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INFLUENCE OF DEFOLIATION AND DEBLOSSOMING ON FRUIT QUALITY OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. GOLA

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Abstract

To investigate the influence of defoliation and deblossoming on fruit quality of guava (*Psidium guajava* L.), trees of cv. 'Gola' were subjected to various levels of defoliation and deblossoming manually [T1 = control (no defoliation and deblossoming), T2 = 100% defoliation + 100% deblossoming, T3 = 50% defoliation + 50% deblossoming, T4 = 0% defoliation + 50% deblossoming, and T5 = 0% defoliation + 100% deblossoming] by using pruning scissor in the last week of April. The physical and biochemical fruit characteristics were recorded at harvest. Defoliation and deblossoming significantly affected the fruit size and maximum fruit size (34.4 cm^{-2}) was exhibited by fruit harvested from trees subjected to T4 in summer. However, other physical fruit quality characteristics did not differ significantly with various levels of defoliation and deblossoming. Fruit harvested from trees subjected to T4 exhibited maximum score for organoleptic characteristics. The level of total soluble solids (12.2%) in the guava juice in summer crop and reducing sugars (2.6%) in winter crops exhibited significantly higher values than other treatments. It can be concluded that trees subjected to different defoliation and deblossoming levels had a significant influence on fruit quality of guava cv. 'Gola'. Application of 50% deblossoming without defoliation produced fruit with better fruit size, organoleptic chatacetistics, souble solids, ascorbic acid and reducing sugars both during summer as well as winter crop.

Introduction

Guava *(Psidium guajava* L.) commonly known as "*Amrood*" in Farsi and Urdu, and "*Jaam"* in Sindhi belongs to family Myrtaceae. It is usually known as the poor man's fruit or apple of the tropics. It was originated in tropical America and then distributed throughout the world. Presently, with respect to its area and production, it is a popular fruit of tropical and subtropical regions throughout the world (Samson, 1986). At present about 106 MMT of guava fruit is being produced in the world (Anon., 2010a). Currently Brazil, USA and China are leading guava producing countries with 24, 10 and 3 MMT production respectively (Anon., 2010a). Like in the world guava also holds important position with respect to area (62 thousand ha) as well as production (555 thousand tonnes) and the Punjab province contributes the major share (77%) of guava production in the Pakistan (Anony., 2010b).

Guava is one of the attractive fruit in appearance, shape, fragrance and nutrition. Depending on cultivars, it contains four times more ascorbic acid than orange (over 200 mg 100^{-1}g) and generally a broad low-calorie profile of essential nutrients (Adrees *et al.*, 2010; Hassimotto *et al.*, 2005; Swain & Padhi, 2012). Its seeds provide omega-3 and omega-6 polyunsaturated fatty acids and especially high levels of dietary fiber (Anon., 2009). It contains carotenoids and polyphenols which are the major classes of dietary antioxidant pigments among plant foods (Hassimotto *et al.*, 2005; Jimenez-Escrig *et al.*, 2001). Due to their astringent properties, mature guava fruits, leaves, roots and bark are used in local medicines to treat gastroenteritis, asthma, high blood pressure, obesity and diarrhea (Joseph & Priya, 2011).

Guava is crop of tropical to subtropical climactic regions and in tropics it bears throughout the year. However, under subtropical climactic conditions like Punjab, Pakistan it can produce two crops in a year i.e. summer season crop (flowering during months of April-May and harvesting during July-August) and winter season crops (flowering during months of November-December and harvesting during February-March) and remains available for 8 to 9 months in the market (Samson, 1986). However, due to poor management practices guava orchards in Pakistan face some physiological disorders. Different diseases like wilt and canker; insect pests like fruit fly and guava moth etc are also the major factors involved in deterioration of productivity and fruit quality. The summer crop is severely attached by fruit fly infestation which adversely affects the quality and results in a significant loss to most of the guava growers. The guava fruit is the preferred food host of fruit fly and the main damage is caused by the larvae, which feed inside the fruit (Norrbom, 2001; Stonehouse *et al.*, 2002). Due to this reason in certain areas of the Pakistan, to get rid of the summer crop, people physically beat their trees at flowering or at initial fruit set stage. Along with removal of leaves this practice results in excessive defoliation and severe bark injury leading towards several physiological problems and diseases. Under sever conditions during higher summer temperature the affected trees heat up due to lack of proper transpiration from the existing foliage. Recently, we reported that application of defoliation and deblossoming significantly `affect the vegetative and reproductive growth of guava (Khan *et al.*, 2011). However, at present very little information is available about the effects of defoliation and deblossoming in relation to tree productivity and fruit quality of guava. Hence, current study was conducted to investigate the effects of defoliation along with deblossoming during summer on fruit quality of summer as well as winter crop of guava cv. Gola under agro-climatic conditions of Faisalabad.

