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Flowering and Fruiting Behavior of Guava (*Psidium guajava* L.)

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Abstract The tagging was done on 5th and 20th day of every month on the three branches in different directions on guava trees cv Hisar Safeda planted at a spacing of 6 m × 6 m during the year 2013-14. The T_1 is marked for the date 05/01/2013, T_2 for 20/01/2013, T_3 for 05/02/2013 and upto T_4 (20/12/2013). The highest flowering (38.0) and fruit yield (23.43 kg/plant) were recorded in T_8 (20/04/13) whereas it was minimum in T_4 (20/02/13) and T_3 (05/02/13) respectively. The maximum days required for fruit set were (14.3) observed in T_1 (05/01/13) and minimum in T_8 (20/04/13). The maximum fruit set percentage (82.0) was observed in T_{22} (20 /11/13) whereas it was minimum in T_{10} (20/05/13). The maximum days required for fruit ripening (131.3) was observed in T_{20} (20/10/13) and minimum in T_9 (05/05/13). The minimum fruit drop percentage was observed in T_{19} (05/10/13) and it was maximum in T_8 (20/04/13). The highest TSS (12.84%) and ascorbic acid (207.76 mg/100g) content were observed in the fruits of T_{16} (20/08/13) and T_{15} (05/08/13) respectively. The acidity was found lowest (0.45%) in T_{16} (20/08/13). The pectin content was found maximum (0.74%) in T_{19} (5/10/13) and minimum T_1 (05/01/13). The maximum fruit weight (158.52 g) was recorded in T_{15} (5/08/13) whereas it was minimum in T_3 (05/02/13). The 100 seed weight (1.15 g) and number of seeds per fruit were (390.9) found maximum in T_{18} (20/09/13) and T_{17} (05/09/13) and it was minimum in T_1 (05/01/13) and T_8 (20/04/13) respectively.

Keywords Guava, Season, Flowering, Fruiting, Yield.

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Introduction

Guava (*Psidium guajava* L.) belongs to family Myrtaceae, called as the apple of the tropics and poor mans apple is one of the most important fruits in India. It is native to Central America. It was introduced to India in the 17th century by Portuguese and

is now being commercially cultivated in 2.68 lakh hectares with production of 36.68 lakh tonnes,with average productivity of 13.7 metric tonnes per hectare. Guava is the fifth most important fruit crop in India after mango, banana, citrus and papaya. In Haryana, guava is grown in an area of 10, 700 hectares with production 1,25,000 MT tonnes [1]. It has been observed that the flowering season vary from region to region. In North India guavas are harvested throughout the year in one or the other region. However, peak harvesting periods in North India are August for rainy season crop, November-December for winter season crop and March-April for spring season crop. In the mild climatic conditions of the other parts of the country, the peak harvesting periods are not so distinct. It is found that fruit yield were maximum during the rainy season while fruit quality is better during winter as compared to the rainy season [2]. In recent past, it has been observed that the flowering behavior of guava shifted due to changed climatic conditions. It necessitates the study on variation in flowering and fruiting behavior of the guava during different fruiting seasons.

Materials and Methods

The present investigation was carried out on guava trees cv Hisar Safeda Planted at a spacing of 6 m ×6 m in experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar during the year 2013-14. These plants were tagged during first week and third week of month and data was collected on various physiological and biochemical parameters. Hisar has a semi-arid climate with hot and dry summer and cold winter. A maximum temperature of around 45°C during summer months of May to June and temperature as low as freezing point accompanied by frost in winter months of December and January are common in the region. About 80% of the annual rainfall (about 450 mm) is received during July to September. The experiment was laid out in randomized block design with three replications, comprising 24 treatments (dates). Guava plants were maintained under uniform condition of orchard management during the study period where all the agronomic practices were carried out as per package of practices. Three branches were selected in different direction on the tree and the number of flowers were counted and then tagged. After flowering, observation for fruit setting was taken and recorded an exact date of fruit setting and the days require for fruit setting from flowering stage were calculated in all seasons. The fruit diameter was measured at 15, 30, 45, 60, 75, 90, 105 and 120 days after fruit set. Five fruits were selected on three different branches of the plant and measured with the help of Digital Vernier Callipers fortnightly in all seasons with replications and the mean value was calculated in millimeter. Five randomly selected fruits from tagged branches of the tree were picked and used for physico-chemical analysis using standard methods. The number of seeds per fruit was counted while hundred seed weight was recorded using electric balance.

