

Effect of bending and fruit thinning for off-season production of guava

A.A. Mamun, M.H. Rahman and A.M. Farooque

Department of Horticulture, Bangladesh Agricultural University, Mymensingh, e-mail: mamunbau150@gmail.com

Abstract: The study was carried out at the Germplasm Centre of Fruit Tree Improvement Programme (GPC-FTIP), Bangladesh Agricultural University, Mymensingh during the period from February, 2011 to March, 2012 to find out the effect of shoot bending and fruit thinning for off-season production of guava. The treatments of the experiment were four varieties of guava viz., Swarupkathi, BAU piyara-5, Chiang Mai (round) and Chiang Mai (long) and six different management practices viz., (i) control (no shoot bending + no fruit thinning); (ii) shoot bending; (iii) 25% fruit thinning; (iv) 50% fruit thinning; (v) 75% fruit thinning and (vi) 100% fruit thinning. The ages of the plants were 4-5 years. Results revealed that the variety Chiang Mai (round) showed superiority over BAU piyara-5, Chiang Mai (long) and Swarupkathi in respect of fruit yield (15.63 kg/plant), individual fruit weight (287.00 g), weight of seeded portion of fruit (85.79 g), weight of non-seeded portion of fruit (192.21 g) and TSS (12.40%) during on-season but during off-season, Swarupkathi showed superiority over Chiang Mai (round), BAU piyara-5 and Chiang Mai (long) in case of yield (11.78 kg/plant) and number of shoots per fruit (6.39). Different management practices had significant effect on all studied parameters in both season, 50% fruit thinning treatment showed the highest fruit yield (20.46 kg/plant) and 75% fruit thinning treatment performed highest TSS (14.73%) during on-season but during off-season shoot bending performed highest fruit yield (13.50 kg/plant). In contrast, above studied parameters were recorded the lowest in control plant where no shoot bending and no fruit thinning were applied. In case of combined effect of variety and different management practices 50% fruit thinning treatment combined with Chiang Mai (round) produced highest yield (23.15 kg/plant) and 75% fruit thinning performed highest TSS (15.83%) during on-season, but shoot bending treatment combined with Swarupkathi gave the highest yield (16.06 kg/plant) and 100% fruit thinning combined with Chiang Mai (round) showed highest TSS (17.94%) during off-season.

Key words: Guava, bending, fruit thinning, off-season production.

Introduction

Guava is a berry like fruit of various myrtaceous trees or shrubs of the genus *Psidium*, especially *Psidium guajava* of botanical family Myrtaceae. It was originated in tropical America (Mexico to Peru) but at present the major guava producing countries are the USA, Cuba, Taiwan, Mexico, Peru, China, Malaysia, India, Pakistan, Thailand and Bangladesh. Guava is often called the “apple of the tropics”. It claims to be the most important fruit in respect of area and production after mango, banana, jackfruit, pineapple, and melon in Bangladesh (BBS, 2010). It grows everywhere in Bangladesh in the homestead gardens even without or little care but commercially cultivated in Barisal, Sylhet, Gazipur, Pirojpur, Swarupkathi, Jessore, Rajshahi and Chittagong (Mondal, 2000). Guavas are up to 5 times richer in vitamin C than oranges. It is also rich in pectin, which has industrial use for jelly production (Bose and Mitra, 1990). It contains appreciable amount of vitamin A, calcium, phosphorus, potassium, sulphur, sodium, chlorine, iron, magnesium, pantothenic acid, riboflavin, thiamin and niacin (FAO, 2009). The leaves of the plant have medicinal values, which aid in curing diarrhoea, swelling and bleeding of gums (Goncalves *et al.*, 2008). Most of the people of Bangladesh suffer from malnutrition specially vitamins and minerals. Guava is a good and cheap source of readily uptake able vitamins and minerals. Guava plant is quite hardy, prolific bearer and highly remunerative even without much care (Bose and Mitra, 1990).