Materials and Methods

Plant material: The research work was carried out on 3 to 4 years old Guava (*Psidium guajava* L.) cv. Gola trees grown under uniform condition at Experimental Fruit Orchard, Institute of Horticultural Sciences, University of Agriculture, Faisalabad (31°25'N; 73°09'E). Twenty guava trees uniform in health, size and vigour were selected for the experiment. Experimental trees were subjected to different levels of defoliation and deblossoming during the last week of April at flower bud initiation stage. The manual defoliation and deblossoming was done by using pruning scissor to study their effects on productivity and fruit quality. Following treatment combinations were used in the study.

T_1 = Control (no defoliation + no deblossoming)
T_2 = 100% defoliation + 100% deblossoming
T_3 = 50% defoliation + 50% deblossoming
T_4 = No defoliation + 50% deblossoming
T_5 = No defoliation + 100% deblossoming

Appart from the exprimental treatments, all the trees were subjected to the same cultural practices such as irrigation, weeding, insect pest and disease control during the study. The experiment was carried out according to Randomized Complete Block Design and single tree was used as a treatment unit replicated four times.

Fruit size: The size of fruit was determined by measuring the fruit width and length by using vernier caliper. Ten fruit per treatment unit were used as sampling unit and then average was determined as were expressed in cm^2.

Fruit firmness: The firmness of the fruit were measured with the help of penitrometer and was expressed in pounds (lbs) as reported by Abbasi *et al*., (2010).

Fruit volume: Fruit volume was obtained by water displacement method and was expressed in ml.

Fruit pulp and **core weight:** Fruit pulp and core weights were determined by weighing five fruits per treatment unit on digital balance (UWE–ESP Digital Electric, Tokyo, Japan) and average weight was expressed in gram.

Pulp: core ratio**:** Pulp to core ratio was calculated by dividing pulp weight by core weight. The average pulp and core percentage per fruit was obtained from the following formula:

$$\text{Pulp or core \% age} = \frac{\text{Pulp or core weight per fruit}}{\text{Average fruit weight}} \times 100$$

Sensory evaluation: Sensory evaluation of fruit quality was performed by using the 9 point hedonic scale described by (Peryam & Pilgrim, 1957).

Total soluble solids (TSS): The TSS of the juice was determined by using the automatic temperature compensating type ATC-20E hand refractormeter (32-10 Honcho, Itabashi-ku, Tokyo 173-0001, Japan) as reported earlier by Khan *et al*., (2009) and was expressed as ^{o}Brix (%).

Titrateable acidity (TA): The TA of the fruit juice was determined by titrating to pH 8.2 with 0.1 N NaOH, using phenolphthalein as an indicator, and was expressed as % malic acid. The SSC:TA ratio was calculated by dividing SSC by the corresponding TA value as reported by Khan *et al*., (2009).

Fruit pH: The pH of the fruit juice was determined with the help of pH meter (Model HI 98107, Hanna instruments, Mauritius).

Ascorbic acid: To determine the ascorbic acid contents in the fruit juice, 10 ml of juice was diluted with 0.4% oxalic acid solution and 5 ml of filtered aliquot was titrated against 2, 6-dichlorophenol indophenol dye to light pink colour end point. Ascorbic acid contents were determined as mg 100 ml^{-1} FW as reported by Saleem *et al*., (2008).

Sugars: Reducing, non-reduceing and total sugars from the juice were determined by using the method of Shafiq *et al*., (2011).

Statistical analysis: The data collted were subjected to analysis of variance (ANOVA) using MSTAT-C statistical software (Freed, 1994) using randomized complete block design. The effects of various treatments were accessed within the ANOVA for various parameters and least significant differences (LSD) were calculated by using the F test ($p \leq 0.05$). All assumptions of the analysis were checked to ensure the validity of the statistical analysis. There were four treatments replicated four times and two trees were taken as a treatment unit.

