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Effects of fruit thinning on the on-and off-season production of guava

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ABSTRACT

The study was conducted at the FTIP Germplasm Centre of the Bangladesh Agricultural University (FTIP BAU-GPC), Mymensingh during the period from July 2017 to October 2018 to find out the effects of fruit thinning on the off-season quality guava production. The two factor experiment consisted of two guava varieties *viz*., Swarupkathi and BAU Peyara-5, and six fruit thinning regimes namely no fruit thinning (control), 20% fruit thinning, 40% fruit thinning, 60% fruit thinning, 80% fruit thinning and 100% fruit thinning. The experiment was carried out in a randomized complete block design (RCBD) with three replications. Guava varieties and fruit thinning both had significant effects on both on-season and off-season guava production. During on-season, Swarupkathi showed superiority over BAU Peyara-5. During off-season, yield of Swarupkathi was 1.73 kg plant^{-1}, whereas BAU Peyara-5 produced only flowers but no fruit due to flower dropping in off-season. In respect of thinning effect during on season 6.05 kg fruit plant^{-1} was produced with 80% fruit thinning, which was the best in on-season. During off-season 1.51kg fruit plant^{-1} was produced with 100% fruit thinning of previous season, which was the best in off-season. For combined effect during on-season, Swarupkathi produced 8.6 kg fruit plant^{-1} at 80% fruit thinning which was found to be better result in Swarupkathi after different times of thinning practices, whereas BAU Peyara-5 produced 3.5 kg fruit plant^{-1} at 80% fruit thinning which was found to be better result in BAU Peyara-5 after different thinning practices. During off-season, Swarupkathi produced 3.01 kg fruit plant^{-1} with 100% fruit thinning of previous season, which was found to be better result in Swarupkathi, while BAU Peyara-5 produced few flowers (3) and did not produce any fruit due to flower dropping.

Keywords: BAU Peyara-5, fruit thinning, guava, productivity, Swarupkathi, TSS

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1 Introduction

Guava (*Psidium guajava*) is a common tropical fruit cultivated in many tropical and sub-tropical regions including Bangladesh. It is an over populated country in the world. For fulfilling the nutritional requirement of these huge population, some fruits have to be cultivated in the home garden and commercially which contain more than one nutrient, easily available, low cost and easily digestible. Guava is a kind of 'Super-fruits' being rich in vitamin C. A single guava than a single orange as it contains five times more

vitamin C (Conway, 2001). Guava is not only rich in vitamin A and C but also rich in pectin. Pectin has significant industrial use for production of jam and jelly (Jawaheer et al., 2003). It also contains considerable amount of calcium (Ca) and phosphorus (P) (Burkill, 1997), potassium (K), sulphur (S), sodium (Na), chlorine (Cl), iron (Fe), magnesium (Mg), pantothenic acid, riboflavin, thiamin and niacin (Singh, 1995). Guava is a very delicious fruit. Many favourite and tasty items are prepared from guava. The prepared products of guava *viz*. jam, jelly, syrup, cheese, roll etc. are imported from many countries of the world (Lee and Brown, 1986). The leaves and fruits of the guava plant contain antioxidant (Verma et al., 2013). Guava leaves have great medicinal values and it helps to cure diarrhoea, swelling and bleeding of gums. Most of the Bangladeshi people suffer from malnutrition due to lack of vitamins and minerals (Ahmed et al., 2012). Guava is a good, cheap and significant source of readily available vitamins and minerals.

Fruit thinning is one of the oldest cultural methods practicing in the temperate and sub-tropical regions. It brings a balance between vegetative and reproductive growth of the plants. The guava flowers and fruits are borne on current season growth. Fruit thinning is considered to be the influence of encouraging new shoots after the harvest which influence off season production of guava with better quality. Some of the commercial varieties of guava in Bangladesh bear fruits twice in a year i.e., once in March to April and another in November to December. The production in the later ones is low but provide better quality fruits with sweeter in taste. Generally, guava plants provide higher yield when the fruits are ripened in rainy season, although the fruits are insipid, watery, poor in taste with poor keeping quality, and fetches low market prices (Anonymous, 1995). Previous reports suggested that fruit thinning is advisable in order to have a winter harvest (Bakry, 2007; Singh et al., 2018). Mamun et al. (2013) found that flower thinning in guava during summer, increase yield and improve quality of fruits during next winter. Thinning of guava fruits in the early stage of their development may help to obtain desirable size of fruits, to reduce breakage of branches and to encourage fruiting in both seasons. The production of guava could be increased during off-season through judicious fruit thinning. This will certainly ensure the demand of guava as well as nutrient throughout the year. Moreover, this may improve the socio-economic condition through financial benefit to the grower and sources of added nutrition to the family. Under the above circumstances, the effect of fruit thinning on flowering and fruiting behaviour of two guava varieties namely Swarupkathi, and BAU Peyara-5, have been included in the present study with the following objectives to know the effect of fruit thinning on the on-season and off-season production; and to find out the better guava variety, which give highest and quality production during off-season.