Results and Discussion

The tagging was done on 5th and 20th day of every month on the guava cultivar Hisar Safeda. It is mentioned here that out of 24 fortnightly intervals, flowering took place only in18 treatments (dates) therefore 18 treatments have been cited for presentation in the Table 1, whereas, T_6 (20/03/13)T_7 (5/04/13), T_{11} (5/06/13), T_{12} (20/06/13), T_{13} (5/07/13) and T_{14} (20/07/13) had shown no flowering. Further, out of 18 flowering dates, there was no fruit set in two flowering dates i.e. T_4 (20/2/2013) and T_5 (5/3/2013) and only 16 dates had fruit set, which are presented in tables showing fruiting and quality characters.

The data regarding number of flowers per branch, depicted in Figure 1, unveiled a spacious variation due to time of year. Flowering in guava takes place on new growth that is why there were continuous flowering almost round the year. The maximum number of flowers per branch 38.0 was recorded in T_8. The minimum number of flowers 12.0 was recorded in T_4 followed by 13.0 in T_5. Rate of flowering in guava is governed by the seasons and the cropping pattern. The plants accumulated sufficient food reserves which is responsible for the initiation of new growth from T_1 to T_5 and heavy flowering in T_8 to T_{10} the reserves were exhausted therefore the flowering in T_{15} to T_{24} were less than flowering in T_8 to T_{10} . It is quite apparent from the data presented in Table 1 that the number of days taken for fruit setting from

Table 1. Fortnightly variation on fruiting attributes of guava. No fruit set in eight out of 24 dates.

Date (Treatments)	Days taken for fruit setting	Days taken to fruit to ripen	Fruit set (%)	Fruit drop (%)
5/1/2013 (T_1)	14.3	112.0	70.00	28.66
20/1/2013 (T_2)	14.0	110.0	69.00	26.33
5/2/2013 (T_3)	13.0	109.0	67.33	30.00
20/4/2013 (T_8)	9.0	108.3	65.33	31.66
5/5/2013 (T_9)	9.3	108.0	64.66	27.33
20/5/2013 (T_{10})	9.0	114.6	60.33	30.00
5/8/2013 (T_{15})	11.3	125.3	69.00	22.66
20/8/2013 (T_{16})	11.7	128.6	70.66	21.66
5/9/2013 (T_{17})	11.7	130.0	71.00	23.00
20/9/2013 (T_{18})	11.7	130.3	74.00	20.00
5/10/2013 (T_{19})	12.7	131.0	76.00	19.00
20/10/2013 (T_{20})	13.0	131.3	78.00	28.66
5/11/2013 (T_{21})	13.3	129.0	80.33	25.66
20/11/2013 (T_{22})	13.3	126.3	82.00	27.33
5/12/2013 (T_{23})	14.0	117.0	77.66	28.33
20/12/2013 (T_{24})	14.0	114.0	76.33	29.66
CD at 5%	1.2	1.9	2.72	3.42