Results and Discussion

Physical characteristics

Fruit size and volume: Fruit harvested from the trees subjected to different levels of defoliation and deblossoming exhibited significant ($p \leq 0.05$) increase in the fruit size in terms of both fruit length and diameter during summer season compared to winter season. Highest fruit size of summer crop at harvest was achieved at 50% deblossoming as compared to control which got minimum fruit size (Table 1). However, in winter maximum fruit size was achieved by 100% defoliation and deblossoming level as compared to control. Lowest fruit size was obtained at 100% deblossoming level. On the average, mean values for summer and winter fruit size was also reflected non-significant differences. Mean fruit size was higher in winter crop as compared to summer crop. Maximum fruit diameter was obtained by the application of 50% deblossoming level, while minimum fruit diameter was achieved at 100% defoliation and deblossoming level as compared to control. Highest fruit diameter was achieved in winter at 100% deblossoming while least minimum diameter was marked at 100% defoliation and deblossoming level (Table 1).

Table 1. Effects of defoliation and deblossoming on fruit diameter, length, size and volume of guava cv. Gola fruit during summer and winter crops.

Treatments	Fruit diameter		Fruit length		Fruit size		Fruit volume	
	Summer (cm)	Winter (cm)	Summer (cm)	Winter (cm)	Summer (cm^2)	Winter (cm^2)	Summer (ml)	Winter (ml)
T1	5.0c	6.2	4.7c	6.1	23.5b	38.0	71.5	130.6
T2	-	6.1	-	6.1	-	37.3	-	102.5
T3	5.6b	6.2	5.5b	6.1	31.1a	38.0	90.5	130.0
T4	6.0a	6.9	5.8a	6.5	34.4a	45.3	106.3	132.5
T5	-	6.7	-	6.7	-	45.1	-	146.3
	*	NS	*	NS	*	NS	NS	NS
Means	**5.5.1b**	**6.4.6a**	**5.3.5b**	**6.2.3a**	**34.9NS**	**35.2NS**	**89.4b**	**131.0a**

*, NS = Significant and non-significant at $p \leq 0.05$, respectively. n = 4 replicates. Any two means not sharing same letter differ significantly at 5% level of probability. T1 = Control; T2 = 100% defoliation + deblossoming; T3 = 50% defoliation + deblossoming; T4 = 50% deblossoming; T5 = 100% deblossoming. No fruit was harvested for T2 and T5 during summer crop

Hand defoliation and deblossoming to guava trees did not significantly affect the fruit volume significantly for both the summer and winter season crops. Maximum fruit volumes were obtained at 50% and 100% deblossoming levels in summer and winter fruits, respectively. However, minimum fruit volumes were observed in control and trees subjected to 100% defoliation and deblossoming levels in summer and winter fruits, respectively. It was observed that overall fruit volume was higher in winter as compared to summer fruits (Table 1).

Maximum fruit size in winter, in trees subjected to 100% defoliation and deblossoming was might be due to maximum food reserves for these fruits were available in winter. However, increase in fruit diameter by 100% deblossoming in winter crop might be due to carbohydrate level restored after treatment applications in summer. Similar results were found with double spray of 15% urea followed by hand deblossoming in summer crop of guava, significantly increased fruit size during winter season compared to the control (Sahay & Singh, 2001). While these results contradicting the findings of Njoroge & Rieghard, (2008) who reported that fruit diameter decreased linearly with increase in time to thin and increased linearly with increase in fruit spacing in peach cv. 'Contender'. Increase in the fruit volume during winter might be possible that due to increase in fruit size, fruit volume was also increased in winter as compared to summer fruit. Increase in fruit volume was might be due to the increased duration of fruit growth and development during winter as compared to summer.

Fruit firmness: Statistical analysis at 5% level of significance for both summer and winter crops reflected significant differences at different levels of defoliation and deblossoming for fruit firmness. Maximum firmness was exhibited in the trees subjected to 50% defoliation & deblossoming and at control in summer and winter crops, respectively (Fig. 1). However, minimum values of fruit firmness were recorded in control and at 50% defoliation & deblossoming in both summer and winter crops, respectively. The interaction between summer and winter season crops was significantly different at different levels of defoliation and deblossoming. However, it is clear that mean firmness was higher (2.9 lbs) in summer as compared to winter (1.6 lbs). Decrease in fruit firmness was observed in winter crop as compared to summer crop at defoliation and deblossoming levels. Similar effect of defoliation and pruning treatments have been observed by Harb (1990) in flesh firmness of guava fruit. However, in 'Sensation' mango, no significant differences were found in fruit firmness between the different levels of pruning (Fivaz & Stassen, 1996).