2 Materials and Methods

2.1 Experimental site

The experiment was conducted at the FTIP Germplasm Centre of the Bangladesh Agricultural University (FTIP BAU-GPC), Mymensingh (24°43′8.3″N, 90°25′41.2″E) during the period from July, 2017 to October, 2018 to study the effects of fruit thinning on the off-season quality guava production.

2.2 Climate and soil

The experimental area was located under the subtropical climate, characterized by heavy rainfall during the months of June to September and scanty rainfall during rest of the period of the year. The site of the experiment was medium high land, which belongs to the Old Brahmaputra Floodplain under the Agro-Ecological Zone 9 having non-calcareous dark gray floodplain soil (UNDP-FAO, 1988). The land was medium high, fertile, well drained and slightly acidic with soil pH varying from 5.5 to 6.8. The amount of organic carbon, total N, available P and K were 0.835%, 0.068, 18 ppm and 0.28 me $100g^{-1}$ of the soil samples, respectively.

2.3 Treatments and design

The experiment was carried out in a randomized complete block design (RCBD) with 3 replications. The experiment consisted of two factors, *viz*., (A) 2 varieties of guava (Swarupkathi and BAU Peyara-5, and (B) 6 levels of fruit thinning. The characteristics of the varieties and description of the fruit thinning operations are described below:

Swarupkathi Swarupkathi is a medium sized tree of 4 years aged with leaves relatively small and pale green in colour. It bears fruits throughout the year. Average weight of fruit is 70-150 g and may attain upto 300 g. Fruits are globose to round shaped with rough surface. Medium sized fruit is greenish white in colour. Endosperm is whitish, sweet in taste and flavoured. Low seeded fruit, which pulp crispy to soft in texture. This variety is widely cultivated at the Barisal of Bangladesh.

BAU Peyara-5 BAU Peyara-5 is a high yielding fruit variety, produces fruits twice in a year. It is large pear-shaped fruits (445 g) with creamy white flesh pulp. Pulp is crispy and slight sour in test (TSS 8.0%). Plant height is medium, ripe fruit colour is yellowish green,

on an average 340-360 seeds present per fruit, seeds are hard, on average 1000-seed weight is around a 3.5-4 g. Fruit setting starts within one year after plantation. Fruits are stored in normal temperature from 7 to 10 days. Fruit contains 210 mg $100g^{-1}$ vitamin C. The yield of BAU Peyara-5 is 28 t ha^{-1}.

T1 (0%) No fruit thinned from the plant;

T2 (20%) In this treatment, from each replication total number of fruits $plant^{-1}$ was counted after fruit set. Out of these, 20% fruits were thinned randomly by hand when the mean weight of individual fruit was 15-20 g (Mamun et al., 2013);

T3 (40%) In this treatment, from each replication total number of fruits $plant^{-1}$ was counted after fruit set. Out of these, 40% fruits were thinned randomly by hand when the mean weight of individual fruit was 15-20 g;

T4 (60%) In this treatment, from each replication total number of fruits $plant^{-1}$ was counted after fruit set. Out of these, 60% fruits were thinned randomly by hand when the mean weight of individual fruit was 15-20 g;

T5 (80%) In this treatment, from each replication total number of fruits $plant^{-1}$ was counted after fruit set. Out of these, 80% fruits were thinned randomly by hand when the mean weight of individual fruit was 15-20 g;

T6 (100%) In this treatment, from each replication total number of fruits $plant^{-1}$ was counted after fruit set. All the fruits were thinned by hand when the average weight of individual fruit was 15-20 g. Generally the effects of 100% fruit thinning during on-season produce better number of fruits during off-season. For each variety 18 plants were selected for the study. All fruits under taken for data collection during off-season.

In each replication total number of fruits $plant^{-1}$ was counted after fruit set. Out of these, fruits were thinned by hand randomly according to the treatments after 20 days of fruit setting and before the natural dropping when the mean weight of individual fruit was 15-20 g (Mamun et al., 2013).