In Bangladesh, some of the varieties of guava set fruits twice in a year, once in March to April and another in November to December. In the later one production is low but quality of fruits is better. Normally higher yield of guava is found that ripens during rainy season which are insipid, watery, poor in taste with poor keeping quality and fetches low market prices. In order to have a winter harvest, fruit thinning is advisable. According to Sing *et al.* (1996), flower thinning from guava plants during summer, improved fruit quality and increase yield during

next winter. Shoot bending is one of the ways to produce better quality fruits in the off-season (Sarker *et al.*, 2005). In case of bending of branch wood tension of branch is increased and phloem formation decreased. As a result photosynthetic product pass slowly from the shoots of bent branch as to the other parts, maintaining increased C: N ratio and induce more flowering and fruit set. Bending forced dormant reproductive buds into growth. The upright branch produces fewer flowers and fruits than the bent branch (Ito *et al.*, 1999). Considering the above facts an experiment was carried out to study the effect of bending and fruit thinning for off-season production of guava.

Materials and Methods

Two separate methods were followed under this experiment for increasing the off-season production of guava. The experimental methods were as follows:

Shoot bending: The branches which were healthy and disease free lateral shoots were selected for shoot bending with care. Shoot bending was done in such a way that the bent branch did not broken down after bending. Shoots were bent at its antigrwth (at 90° angle) with the help of a piece of rope. Before shoot bending 3-5 leaves were kept at the upper portion of the branch to continue its photosynthesis and respiration process and rest leaves were removed off.

Fruit thinning: Total number of fruits per plant in each replication was counted after fruit set. Out of these according to treatment fruits were thinned randomly by hand when the average weight of individual fruit was 15-20 g.

According to the management practices, the experiment consists of two factors with three replications. These are following-

Factor A: It consists of four varieties; i) V_1 = Swarupkathi, ii) V_2 = BAU piyara -5, iii) V_3 = Chiang Mai (round) and V_4 = Chiang Mai (long).

Factor B: six management practices;

M ₁	(Control)	:	No shoot bending and fruit thinned from the plant.
M ₂	(Shoot bending)	:	Shoots were bent at its antigrowth (at 90° angle) with the help of a piece of rope. Before shoot bending 5-7 leaves were kept at the upper portion of the branch to continue its photosynthesis and respiration process and rest leaves were removed off.
M ₃	(25% fruit thinning)	:	In this treatment, total number of fruits per plant in each replication was counted after fruit set. Out of these 25 per cent fruits were thinned randomly by hand when the average weight of individual fruit was 15-20 g.
M ₄	(50% fruit thinning)	:	In this treatment total number of fruits per plant in each replication was counted after fruit set. Out of these 50 per cent fruits were thinned randomly by hand when the average weight of individual fruit was 15-20 g.
M ₅	(75% fruit thinning)	:	In this treatment, total number of fruits per plant in each replication was counted after fruit set. Out of these, 75 per cent fruits were thinned randomly by hand when the average weight of individual fruit was 15-20 g.
M ₆	(100% fruit thinning)	:	In this treatment, total number of fruits per plant in each replication was counted after fruit set. All the fruits were thinned by hand when the average weight of individual fruit was 15-20 g.

The data collections were done based on the following points- number of shoots/branch, individual fruit weight, weight of seeded portion of fruit, weight of non-seeded portion of fruit, yield (kg/plant) and total soluble solids (TSS). The collected data were analyzed by a statistical programme MSTAT-C following the appropriate design of the experiment (Gomez and Gomez, 1984). The means for all the treatments were calculated and the analysis of variance (ANOVA) for most of the characters under consideration were performed by the least significance

difference (LSD) test taking the probability level 1% as the maximum unit of significance.

Results and Discussion

Number of shoots per branch

Performance of variety: Significant variations were observed on the number of shoots per branch both in on-season and off-season. The highest number of shoots per branch was observed in Swarupkathi in both seasons (on-season 7.89 and off-season 6.39) and the lowest was observed in Chiang Mai (long) (Table 1).