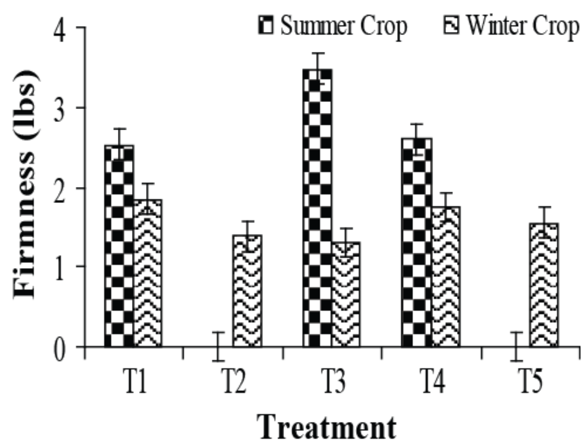

Fig. 1. Effect of defoliation and deblossoming on firmness of summer and winter fruit of guava cv. Gola trees. Vertical bars indicate ± S.E. of mean. n = 4 replicates. T1 = Control; T2 = 100% defoliation + deblossoming; T3 = 50% defoliation + deblossoming; T4 = 50% deblossoming; T5 = 100% deblossoming.

Fruit weight: The influence of hand defoliation and deblossoming did not affect the fruit weight of both summer and winter season crops significantly. Maximum fruit weight was exhibited by fruit harvested from the trees subjected to 50% and 100% deblossoming as compared to control both in summer and winter season crops, respectively (Table 2). However, minimum fruit weight was gained in control and in 100% defoliation and deblossoming levels in summer and winter crop, respectively. Interaction of fruit weight between summer and winter crop at different levels of defoliation and deblossoming reveals that there were non-significant differences. However, means values for fruit weight showed significant differences during summer and winter season crops. The maximum fruit weight (133.6 g) was achieved in winter as compared to summer season crop (82.5 g) (Table 2). In winter, the duration of fruit growth increased, and increased fruit weight was might be due to increase in sucrose accumulation in the pulp tissues of guava fruits. Similarly, maximum fruit weight was achieved with branch pruning (30 cm of length) of guava trees (Hojo *et al.*, 2007; Hussein, 2006). Due to defoliation and deblossoming levels, there was a chance to penetrate light freely inside the canopy. So it might be possible that net photosynthesis increased and maximum reserves were collected in the trees which ultimately utilized by the fruit during their growth and development. Those reserves were utilized by the fruits which helped them to attained increased fruit weight. Similarly, thinning treatments of plums have been fund significantly effective to improve the mean fruit weight (Hamilton-Ilha *et al.*, 1999). However, fruit thinning of 'Sensation' reduced total fruit weight per tree by approximately 50% and 30% respectively (Fivaz & Stassen, 1995).

Pulp and core weight: Similar results were found in all the treatments for pulp weight and core weight as recorded for fruit weight (Table 2). Highest values for pulp weight and core weight were came across at 50% and 100% levels of deblossoming followed by 50% defoliation and deblossoming in summer and winter crops, respectively as compared to control. However, lowest values were recorded for pulp weight and core weight in un-treated trees and 100% defoliation and deblossoming treated trees in summer and winter crop, respectively (Table 2). Pulp weight was found 10% higher than the untreated ones in winter fruits. With the increase in fruit weight, the pulp weight was also increased by defoliation and deblossoming treatments. Maximum food reserve might be available to the fruit to develop its pulp rigorously. While, guava seeds are full of carbohydrates and proteins so defoliation and deblossoming might had increased total available seeds in winter crop hence total number of seeds in the winter fruits were found increased as compared to summer season fruits.