2.4 Intercultural operations

Weeding was done at an interval of 15 days up to fruit set and it was continued at an interval of ten days from fruit set to harvest. These were controlled by niri and spade. Fertilizers @ 200 g urea, 100 g TSP, 200 g MoP and 100 g Zinc, and 10 kg well decomposed cowdung were applied $plant^{-1}$ of 15th days before fruit thinning. Manures were applied through ring placement. Irrigation was applied during on-and off-season. During off-season water is required more than on-season. Flood irrigation and drain method was maintained during irrigation after and before flower set. During on-and-off season disease and pest are harmful for production. During on-season Furadan @ 3 mL L^{-1} was applied to remove guava fruit fly. Different kind of cupper and sulfer fungicide were applied to avoid different disease. In the experiment 10 fruits were selected at random from each plant labelled and the fruits were harvested by hand picking at regular intervals at mature stage when yellowish green colour developed. This stage is mostly liked for consumption (Singh, 1995).

2.5 Parameters measured

Experimental data were recorded from the plants on the following parameters (from fruit thinning).

Number of flower set $plant^{-1}$ The number of flowers $plant^{-1}$ was recorded up to 1st July, 2017 (during on season) and 15th October, 2017 (during off-season).

Number of fruit set $plant^{-1}$ The number of fruits set $plant^{-1}$ was recorded up to 25th July, 2017 (during on season) and 20th November, 2017 (during off-season).

Fruit yield $plant^{-1}$ Fruits at different days and yield $plant^{-1}$ was recorded in kg and the total harvested fruits were calculated as yield $plant^{-1}$.

Total soluble solids (TSS) Total soluble solids (TSS) were recorded in percentage by the hand refractometer from extracted juice of the sample fruits.

2.6 Statistical analysis

The analyses of variance (ANOVA) of the parameters under study were performed using F-variance test. The significance of the differences in mean of the treatment was calculated using least significant difference (LSD) test at 1 and 5% levels of probability.

3 Results and Discussion

3.1 Number of flower set $plant^{-1}$

During on-season, flower started to open in varieties from 1st July 2017 and that continued up to 20th July 2017. The number of flower set $plant^{-1}$ in case of variety was significant during on-season. However, the highest number of flower set $plant^{-1}$ (195.78) was recorded in the variety Swarupkathi and the lowest

(20.17) was recorded in BAU Peyara-5 (Fig. 1). During off-season, from 15th October 2017, the flower started to open in all varieties and that continued up to 10th November 2017. During off-season the number of flower set plant^{-1} was significantly influenced by guava variety. The highest number of flower set plant^{-1} (46.67) was found in the variety Swarupkathi and the lowest (1.61) was found in BAU Peyara-5. Mamun et al. (2013) observed the same result in case of Swarupkathi with other 3 varieties.

The number of flower set plant^{-1} was significantly influenced by different thinning treatments during on-season (Fig. 2). The highest number of flower set plant^{-1} (186.17) was observed in the 80% fruit thinning and lowest (109) was recorded in the treatment of 0% fruit thinning during on-season (Fig. 2). During off-season, the number of flower set plant^{-1} has found to be significantly affected by different thinning treatments. The highest number of flower set plant^{-1} (35.83) was observed in the 100% fruit thinning and the lowest (14) was recorded in the treatment 0% fruit thinning during off-season (Fig. 2). This might be due to the thinning treatments increases the number of flowers set plant^{-1} during off-season. Similar result observed by Mamun et al. (2013). It was reported that the shoot bending increases the number of flower plant^{-1} during off-season. (Ghose, 2003).

The number of flower set plant^{-1} was significantly influenced by the combined effect of variety and different thinning treatments on during on-season ((Table 1)). During on-season, the highest number of flower set plant^{-1} (340) was recorded in Swarupkathi with 80% fruit thinning and the lowest (200) was recorded with 0% fruit thinning treatments. The highest number of flower set plant^{-1} (32.33) was recorded in BAU Peyara-5, with 80% fruit thinning and the lowest (18) was recorded with 0% fruit thinning treatments. During off-season, number of flower set plant^{-1} was significantly influenced by the combined effect of variety and different thinning treatments. During on-season, the highest number of flower set plant^{-1} (68) was recorded in Swarupkathi with 100% fruit thinning and the lowest (28) was recorded in 0% fruit thinning treatments. On the contrary, the highest number of flower set plant^{-1} (3.67) was recorded in BAU Peyara-5 with 100% fruit thinning and the lowest (0) was recorded in the treatment combination with 0 % fruit thinning treatment. This could be due to the management practices, which increases the number of flowers plant^{-1} during both the seasons. It was reported that the highest number of flowers set plant^{-1} was recorded in the treatment combination of Swarupkathi with shoot bending treatment in both seasons (Mamun et al., 2013).