Table 1. Effect of variety on number of shoots per branch, individual fruit weight and weight of seeded portion of fruit in guava

Variety	Number of shoots per branch		Individual fruit weight (g)		Weight of seeded portion of fruit (g)	
	On-season	Off-season	On-season	Off-season	On-season	Off-season
Swarupkathi	7.89	6.39	74.22	184.28	23.69	52.41
BAU piyara-5	6.22	5.33	241.17	347.50	74.91	103.27
Chiang Mai (round)	7.11	5.66	278.00	423.11	85.79	128.79
Chiang Mai (long)	6.00	5.11	264.11	410.72	83.52	126.27
LSD (0.01)	0.72	0.60	3.13	10.17	3.13	10.17
Level of significance	**	**	**	**	**	**

Table 2. Effect of different management practices on number of shoots per branch, individual fruit weight and weight of seeded portion of fruit in guava

Management practices	Number of shoots per branch		Individual fruit weight (g)		Weight of seeded portion of fruit (g)	
	On-season	Off-season	On-season	Off-season	On-season	Off-season
Control	4.83	4.00	168.17	253.33	52.89	71.37
Shoot bending	12.92	10.75	179.42	277.75	56	81.7
25% fruit thinning	5.33	4.67	256.00	307.17	79.11	94.15
50% fruit thinning	6.75	4.83	307.00	373.08	98.75	114.79
75% fruit thinning	5.92	5.08	375.67	388.75	115.11	125.31
100% fruit thinning	5.67	5.50	00	409.75	0.00	129.79
LSD (0.01)	0.89	0.74	3.84	12.45	3.84	12.45
Level of significance	**	**	**	**	**	**

Effect of management practices: The effect of different management practices on the number of shoots per branch in guava was significant in both seasons. The highest number of shoots per branch was recorded in the shoot bending treatment during on-season (12.92) and off-season it was (10.75). The lowest number of shoots per branch (4.83) was recorded in the control treatment during on-season and during off-season it was (4.00) (Table 2). Ahmed *et al.* (2000) reported that ringing plus bending produce more shoots that supports the present experimental results partially.

Combined effect of variety and management practices: The combined effect of variety and different management practices on the number of shoots per branch was significant in both seasons. The highest number of shoots per branch was recorded in the treatment combination of Swarupkathi with shoot bending treatment in both seasons (on-season 14.33 and off-season 12.00) and the lowest number of shoots per branch was recorded in the treatment combination of Chiang Mai (long) with the control treatment in both seasons (Table 3).

Individual fruit weight (g)

Performance of variety: Highly significant differences were recorded among the different guava variety on individual fruit weight in both seasons. The variety Chiang Mai (round) produced heaviest fruit in both season (on-

season 278.00 g and off-season 423.11 g) and Swarupkathi produced lightest fruit in both season (Table 1).

Effect of management practices: A significant variation was observed in case of individual fruit weight due to different management practices in both seasons. The highest individual fruit weight (375.67 g) was observed in 75% fruit thinning treatment during on-season but during off-season it was (409.75 g) in 100% fruit thinning treatment. The lowest individual fruit weight in both seasons was recorded in the control treatment (Table 2). Islam *et al.* (1992) reported that fruit weight increased by increasing fruit thinning percentage. In the present experiment, similar results were also observed.

Combined effect of variety and management practices: In both season, a significant variation was observed in case of individual fruit weight due to the combined effect of variety and different management practices. The highest individual fruit weight (493.67 g) was observed in the treatment combination of Chiang Mai (round) with 75% fruit thinning treatment during on-season but during off-season it was (560.67 g) in the treatment combination of Chiang Mai (round) with 100% fruit thinning treatment. In contrast, the lowest individual fruit weight (72.33 g) was recorded in the treatment combination of Swarupkathi with the control treatment during on-season and during off-season it was (164.0 g, Table 3).

Table 3. Combined effect of variety and different management practices on number of shoots per branch, individual fruit weight and weight of seeded portion of fruit in guava