The results were quite different for pulp: core ratio as compared to pulp weight and core weight. Maximum pulp: core ratio was recorded in control treatments followed by 50% defoliation and deblossoming and 100% defoliation and deblossoming in summer and winter season crops, respectively (Table 2). However, minimum pulp: core ratio was found in the fruits of trees treated at 50% defoliation and deblossoming level in during both seasons, respectively. Though, the relationship among summer and winter season crops at different levels of defoliation and deblossoming was found non-significant. But winter crop got slightly higher pulp: core ratio (4.22) as compared to summer crop (4.21) (Table 2). An increased pulp: core ratio was might be due to effect of defoliation and deblossoming on utilizing maximum tree reserves, but this increase is not being considerable.

Organoleptic evaluation: Significant differences were found for fruit taste of winter season crop as compared to summer crop (Table 3) in which non-significant differences were determined at different defoliation and deblossoming levels. Similarly, the mean values of fruit organoleptic characteristics exhibited significant difference in winter as compared to summer season crop (Fig. 2). Highest values for taste, texture and aroma were recorded at 50% deblossoming and 50% defoliation and deblossoming in summer and winter crops, respectively. While, flavour and pulp colour got highest vlaues at 50% deblossoming in both summer and winter fruits. Similarly, minimum hedonic scores were given to taste and flavour in 50% defoliation and deblossoming and in control tree fruits in summer and winter, respectively. However, pulp colour, texture and aroma were achieved fewer scores in un-treated ones and at 100% defoliation and deblossoming levels. The interaction between summer and winter fruit organoleptic characteristics scores were found non-significant at different levels of defoliation and deblossoming.

All the organoleptic characteristics were non-significantly different in summer and this might be due to the high levels of defoliation and deblossoming. By which trees became under stress and fruit were not able to receive nutrients in summer. However, in winter these characteristics were significantly different to each other at different treatment levels. This might be due to that the food reserves which were not received by the fruits in summer, easily available to the winter fruit.

Table 2. Effects of defoliation and deblossoming on fruit weight, pulp weight, core weight and pulp: Core ratio of guava cv. Gola fruit during summer and winter crops.

Treatments	Fruit weight		Pulp weight				Core weight				Pulp: core	
	Summer (g)	Winter (g)	Summer (g)	Winter (g)	Summer (%)	Winter (%)	Summer (g)	Winter (g)	Summer (%)	Winter (%)	Summer (ratio)	Winter (ratio)
T1	63.6	122.6	49.4	100.1	77.7	81.7	14.1	22.2	22.1	18.1	4.5	4.9
T2	-	117.9	-	97.4	-	82.6	-	20.0	-	17.0	-	4.8
T3	83.7	144.5	67.0	113.4	80.0	78.5	16.6	31.0	19.8	21.4	4.0	3.8
T4	100.2	133.8	77.8	105.0	77.7	92.2	22.3	28.4	22.3	21.2	4.2	4.0
T5	-	151.6	-	117.3	-	77.4	-	34.2	0.0	22.5	-	3.9
	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Means	**82.5b***	**133a***	**64.7b***	**106a***	**78.5b***	**82.5a***	**17.7b***	**27.2a***	**21.4NS**	**20.0NS**	**4.2NS**	**4.2NS**

*, NS = Significant and non-significant at $p \leq 0.05$, respectively. n = 4 replicates. Any two means not sharing same letter differ significantly at 5% level of probability. T1 = Control; T2 = 100% defoliation + deblossoming; T3 = 50% defoliation + deblossoming; T4 = 50% deblossoming; T5 = 100% deblossoming. No fruit was harvested for T2 and T5 during summer crop