3.2 Number of fruit set plant^{-1}

The number of fruits set plant^{-1} was significantly influenced by guava variety during on-season. During on-season, the higher number of fruits set plant^{-1} (69.17) was recorded in Swarupkathi, which was higher than that of BAU Peyara-5 (7.59) (Fig. 1). During off-season BAU Peyara-5 did not produce fruits due to flower drop and also for low age. On the other hand, Swarupkathi produced (20.17) fruits in off-season. Mamun et al. (2013) also reported the similar result. In both the seasons, the number of fruits set plant^{-1} was significantly influenced by different management practices. Mamun et al. (2013) and Sarker and Ghosh (2006) observed the similar result in case of shoot bending treatment.

The different fruit thinning treatemnts significantly influenced the number of fruit set plant^{-1}. During on-season the higher (59.50) number of fruits set plant^{-1} was recorded with 80 %thinning treatment whereas the lower (35.50) was resulted by the control (0%) fruit thinning treatment (Fig. 2). During off-season 100% fruit thinning produced higher (20) number of fruits set plant^{-1}, whereas the lower (4.84) was resulted by 0% fruit thinning treatment (Fig. 2). Islam et al. (1992) reported that fruit number increases through increasing the fruit thinning percentage in guava.

Combined effect of variety and fruit thinning had significant influence on the number of fruits set plant^{-1} during on-season (Table 1). In Swarupkathi the higher number of fruits set plant^{-1} (108) was recorded with 80% fruit thinning. The lower number of fruits set plant^{-1} (63) was recorded with 0% fruit thinning (Table 1). In BAU Peyara-5, the higher number of fruits set plant^{-1} (11) was recorded with 80% fruit thinning. The lower number of fruits set plant^{-1} (8) was recorded with 0% fruit thinning (Table 1).

3.3 Fruit yield plant^{-1}

The effect of variety on fruit yield was significant during on-season. Swarupkathi produced (4.44 kg) fruits plant^{-1}, which is higher than that of BAU Peyara-5 (2.31 kg) during on-season (Fig. 1). While during off-season, Swarupkathi produced (1.73 kg) fruit and on the other hand BAU Peyara-5 did not produce any fruit due to flower dropping and younger age might contains less amount of carbohydrate.

Fruit yield was significantly influenced by different thinning treatments during on-season. Highest fruit yield plant^{-1} (6.05kg) was observed in 80% fruit thinning treatment (Fig. 2). In contrast, the lowest fruit yield plant^{-1} (2.93 kg) was recorded in control (0%) treatment. Gonzaga et al. (1997) observed that fruit thinning increased a yield of individual fruit and the yield of individual fruit was the maximum when 75% fruits were thinned. In the present exper-

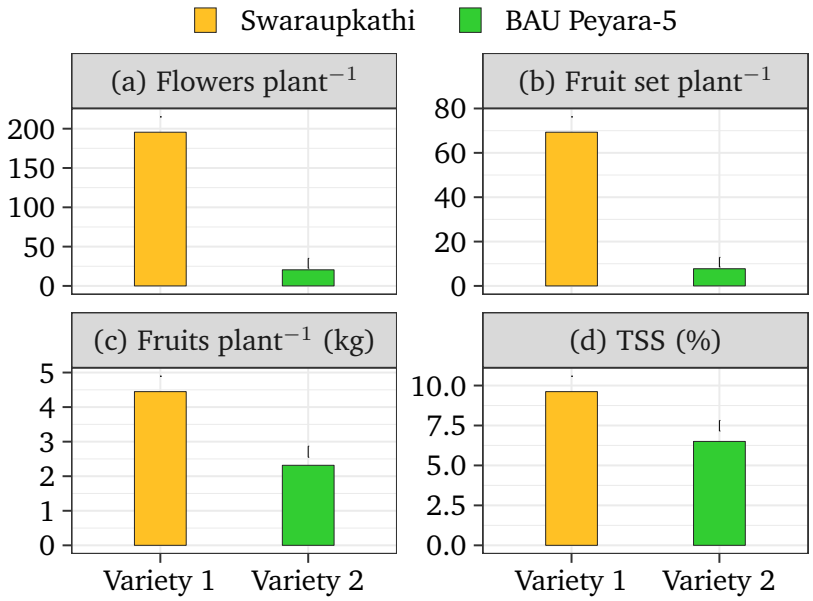

Figure 1. Flowering, fruit set, yield and total soluble solid contents of Swarupkathi and BAU Peyara-5

