1.81	191.49
T_6-Ethephon 750 ppm	7.89	5.86	2.03	194.27
T_7- Control	7.07	5.14	1.93	178.99
Mean	7.45	5.53	2.02	186.46
CD (P=0.05 %)	0.14	0.42	NS	2.17

4. CONCLUSION

It is concluded from the study that paclobutrazol 750 ppm proved to be the most effective treatment in enhancing fruit physical characters, however it was closely followed by ethephon 750 ppm. Fruit bio-chemical characters were found to be significant by the use of ethephon 750 ppm. Hence it has been suggested that ethephon 750 ppm could be used for improving the quality characters of guava fruits cv. Sardar.

REFERENCES

1. Jain MC and Dashora LK. Growth, flowering, fruiting and yield of guava (*Psidium guajava* L) cv. Sardar as influenced by various plant growth regulators. International Journal of Agricultural Sciences. 2007; 3 (1) : 4-7

2. Bal JS. Fruit Growing (Kalyani Publishers) ; 1997 Third Revised Edition ; 2014.

3. Singh C and Bal JS. Effect of nutrients and growth regulators on fruit drop, size and yield of ber (*Zizyphus mauritiana* Lamk). International Journal of Agricultural Sciences. 2006 ; 2 (2) **:** 358-360

4. Brar JS and Bal JS. Role of paclobutrazol and ethephon in reproductive growth of 'Allahabad Safeda' guava (*Psidium guajava* L.) plants at different spacing. Journal of Horticultural Sciences. 2010 ; 5 (2) **:** 128-133.

UNDER PEER REVIEW

5. Singh HJ and Bal JS. Effect of pruning and growth regulators on physico-chemical characters of guava during rainy season planted at different spacing. International Journal of Agricultural Sciences. 2006 ; 2 (2) **:** 533-537.

6. Yadava LP, Patil R and Gupta VK. Effect of paclobutrazol and ethephon on the biochemical constituents of cape gooseberry (*Physalis peruviana* L). Asian Journal of Biological Sciences. 2008 ; 3 (1) : 124-126.

7. AOAC. Official methods of analysis. 12th edn. 1990 ; Association of Official Analytic Chemists, Washington DC.

8. Brar JS, Dhaliwal HS and Bal JS. Influence of Paclobutrazol and Ethephon on fruit quality of 'Allahabad Safeda' Guava. Hortflora Research Spectrum. 2012 ; 1(2) : 135-13.

9. Kaur M, Gill MIS and Arora NK. Effect of pre-harvest treatment on yield, maturity and quality of Flame Seedless grape (*Vitis vinifera* L). Journal of Horticultural Sciences. 2013 ; 8(1) : 35-40

10. Taheri A, Cline JA, Jayasankar S and Pauls PK. Ethephon-induced abscission of ''Redhaven'' peach. American Journal of Plant Sciences. 2012 ; 3 : 295-301.

11. Bamini T, Parphiban S and Manivanan MI. Effect of pruning and paclobutrazol application on yield and quality of mango (*Mangifera indica* var. Neelam) Asian Sciences. 2009 ; 4 (1&2) : 65-68.

12. Meitei SB, Patel RK, Deka BC, Deshmukh NA and Singh A. Effect of chemical thinning on yield and quality of peach cv. Flordasun. African Journal of Agricultural Research. 2013 ; 8 (27) : 3558-3565.

13. Goswami JD, Patel NM, Bhadauria HS and Wankhade VR. Effect of plant growth substances on growth, fruit setting and yield of pomegranate cv. Sinduri. International Journal of Agricultural Sciences. 2013; 9 (1) : 332-334.

14. Singh B, Singh S and Sandhu S. Effect of growth retardants on vegetative growth, flowering and fruiting of litchi cv. Calcuttia. Hortflora Research Spectrum. 2012 ; 1(1) : 29-33.

15. Yadav S, Bhatia SK, Godara RK and Rana GS. Effect of growth regulators on yield and quality of winter season guava cv. L-49. Harayana Journal of Horticultural Sciences. 2001; 30 (1/2) : 133-137.

UNDER PEER REVIEW

16. Suleman M, Sharma JR, Kumar R, Gupta RB and Singh S. Effect of different chemicals on cropping pattern and quality of guava cv. Sardar. Harayana Journal of Horticultural Sciences. 2006 ; 35 (3/4) : 226-227.

17. Coneva E and Cline J. Ethrel delays blossoming, reduces fruit set and increases fruit size of BabyGold 5 peaches. 2009; http://www.uoguelph.ca/plant/treefruit/outreach/ethrelposter.pdf.

18. Rajput RP, Senjaliya HJ, Vala GS and Mangroliya GS. Effect of various plant growth regulators on yield and quality of guava (*Psidium guajava* L). International Journal of Agricultural Sciences. 2015 ; 11(1) : 179-182.

19. Ruffner HP, Hoblet W and Rast D. Gluconeogenesis in the ripening berries of *Vitis vinifera*. Vitis. 1975 ; 13 : 319-322.

20. Hazarika TK, Sangma BD, Mandal D, Nautiyal BP and Shukla AC. Effect of plant growth regulators on growth, yield and quality of tissue cultured papaya (*Carica papaya*) cv. Red lady. Indian Journal of Agricultural Sciences. 2015 ; 86 (3) : 404-408.

21. Kazemi M. Pre-harvest foliar application of paclobutrazol, boric acid and gibberellic acid influences vegetative growth, reproductive characteristics and quality of strawberry (*Fragaria* × *ananassa* Duch. Cv. Camarosa). Bulletin of Environment Pharmacology Life Sciences. 2014 ; 3 (4): 183-187.

22. Baskaran A and Sathiamurthy S. Effect of growth retardants on quality of papaya (*Carica papaya* Linn) cv. CO_2. The Asian Journal of horticulture. 2008; 3(2) : 313-314.

23. Godara AK, Chauhan KS and Kumar A. Effect of various pre harvest treatments on the quality of Thompson seedless grapes. Haryana Journal of Horticultural Sciences. 2002 ; 31 : 164-167.

24. Kacha HL, Giriraj J and Patel SK. Performance of various plant growth regulators on yield and quality of phalsa (*Grewia asiatica* L) Hortflora Research Spectrum. 2014 ; 3 (3) : 292-294.