Variety	Management practices	No. of shoots per branch		Individual fruit wt. (g)		Wt. of seeded portion of fruit (g)	
		On-season	Off-season	On-season	Off-season	On-season	Off-season
Swarupkathi	Control	5.67	4.33	72.33	164.00	21.97	40.68
	Shoot bending	14.33	12.00	75.33	171.00	24.26	42.27
	25% fruit thinning	6.00	5.33	86.33	176.00	27.32	49.87
	50% fruit thinning	6.33	5.33	97.33	186.33	31.63	56.4
	75% fruit thinning	5.33	5.00	114.00	203.33	36.97	61.5
	100% fruit thinning	6.67	5.67	0.00	205.00	0.00	63.77
BAU piyara-5	Control	4.67	4.00	194.67	251.33	59.43	59.69
	Shoot bending	12.67	10.00	213.33	302.33	65.64	88.92
	25% fruit thinning	5.33	5.33	269.67	325.00	84.24	99.74
	50% fruit thinning	6.00	4.67	356.00	382.33	111.21	119.43
	75% fruit thinning	6.67	5.00	413.33	395.33	128.95	122.26
	100% fruit thinning	7.33	5.33	0.00	428.67	0.00	129.57
Chiang Mai (round)	Control	4.67	4.00	182.67	301.33	71.83	94.13
	Shoot bending	13.33	11.67	193.33	346.00	74.78	104.6
	25% fruit thinning	5.33	4.33	368.00	363.33	93.55	116.64
	50% fruit thinning	5.00	4.00	359.00	425.67	125.54	146.45
	75% fruit thinning	5.67	5.33	493.67	511.00	149.03	154.65
	100% fruit thinning	6.33	5.67	0.00	560.67	0.00	156.25
Chiang Mai (long)	Control	4.33	3.67	223.00	291.67	59.3	90.97
	Shoot bending	11.33	9.33	235.67	292.67	58.33	91.02
	25% fruit thinning	4.67	4.33	300.00	364.33	111.35	110.37
	50% fruit thinning	5.33	4.67	415.67	485.33	126.63	128.94
	75% fruit thinning	6.00	5.00	481.67	509.33	145.5	162.82
	100% fruit thinning	6.67	5.33	0.00	531.67	0.00	173.50
LSD (0.01)		1.77	1.47	8.07	24.70	7.67	24.90
Level of significance		**	**	**	**	**	**

Weight of seeded portion of fruit (g)

Performance of variety: In varieties, the weight of seeded portion of fruit varied significantly in both on-season and off-season. The highest weight of seeded portion of fruit was recorded in Chiang Mai (round) (85.79 g) and (128.79 g) during on-season and off-season respectively and the lowest weight of seeded portion of fruit in both seasons was recorded in Swarupkathi (23.69 g) and (52.41 g) respectively (Table 1).

Effect of management practices: Highly significant differences were recorded among the different management practices on weight of seeded portion of fruit in both seasons. The highest weight of seeded portion of fruit (115.11 g) was recorded in 75% fruit thinning treatment in on-season but in off-season it was recorded (129.79 g) in 100% fruit thinning treatment. In contrast, the lowest weight of seeded portion of fruit was recorded in the control treatment (52.89 g) and (71.37 g) respectively in on-season and off-season (Table 2).

Combined effects of variety and management practices: The combined effect of variety and different

management practices on weight of seeded portion of fruit was also highly significant. The highest weight of seeded portion of fruit (149.03 g) was noticed in the treatment combination of Chiang Mai (round) with 75% fruit thinning treatment in on-season but in off-season it was recorded (173.50 g) in the treatment combination of Chiang Mai (long) with 100% fruit thinning treatment. In contrast, the lowest weight of seeded portion of fruit was recorded in the treatment combination of Swarupkathi with the control treatment (21.97 g) and (40.68 g) respectively in on-season and off-season (Table 3).

Weight of non-seeded portion of fruit (g)

Performance of variety: In varieties, the weight of non-seeded portion of fruit varied significantly in both on-season and off-season. The highest weight of non-seeded portion of fruit (192.21 g) was recorded in Chiang Mai (round) during on-season and during off-season it was recorded (294.32 g) also in Chiang Mai (round). In contrast, the lowest weight of non-seeded portion of fruit was recorded in Swarupkathi (50.53 g) and (131.87 g) in on-season and off-season respectively (Table 4).