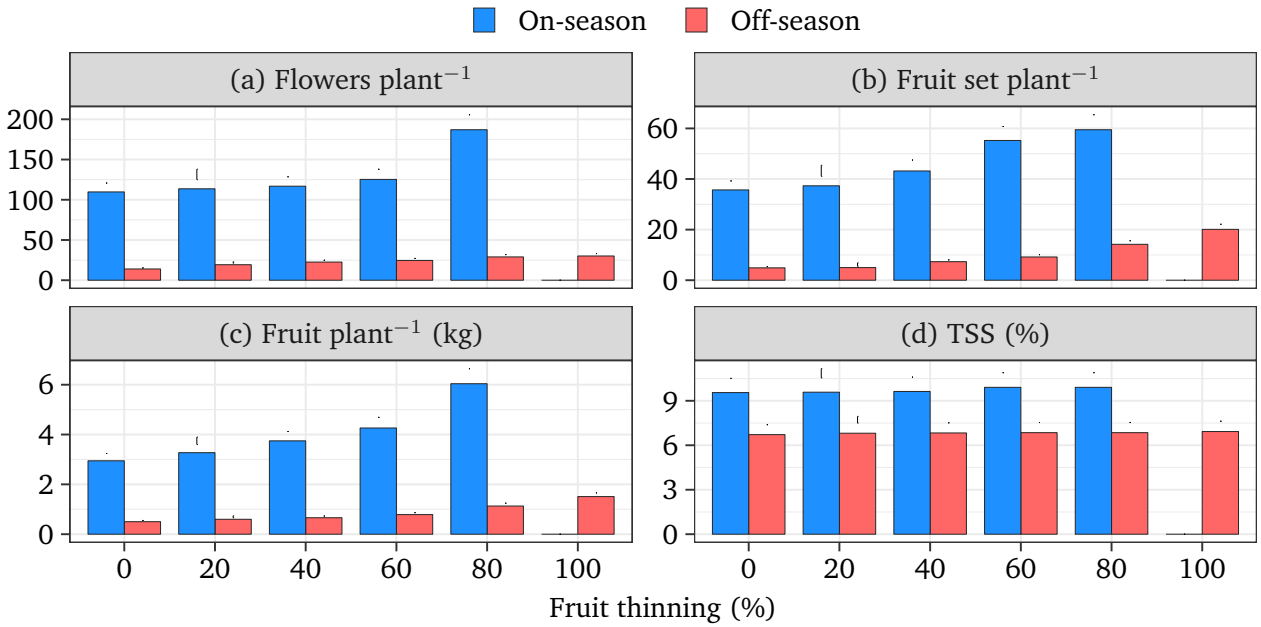

Figure 2. Flowering, fruit set, yield and total soluble solid contents of guava as affected by fruit thinning

Table 1. Combined effects of variety and fruit thinning on flowering, fruit set, yield and total soluble solids of guava

Variety	Fruit thinning (%)	Flower set plant^{-1}		Fruits set plant^{-1}		Fruit yield plant^{-1}		TSS (%)	
		ONS	OFS	ONS	OFS	ONS	OFS	ONS	OFS
V1	0	200	28	63	9.67	3.8	1	11.42	13.42
	20	205	38.33	66	10	3.82	1.2	11.46	13.63
	40	210	44	78	14.67	4.69	1.31	11.48	13.64
	60	219.67	47	100	18.33	5.7	1.57	11.64	13.66
	80	340	54.67	108	28.33	8.6	2.26	11.65	13.7
	100	0	68	0	40	0	3.01	0	13.78
V2	0	18	0	8	0	2.05	0	7.6	0
	20	20	0	8.2	0	2.7	0	7.69	0
	40	21	1	8.33	0	2.8	0	7.72	0
	60	29.67	2	10	0	2.83	0	8.07	0
	80	32.33	3	11	0	3.5	0	8.11	0
	100	0	3.67	0	0	0	0	0	0
$LSD_{0.01}$		49.58	5.06	6.02	2.07	1.26	0.07	0.26	0.1
Sig. level		**	**	**	**	**	**	**	**