flowering varies from 9.0 days (T_8 and T_{10}) to 14.3 days (T_1). The high temperature and longer day length reduced the time taken for the flowers to set fruits. The result finds conformity with the experimental outcome of Dubey et al. [3]. The data regarding days taken to fruit ripening presented in Table 1 showed that the treatment T_9 had taken minimum days for maturity (108.0 days) followed by 108.3 days in T_8. Maximum days required for maturity were 131.3 days (T_{20}) followed by 131.0 days in T_{19}. High temperature accompanied with high humidity in T_8 to T_{15} accelerated fruit growth and ripening during rainy season. The results are in conformity with findings of Milan [4]. Maximum fruit ser (82%) was recorded in T_{22} flowering and it was minimum (60.33%) in T_{10} flowering. As the number of flowers was more inT_8 to T_{10}, the competition for nutrients and photosynthates becomes higher which result in poor fruit setting and then poor fruit retention. The extremely high temperature might have restricted the activity of pollinators resulting in poor fruit set during the month of May. The results are in conformity with those of Dubey et al. [3]. Maximum fruit drop was observed in T_8 (31.66%) and minimum (19.00%) in T_{19} flowering. The possible reason for fruit drop in summer

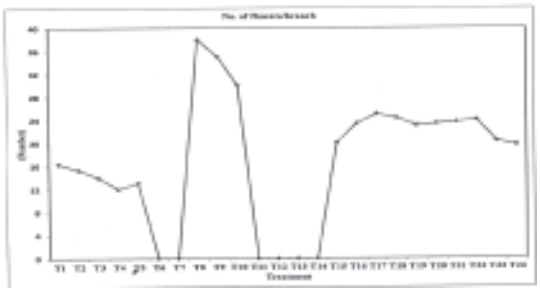

Fig. 1. Fortnightly variation on number of flowers per branch of guava.

may be ascribed to low soil moisture, high temperature, low humidity and strong winds which can accelerate fruit drop. Secondly, due to higher competition for nutrients and photosynthates the plant cannot retain all the fruits.

The data regarding fruit diameter depicted in Figure 2 shows that there was no significant difference in fruit diameter in initial 15 days in all dates (treatments) of flowering. There were significant differences in fruit diameter at 30 days after fruit setting. The maximum diameter noted was 14.70 mm in T_{21} (5/11/13) and the minimum (12.13 mm) in T_{24} (20/12/13). The maximum fruit diameter at 45 days was 20.66 mm in T_9 (5/05/13) followed by T_{21} (20.24 mm) (Table 2). Fruit diameter recorded at 15 days to 120 days after fruit set shows wide variation. A steady growth in fruit size recorded from 15 to 45 days of fruit development after that a fast increase was observed from 45 to 90 days, then a slow increase was observed. It is because of variation in temperature and availability of moisture which differ in all seasons. The fruits of T_{15} to T_{22} recorded maximum fruit diameter followed by T_8 to T_{10}, whereas minimum fruit diameter was observed in T_{23} to T_{24} and from T_1 to T_3. This variation may be due to phenotypic and environmental interactions within the season as more metabolites move during winter because the time period spent up to ripening was more during cool season which resulted in more increment in fruit size. Similar variations were observed earlier [5, 6].

It is obvious that maximum fruit weight (158.5

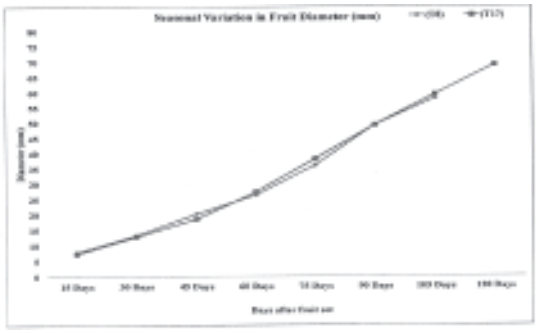

Fig. 2. Variation in fruit diameter (mm) at fortnightly interval in guava.

g) was recorded in T_{15} and minimum was (80.6 g) in T_3 and it showed significant variation because of restricted fruit to leaf ratio and limited exposure of light due to cloudy weather and fog, coupled with new vegetative growth probably less photosynthates were available for fruit growth in T_8 to T_{10} and from T_1 to T_3 hence., medium to smaller size fruits were obtained. However, during T_{15} to T_{22} fruits received more organic metabolites and thus gained weight because of higher fruit to leaf ratio and better exposure to light . Similar observations were recorded by Singh [7].