Table 4. Effect of variety on weight of non-seeded portion of fruit, yield and TSS in guava

Variety	Wt. of non-seeded portion of fruit (g)		Yield (kg/plant)		TSS (%)	
	On-season	Off-season	On-season	Off-season	On-season	Off-season
Swarupkathi	50.53	131.87	11.82	11.78	9.69	13.79
BAU piyara-5	166.26	244.23	14.40	9.67	11.37	15.76
Chiang Mai (round)	192.21	294.32	15.63	8.95	12.40	16.02
Chiang Mai (long)	180.59	284.45	13.98	8.78	10.92	15.02
LSD (0.01)	64.99	32.45	64.99	32.45	0.17	0.32
Level of significance	**	**	**	**	**	**

Table 5. Effect of different management practices on weight of non-seeded portion of fruit, yield and TSS in guava

Management practices	Wt. of non-seeded portion of fruit (g)	Yield (kg/plant)	TSS (%)
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	On-season	Off-season	On-season	Off-season	On-season	Off-season
Control	115.28	181.96	13.67	8.43	11.96	13.55
Shoot bending	123.42	196.05	16.66	13.50	11.76	13.77
25% fruit thinning	176.89	213.02	16.90	10.16	12.87	14.65
50% fruit thinning	208.25	258.29	20.46	12.43	13.75	16.06
75% fruit thinning	260.56	263.44	10.06	8.09	14.73	16.31
100% fruit thinning	0.00	279.96	00.00	7.19	0.00	16.54
LSD (0.01)	79.60	39.74	79.60	39.74	0.21	0.40
Level of significance	**	**	**	**	**	**

Effect of management practices: Highly significant differences were recorded among the different management practices on weight of non-seeded portion of fruit in both seasons. The highest weight of non-seeded portion of fruit (260.56 g) was recorded in 75% fruit thinning treatment during on-season but during off-season it was recorded (279.96 g) in 100% fruit thinning treatment. In contrast, the lowest weight of non-seeded portion of fruit was recorded in the control treatment (115.28 g) and (181.96 g) respectively in on-season and off-season (Table 5).

Combined effects of variety and management practices: The combined effect of variety and different management practices on weight of non-seeded portion of fruit was also highly significant. The highest weight of non-seeded portion of fruit (344.64 g) was noticed in the treatment combination of Chiang Mai (round) with 75% fruit thinning treatment during on-season but during off-season it was recorded (404.42 g) in the treatment combination of Chiang Mai (round) with 100% fruit thinning treatment. In contrast, the lowest weight of non-seeded portion of fruit was recorded in the treatment combination of Swarupkathi with the control treatment (50.36 g) and (123.32 g) respectively in on-season and off-season (Table 6).

Yield (kg/plant)

Performance of variety: Variety had significant effect on fruit yield (kg/plant). The highest fruit yield (15.63 kg/plant) was recorded in Chiang Mai (round) and the lowest fruit yield (11.82 kg/plant) was recorded in Swarupkathi during on-season (Table 4). During off-season, the highest fruit yield (11.78 kg/plant) was

recorded in Swarupkathi and the lowest fruit yield (8.78 kg/plant) was recorded in Chiang Mai (long) (Table 4).

Effect of management practices: A significant variation was observed in case of fruit yield (kg/plant) due to different management practices. The highest fruit yield (20.46 kg/plant) was recorded in 50% fruit thinning treatment and the lowest fruit yield (10.06 kg/plant) was observed in 75% fruit thinning treatment during on-season (Table 5). During off-season, the highest fruit yield (13.50 kg/plant) was recorded in shoot bending treatment and the lowest fruit yield (7.19 kg/plant) was recorded in 100% fruit thinning treatment (Table 5). Shoot bending increased the fruit yield per plant and quality fruit during off-season (Sarker *et al.*, 2005). Fruit thinning to the extent of 50% increased the fruit yield per plant and fruit yield reduced in 75% or more percent of fruit thinning (kabir, 2005) that's supports the present experimental results.

Combined effects of variety and management practices: The combined effect of variety and different management practices on fruit yield (kg/plant) was significant both in on-season and off-season. The highest fruit yield (23.15 kg/plant) was recorded in the treatment combination of Chiang Mai (round) with 50% fruit thinning treatment and the lowest fruit yield (7.45 kg/plant) was recorded in the treatment combination of Swarupkathi with 75% fruit thinning treatment during on-season (Table 6). During off-season, the highest fruit yield (16.06 kg/plant) was recorded in the treatment combination of Swarupkathi with shoot bending treatment and the lowest fruit yield (6.35 kg/plant) was recorded in the treatment combination of Chiang Mai (long) with 100% fruit thinning treatment (Table 6).