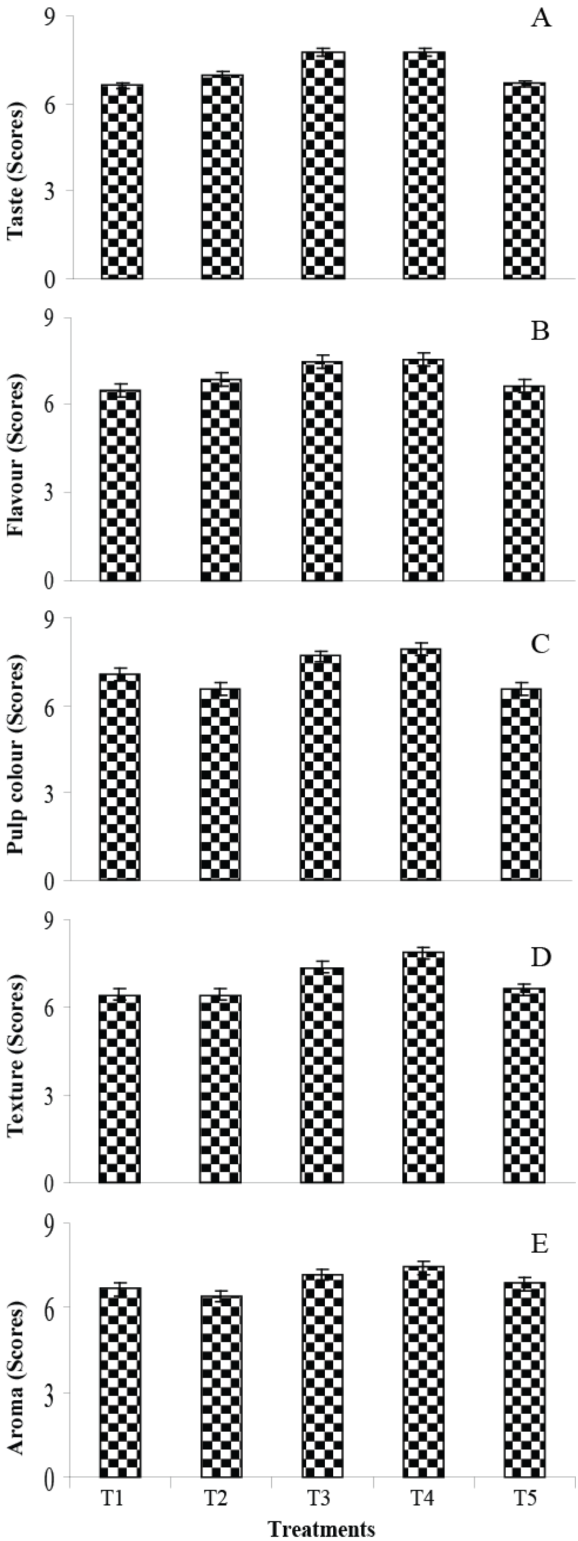

Fig. 2. Effects of defoliation and deblossoming on fruit organoleptic values: taste (A), flavour (B), pulp colour (C), Texture (D) and Aroma (E) of guava cv. Gola fruit in winter. Vertical bars indicate ± S.E. of means. n = 4 replicates. T1 = Control; T2 = 100% deblossoming + defoliation; T3 = 50% deblossoming + defoliation; T4 = 50% deblossoming; T5 = 100% deblossoming.

Chemical characteristics

TSS, TA and TSS: TA ratio: TSS refers to the percentage of various solids which are present in a soluble form in the juice including sugars, acids, proteins, vitamins and minerals etc., with sugars being the major component. Hand defoliation and deblossoming significantly affected the TSS of summer fruits as compared to winter fruits (Table 4). Maximum ^{o}Brix was recorded in the fruit harvested from untreated trees in summer as compared to winter in which maximum TSS was recorded at 50% deblossoming. Similarly, winter fruit ^{o}Brix was lower than the summer fruits. Increase of TSS in control trees during summer may be due to some special kind of enzymes regulation, involved in the formation of sugars and proteins. In case of other treatments, TSS value was lower may be due to stress conditions prevailed in the trees treated at high levels (Hussein, 2006). However, in an earlier study, thinned and un-thinned guava trees resulted in unaffected TSS contents of strawberry guava fruit (Michels & Normand, 2004), and the effects of defoliation and pruning treatments on TSS percentage were also consistent in guava (Harb, 1990). In the main crop of guava during summer season, TSS was recorded more in the larger fruits obtained by thinning (Biswas *et al.*, 1989). Both the fruit TA and TSS: TA ratios were found non-significantly different at different levels of defoliation and deblossoming. TA of fruit juice was found highest in fruit harvested from tres subjected to 50% deblossoming as compared to control in both summer and winter season crops (Table 4). The increase in TA of summer fruit was might be due to high defoliation and deblossoming levels, attributed to their effects on certain carbohydrate stimulating enzymes. Similarly with the application of deblossoming, the TA of the guava fruit was decreased (Tahir & Kamran, 2002). However, the effect of defoliation and pruning treatments was negligible on TA percentage of guava fruit juice (Harb, 1990). Fruit maturation seemed to be accelerated in summer pruned trees, which resulted in lower TA in peach fruit (Hussein, 2006). Fruit TSS: TA ratio was recorded maximum in the fruits of trees subjected to 50% defoliation and deblossoming (Table 4). Increase in TSS: TA in winter at 50% defoliation and deblossoming was might be due to more availability of nutrients in response of summer treatments (Basu *et al.*, 2007).