Yield is known to be a polygenic character. Besides, care and management of orchard age of plant and season are the other important factors influencing the yield. In present study it was observed that the maximum yield was noted 23.43 kg/ plant in T_8 which was significantly higher than other treatments. It was recorded minimum 4.56 kg in T_3. The crop taken from T_8 to T_{10} has given maximum yield followed by T_{19} to T_{20} and minimum from T_{23} to T_{24} and from T_1 to T_3. The maximum yield may be due to higher number of flowers obtained in T_8 to T_{10} and full utilization of the yield potential by the plants, while due to exhaustion of the food reserves, less number of flowers and fruits were produced on the tree during other cropping seasons. Seediness is the major problem in many fruit crops and more so in guava. It is also known in guava that complete seedlessness will result in deformed and misshapen fruits accompanied by reduction in fruits size. Since the presence of seeds determines shape and size of fruit, it is desirable to have fruit with few and soft seeds. From the present study, it was observed that in general there was a wide variation with respect to seed characters among the treatments. Minimum number of seeds per fruit (209.1) was observed in T_8 whereas maximum seed count (390.9) was recorded in T_{17}. Hundred seed weight was maximum (1.15 g) in T_{18}, whereas minimum in T_1 (0.42 g). Such

Table 2. Variation in fruit diameter (mm) at fortnightly interval in guava. No fruit set in eight out of 24 dates.

Date (Treatment)	15 days	30 days	45 days	60 days	75 days	90 days	105 days	120 days
5/1/2013 (T_1)	7.08	12.16	18.13	25.29	35.30	44.97	53.97	–
20/1/2013 (T_2)	7.89	12.87	19.15	26.11	35.00	46.38	54.95	–
5/2/2013 (T_3)	7.75	13.10	19.36	27.80	35.78	47.66	56.10	–
20/4/2013 (T_8)	7.92	13.27	20.14	26.34	35.97	49.09	57.86	–
5/5/2013 (T_9)	8.86	13.35	20.66	28.72	38.39	48.58	57.96	–
20/5/2013 (T_{10})	8.12	14.36	19.36	29.11	39.11	48.95	57.25	–
5/8/2013 (T_{15})	7.86	13.45	19.02	29.18	38.37	50.75	59.68	68.71
20/8/2013 (T_{16})	7.74	14.68	18.87	28.77	39.05	50.56	59.25	69.03
5/9/2013 (T_{17})	7.39	12.92	18.49	27.28	38.06	49.03	59.11	68.74
20/9/2013 (T_{18})	8.15	12.97	19.90	28.69	38.60	50.71	59.06	69.00
5/10/2013 (T_{19})	8.30	13.03	19.11	28.39	35.64	49.81	60.66	70.31
20/10/2013 (T_{20})	7.72	12.97	18..14	28.09	37.26	47.98	58.41	68.57
5/11/2013 (T_{21})	7.74	14.70	20.24	26.30	37.94	49.80	58.47	67.76
20/11/2013 (T_{22})	7.39	13.18	17.82	27.72	38.75	49.15	59.30	69.51
5/12/ 2013 (T_{23})	7.73	13.34	19.43	24.97	34.97	45.34	54.96	60.32
20/12/2013 (T_{24})	7.66	12.13	17.95	25.46	34.72	44.68	55.34	60.65
CD at 5%	NS	1.27	1.40	1.63	1.11	1.86	0.71	0.54

Table 3. Fortnightly variation on fruiting, quality and seed attributes in guava. No fruit set in eight out of 24 dates.