ONS = On-season, OFS = Off-season; V1 = Swarupkathi, V2 = BAU Peyara-5; ** = Significant at 1% level of probability

iment, similar results were also observed. During off-season, fruit yield was significantly affected by different thinning treatments. The highest fruit yield (1.51 kg) was observed in 100% fruit thinning treatment. The lowest fruit yield (0.50 kg) plant^{-1} was recorded in the control treatment (0% fruit thinning treatment) (Fig. 2). Islam et al. (1992) reported that fruit yield increased by increasing of fruit thinning percentage. In the present experiment, similar results were also observed.

Fruit yield was significantly influenced by the combined effect of variety and thinning effects during on-season (Table 1). The highest fruit yield (8.60 kg) plant^{-1} was observed in the treatment combination of Swarupkathi with 80% fruit thinning treatment. In contrast, the lowest fruit yield (3.80 kg) plant^{-1} was recorded with the control (0%) treatment. In BAU Peyara-5, the highest fruit yield (3.50 kg) was observed with 80% fruit thinning treatment, while the lowest fruit yield (2.05 kg) was recorded with the control (0%) fruit thinning treatment. During off-season, combined effect of variety and thinning treatments had significant influence on fruit yield plant^{-1}. Hoque and Irabagon (1994) observed that fruit weight increased 2.5 and 2.1 times by heavy and light thinning than the control.

3.4 Total soluble solids (TSS)

Total soluble solids were significantly affected by variety during on-season. The highest TSS (9.61%) was found in the variety Swarupkathi and lowest (6.53%) was recorded in the variety BAU Peyara-5 during on-season (Fig. 1). Singh et al. (1996) found that TSS is higher in winter than in rainy season which supports the current results of the experiment. The highest TSS (13.64%) was recorded in the Swarupkathi during off-season but due to flower droppings, BAU Peyara-5, did not produce any fruit.

During on-season, different fruit thinning significantly influenced total soluble solids (TSS) content of guava. Results revealed that TSS was higher in fruit thinning than no fruit thinning plant. The highest TSS (9.88%) was recorded in 80% fruit thinning treatment. In contrast, the lowest TSS (9.51%) was recorded in the control of 0% fruit thinning treatment during on-season (Fig. 2). TSS is higher in the fruit of maximum fruit thinned plants than the others reported by Islam et al. (1992) also supports the present experimental results. During off-season, total soluble solid (TSS) was significantly influenced by different thinning practices. Results revealed that TSS was highest in fruit thinning than no fruit thinning plant. The highest TSS (6.89%) was recorded in 100% fruit thinning treatment. In contrast, the lowest TSS (6.71%) was recorded in 0% fruit thinning treatment (Fig. 2). TSS increases by increasing fruit thinning percentage reported by Tahir and Hamid (2002), which support the present results of the experiment.

Total soluble solids (TSS) content were significantly influenced by the combined effect of variety and fruit thinning practices during on-season (Table 1). The highest TSS (11.65%) was found in the treatment combination of Swarupkathi with 80% fruit thinning treatment and the lowest TSS (11.42%) was recorded with 0% fruit thinning treatment. Total solu-

ble solids (TSS) content were also significantly influenced by the combined effect of variety and fruit thinning practices during off-season. In Swarupkathi, the highest TSS (13.78%) was recorded with 100% fruit thinning and lowest (13.42%) was observed with 0% treatment but due to flower dropping, BAU Peyara-5 did not produce any fruit in off-season.

4 Conclusions

The experiment was carried out to find out the effect of fruit thinning on the on and off-season production of guava. During on-season, the effects of variety on plant characteristics, yield attributes and fruit yield of guava were significant except fruit length and breadth. Swarupkathi showed superiority than BAU Peyara-5 with 80% fruit thinning. The following recommendations were made based on the findings of the present study viz. Fruit thinning to the extent of 100% increases the yield significantly. Harvesting time increases the TSS (Total soluble solids). During on-season guava production is high but the taste of fruit is poor, insipid and watery. During off-season the production is low but the quality of fruit is better with high TSS value. BAU Peyara-5 did not produce fruit due to failure of flower set. If thinning is operated during off-season in guava, fruit quality can be improved. The experiment was conducted only in BAU germplasm centre; it is general recommendation for successful guava production, the experiment may be repeated in other locations.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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