pH: Non-significant differences for pH of guava fruit juice were recorded at different levels of defoliation and deblossoming. Maximum pH of fruit juice was retrieved in the control fruit and 100% defoliation and deblossoming treated levels in summer and winter crops, respectively. While, minimum values of pH was recorded in the fruits treated at levels of 50% defoliation & deblossoming and 100% deblossoming in summer and winter crops, respectively (Table 4). The highest pH value in winter crop at 100% defoliation and deblossomed trees was might be due to more food reserves available to the fruits in winter as compared to summer. There was no fruit on these trees in summer so fewer nutrients were available and utilized by the fruits. However, mean pH values for summer and winter crops was observed similar to each other.

Table 3. Effects of defoliation and deblossoming on organoleptic characters of guava cv. Gola fruit during summer and winter crops.

Treatments	Taste		Flavor		Pulp color		Texture		Aroma	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
T1	6.8	6.6	6.9	6.5c	6.1	7.1c	6.9	6.4b	6.5	6.7c
T2	-	7.0b	0.0	6.9b	-	6.6c	-	6.4b	-	6.4c
T3	6.1	7.8a	6.4	7.4ab	6.4	7.7ab	7.1	7.4a	7.1	7.2ab
T4	6.9	6.7c	6.9	7.6ab	7.0	8.0ac	7.4	7.9a	7.6	7.4a
T5	-	0.0	0.0	6.6c	-	6.6c	-	6.6b	-	6.9abc
	NS	*	NS	*	NS	*	NS	*	NS	*
Means	**6.6**	**7.4**	**6.7**	**7.2**	**6.5**	**7.6**	**7.1**	**7.2**	**7.1**	**7.1**

*, NS = Significant and non-significant at $p \leq 0.05$, respectively. n = 4 replicates. Any two means not sharing same letter differ significantly at 5% level of probability. T1 = Control; T2 = 100% defoliation + deblossoming; T3 = 50% defoliation + deblossoming; T4 = 50% deblossoming; T5 = 100% deblossoming. No fruit was harvested for T2 and T5 during summer crop.

Table 4. Effects of defoliation and deblossoming on fruit total soluble solids (TSS), titratable acidity (TA), TSS: TA ratio, pH and ascorbic acid (AA) contents of guava cv. Gola trees in summer and winter crops.

Treatments	TSS		TA		TSS:TA		pH		AA	
	Summer (°Brix)	Winter (°Brix)	Summer (%)	Winter (%)	Summer ratio	Winter ratio	Summer	Winter	Summer (mg 100 g^{-1})	Winter (mg 100 g^{-1})
T1	14.0a	11.1	0.09	0.07	170.0	152.7	4.1	3.8	73.9	40.5
T2	0.0	8.3	0.0	0.08	0.0	114.8	0.0	4.2	0.0	42.1
T3	12.2b	11.6	0.08	0.06	183.5	200.8	3.6	4.0	44.0	46.0
T4	12.2b	11.7	0.12	0.11	113.1	111.3	3.7	3.9	50.3	55.6
T5	0.0	11.3	0.0	0.07	0.0	164.0	0.0	3.7	0.0	55.6
	*	NS	NS	NS	NS	NS	NS	NS	NS	NS
Means	**12.8a ***	**11.5b ***	**0.1**	**0.08**	**155.5**	**154.9**	**3.8**	**3.9**	**56.1**	**47.4**

*, NS = Significant and non-significant at $p \leq 0.05$, respectively. n = 4 replicates. Any two means not sharing same letter differ significantly at 5% level of probability. T1 = Control; T2 = 100% defoliation + deblossoming; T3 = 50% defoliation + deblossoming; T4 = 50% deblossoming; T5 = 100% deblossoming. No fruit was harvested for T2 and T5 during summer crop