Date (Treatments)	Av fruit weight (g)	Av fruit yield (kg/tree)	Wt. of 100 seeds (g)	No. of seeds/ fruit	TSS (%)	Acidity (%)	Ascorbic acid (mg /100g	Pectin (%)
5/1/2013 (T_1)	88.0	5.54	0.42	307.8	9.60	0.58	115.4	0.57
20/1/2013 (T_2)	89.6	6.32	0.59	294.5	9.83	0.60	123.2	0.58
5/2/2013 (T_3)	80.6	4.56	0.63	301.0	9.76	0.58	117.2	0.59
20/4/2013 (T_8)	93.4	23.43	0.81	209.1	9.90	0.58	110.8	0.62
5/5/2013 (T_9)	94.4	22.10	0.74	213.3	9.84	0.57	115.0	0.61
20/5/2013 (T_{10})	91.4	19.56	0.73	217.4	10.01	0.53	118.3	0.58
5/8/2013 (T_{15})	158.5	13.74	1.06	373.4	12.54	0.46	207.7	0.66
20/8/2013 (T_{16})	151.5	11.08	1.07	368.7	12.84	0.45	194.7	0.68
5/9/2013 (T_{17})	148.2	11.05	1.05	390.9	12.14	0.46	201.7	0.70
20/9/2013 (T_{18})	144.0	12.10	1.15	385.1	11.40	0.48	205.5	0.73
5/10/2013 (T_{19})	147.6	15.03	1.09	382.0	11.18	0.50	206.8	0.74
20/10/2013 (T_{20})	100.7	14.15	0.63	318.7	10.59	0.54	132.0	0.66
5/11/2013 (T_{21})	102.4	10.18	0.53	311.3	10.79	0.52	139.1	0.65
20/11/2013 (T_{22})	108.1	10.47	0.55	326.5	10.75	0.54	134.2	0.62
5/12/2013 (T_{23})	86.1	6.48	0.50	337.4	10.41	0.54	129.3	0.62
20/12/2013 (T_{24})	81.5	4.74	0.44	335.4	10.45	0.53	123.1	0.60
CD at 5%	5.02	1.73	0.06	5.00	0.90	0.04	4.90	0.07

variation among the treatments in seed characters may be attributed to climatic variation. Seed number is known to be a function of value fertility and effective fertilization. These results are in conformity with the findings of Patel et al. [8].

Among the different factors influencing fruit quality, total soluble solids indicates higher sugar content in the fruits and is considered as one of the important criterion for dessert quality. It is quite apparent from the data that TSS, pectin and ascorbic acid contents were found higher during T_{15} to T_{19} followed by T_{20} to T_{24} and acidity was also minimum (0.45%) in T_{16} whereas it was maximum in T_2. Pectin content was observed high (0.74%) in T_{19} in firm mature fruit and it tends to decreases when full ripening occurs. Similar trends were confirmed by the finding of Hegde and chharia [9]. Biosynthesis of pectin is inversely correlated with low pH of cell sap and it finds conformity with the results of [10]. The fruits of T_{15} to T_{19} had significantly higher values of various quality attributes as compared to T_1 to T_3 and T_8 to T_{10}, respectively (Table 3). Moderate acid content coupled with high total sugar content (12.84%) as observed in the T_{16} appeared to be favoring good taste and flavor of its fruits, whereas high acidity (0.60%) in T_2 resulted in the poor acceptability of its fruits in the market.Higher ascorbic acid content was observed (207.7 mg/100g) in T_{15} followed by T_{19} as it is negatively correlated with pectin contents and increases with ripening while T_8 and T_9 produced fruits with lower ascorbic acid content. The larger variation in ascorbic acid content may be attributed to seasonal conditions. The percentage of various constituents in the rainy season were low due to cloudy weather and presence of relatively more moisture as well as the time period up to ripening was less resulting in less metabolites particularly sugars. The inferior quality of the fruits from T_1 to T_3 and T_8 to T_{10} might be attributed to the initiation of new growth coupled with leaf fall and also prevalence of higher atmospheric temperature at the time of fruit growth and development in 3rd phas of their growth as well as the development of sweetness, color and aroma is dependent on low temperature and dry atmosphere. These results are in conformity with the findings of Hegde and Chharia [9].

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