Table 6. Combined effect of variety and different management practices on weight of non-seeded portion of fruit, yield and TSS in guava

Variety	Management practices	Wt. of non-seeded portion of fruit(g)		Yield (kg/plant)		TSS (%)	
		On-season	Off-season	On-season	Off-season	On-season	Off-season
Swarupkathi	Control	50.36	123.32	12.70	10.42	10.48	12.65
	Shoot bending	51.07	128.73	16.42	16.06	10.92	12.75
	25% fruit thinning	59.01	126.13	15.95	12.72	11.32	13.58
	50% fruit thinning	65.7	129.93	18.41	14.46	12.35	14.28
	75% fruit thinning	77.03	141.83	7.45	8.54	13.08	14.67
	100% fruit thinning	0.00	141.23	0.00	8.50	0.00	14.83
BAU piyara-5	Control	135.24	191.64	14.47	8.76	12.44	13.67
	Shoot bending	147.69	213.41	18.23	13.59	11.90	14.02

	25% fruit thinning	185.43	225.26	17.17	9.64	13.66	14.92
	50% fruit thinning	244.79	262.9	21.07	11.56	14.57	17.62
	75% fruit thinning	284.38	273.07	11.29	7.24	15.52	16.90
	100% fruit thinning	0.00	299.1	0.00	7.25	0.00	17.09
	Control	110.84	207.2	14.27	7.22	12.39	14.17
	Shoot bending	118.55	241.4	16.43	10.15	12.20	14.57
Chiang Mai (round)	25% fruit thinning	274.45	246.69	17.07	9.19	13.52	15.54
	50% fruit thinning	233.46	279.22	23.15	12.33	14.57	16.60
	75% fruit thinning	344.64	356.35	10.86	8.17	15.83	17.09
	100% fruit thinning	0.00	404.42	0.00	6.63	0.00	17.94
	Control	163.7	200.7	13.24	7.31	12.53	13.72
	Shoot bending	177.34	201.65	15.54	10.19	12.03	13.73
Chiang Mai (long)	25% fruit thinning	188.65	253.96	17.42	9.10	12.97	14.57
	50% fruit thinning	289.04	356.39	19.22	11.35	13.50	15.43
	75% fruit thinning	336.17	346.51	10.63	8.41	14.47	15.88
	100% fruit thinning	0.00	358.17	0.00	6.35	0.00	16.80
LSD (0.01)		159.20	79.49	159.20	79.49	0.42	0.79
Level of significance		**	**	**	**	**	**

Total soluble solids (TSS)

Performance of variety: Total soluble solids were significantly affected by variety in both on and off season. The highest TSS was recorded in the variety Chiang Mai (round) during on-season (12.40%) and during off-season it was (16.02%). The lowest TSS (9.69%) was recorded in the variety Swarupkathi during on-season and during off-season it was (16.02%) (Table 4). Singh *et al.* (1996) found that TSS is higher in winter than rainy season that supports the present experimental results.

Effect of management practices: Total soluble solids (TSS) were significantly influenced by different management practices in both seasons. Results revealed that TSS was higher in fruit thinning and shoot bending plant than no shoot bending and no fruit thinning plant. The highest TSS (14.73%) was recorded in 75% fruit thinning treatment during on-season and during off-season it was (16.54%) in 100% fruit thinning treatment (Table 5). TSS increases by increasing fruit thinning percentage reported by Tahir and Hamid (2002) which supports the present experimental results.

Combined effects of variety and management practices: The combined effect of variety and different management practices on total soluble solids was significant in both seasons. During on-season, the highest TSS (15.83%) was recorded in the treatment combination of Chiang Mai (round) with 75% fruit thinning and during off-season it was recorded (17.94%) in the treatment combination of Chiang Mai (round) with 100% fruit thinning treatment. In both season the lowest TSS was recorded in the treatment combination of Swarupkathi with the control treatment (Table 6).

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