Ascorbic acid: Ascorbic acid contents reveal non-significant differences for both summer and winter crops by application of various levels of manual defoliation and deblossoming. Higher ascorbic acid contents were recorded in control fruits during summer as compared to winter crop in which maximum ascorbic acid contents were observed both at 50% and 100% deblossoming levels. Lower ascorbic acid contents were observed at 50% defoliation and deblossoming in summer season crop, while in winter least ascorbic acid contents were recorded in fruit of untreated trees. Mean values of the ascorbic acid contents of two crops showed maximum level in the fruit harvested from control trees followed by the ascorbic acid contents of the fruits harvested from trees treated with 50% deblossoming and 50% defoliation + deblossoming. The interaction between summer and winter crops for ascorbic acid contents reveals non-significant differences at different levels of defoliation and deblossoming (Table 4). Defoliation and deblossoming might be play an active role in the production of auxin in plant species as the production of auxin increases ascorbic acid content in fruits. However, deblossoming in guava improved the level of ascorbic acid contents (Tahir & Kamran, 2002). While Harb (1990) contradicting these findings by showing negligible effects of defoliation.

Total, non-reducing and reducing sugar: The total sugars and non-reducing sugar contents of Guava cv. 'Gola' from trees subjected to defoliation and deblossoming did not show any significant differences in both the summer and winter season fruit (Table 5). Highest level of total sugars and non-reducing sugars were determined in control fruit during summer, while in winter season total sugar was found maximum in fruit harvested from trees subjected to 50% defoliation and deblossoming level as compared to control. Mean values of non-reducing sugars significantly higher in winter fruit than the summer fruit (Table 5). During fruit maturation, the sugar accumulation and transformation is regulated by the activities of enzymes which may be involved in the sucrose metabolism in the fruits. However, deblossoming improved the fruit quality of winter crop of guava with improved sugars amount (Tahir & Kamran, 2002). While Dhinesh & Yadav (2004) found best results for total sugar by thinning peach cv. 'Contender' with GA_3 at 100 ppm spray. Similarly, highest non-reducing sugars were exhibited by the fruit subjected to 50% defoliation and deblossoming levels may be due to maximum storage of nutrients in the tree branches, which were then utilized by the fruits of winter crop. These results are in line with the findings of Basu *et al*., (2007).

Table 5. Effects of defoliation and deblossoming on fruit total sugars, non-reducing sugars and reducing sugars of guava cv. Gola trees in summer and winter crops.

Treatments	Total sugars		Non-reducing sugars		Reducing sugars	
	Summer (%)	Winter (%)	Summer (%)	Winter (%)	Summer (%)	Winter (%)
T1	10.9	10.7	7.1	8.0	3.4	2.3
T2	0.0	10.7	0.0	7.8	0.0	2.5
T3	10.0	11.7	6.3	8.6	3.3	2.6
T4	10.2	10.2	6.6	7.5	3.2	2.3
T5	0.0	10.7	0.0	8.1	0.0	2.2
	NS	NS	NS	NS	NS	*
Means	**10.34NS**	**10.86NS**	**6.68 ***	**8.06 ***	**3.31 ***	**2.38 ***

*, NS = Significant and non-significant at $p \leq 0.05$, respectively. n = 4 replicates. Any two means not sharing same letter differ significantly at 5% level of probability. T1 = Control; T2 = 100% defoliation + deblossoming; T3 = 50% defoliation + deblossoming; T4 = 50% deblossoming; T5 = 100% deblossoming. No fruit was harvested for T2 and T5 during summer crop

Observations regarding reducing sugar contents from the fruit harvested in winter crop showed significant differences at different treatment levels. Highest reducing sugar value was observed in fruit harvested during summer from for trees subjected to 50% defoliation and deblossoming (2.6%) as compared to control in winter crop. However, it was clearly observed from the data that mean reducing sugar was highest (3.3%) in summer as compared to winter (2.4%) crop (Table 5). As compared to other sugar contents, highest reducing sugar was obtained during summer as compared to winter. Although, the winter fruit have significant results for reducing sugars but these were lower than the summer crop. The reason for lower value of reducing sugar in winter fruits was not clear and needs further investigations. Our results contradict the findings of Basu *et al*., (2007), who stated that by deblossoming of guava in summer, reducing sugar values in fruit can be increased in the coming season crop.

In conclusions, application of different levels of defoliation and deblossoming had a significant effect on fruit quality of guava cv. Gola. The results suggested that guava trees subjected to 50% deblossoming with no defoliation exhibit better fruit quality in terms of fruit size, firmness, sugar contents, ascorbic acid level, both in summer as well as in winter season crops.

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