

## Flowering and Fruiting Behavior of Selected Mango Varieties in West Garo Hills of Meghalaya

Abhishisha Mawkhiew, Lolly S. Pereira

Received 15 August 2020, Accepted 21 November 2020, Published on 7 January 2021

### ABSTRACT

Flowering and fruiting behavior of three varieties of mango viz., Amrapali, Dashehari and Kesar were observed during the years 2017 and 2018, which is situated approximately between 90°30' and 89°40'E latitudes and 26° and 25° 20'N longitudes. Variety Kesar exhibited earliest panicle emergence (3<sup>rd</sup> January- 25<sup>th</sup> January), earliest male flowering (18<sup>th</sup> January- 24<sup>th</sup> February) and earliest hermaphrodite flowering (21<sup>st</sup>-January -6<sup>th</sup> March) during the period of investigation. End of flowering was earliest in variety Amrapali (5<sup>th</sup> March-10<sup>th</sup> April). Maximum duration from panicle emergence to flowering was recorded in Amrapali (19.88 days). Maximum duration of male flowering (7.39 days) was observed in Kesar whereas maximum duration of hermaphrodite flowering (18.11 days) was recorded in Amrapali. The longest flowering period was noted in Kesar (27.09). Highest number (262.5) and percentage (80.62%) of male flowers was observed in Dashehari while highest number (77.29) and percentage (30%) of hermaphrodite flowers was recorded in Amrapali. Dashehari recorded highest sex ratio of 4.84 indicating presence of more male flowers per hermaphrodite flower. Earliest fruit set (1<sup>st</sup>-18<sup>th</sup> March) was recorded in Amrapali closely

followed by Kesar (2<sup>nd</sup>-17<sup>th</sup> March). Number of initial fruit set was highest (28.27) in Amrapali which also recorded the highest percentage of fruit set (11.88%), highest number of fruits retained per panicle (2.16) and highest percentage of fruit retention (7.59%). Variety Dashehari required the shortest duration (126.3 days) to reach harvest maturity while Amrapali attained maturity in 132.01 days and Kesar required the longest duration of 135.98 days for fruit maturity.

**Keywords:** Mango, Flowering, Sex ratio, Fruit set, Fruit retention.

### INTRODUCTION

Mango (*Mangifera indica*) belonging to the family Anacardiaceae has been in cultivation in India for more than 4000 years (Loay *et al.* 2005). It has been a favorite fruit in India throughout history and has been repeatedly acclaimed as the “king of fruits” (Maiti and Das 2007). It is the most important commercially grown fruit crop of India. Mango thrives well in tropical and sub-tropical climate and can be grown on a wide variety of soils from alluvial to lateritic soils except in black cotton soil having poor drainage. It can be grown upto 1,100 m above mean sea level. A temperature range of 24 to 27°C is ideal for its cultivation and higher temperatures during fruit development and maturity give better quality fruits. It grows well in regions with rainfall between 25 cm and 250 cm. Regions having bright sunny days and moderate humidity during flowering are ideal for mango cultivation. The area under mango cultivation in India during 2015-2016 was 2,209 thousand hectare with a production of 1,8643

---

Abhishisha Mawkhiew, Lolly S. Pereira\*  
Department of RDAP, North Eastern Hill University, Tura campus,  
Tura 794002, West Garo Hills, Meghalaya, India  
Email: drlollysp@gmail.com  
\*Corresponding author

thousand MT and productivity of 8.4 MT/ha (Source: Horticultural Statistics at a Glance 2017). Mango flowers are borne on terminal inflorescence called panicle which are highly branched and can be upto 60 cm long in some varieties. Mango inflorescence bears two types of flowers - male and hermaphrodite (perfect). Hermaphrodite flowers lead to fruit set through pollination and fertilization. The initial fruit set is directly related to the proportion of perfect flowers (Singh *et al.* 2015). A mango tree can have 200–3000 panicles with a potential to produce tremendous number of flowers (Barui and Ghosh 2002). Flowering in mango is a very complex phenomenon and a decisive factor in productivity. Mango flowering is an important physiological event that sets the start of fruit production (Jameel *et al.* 2018). Mango flowering is greatly influenced by weather conditions and varietal genotypes and is the most important trait as it directly affects yield (Hada and Singh 2017, Azam *et al.* 2018). Variability of mango flowering depends on cultivar, tree age, environmental condition and growth condition (Jameel *et al.* 2018). Considering the significance of the event of flowering in mango fruit production and limited reports on flowering and fruiting of mango in this region, an experiment was

conducted to study the flowering and fruiting behavior of selected mango varieties in West Garo Hills of Meghalaya (Tables 1 and 2).

## MATERIALS AND METHODS

The present experiment was carried out in the instructional farm of Department of Rural Development and Agricultural Production (RDAP) of North Eastern Hill University, Tura campus, Tura, West Garo Hills District, Meghalaya, during the years 2017 and 2018. The farm is located in Rongram block of West Garo Hills which is situated approximately between 90°30' and 89°40'E latitudes and 26° and 25° 20'N longitudes at an elevation of 872 m above mean sea level. The experiment was carried out on 13 years old healthy trees of three varieties (treatments) viz., Amrapali, Dashehari and Kesar with seven replications each. The experiment was laid out in Randomized Block Design (RBD) and trees were maintained under uniform cultural practices. The observations on flowering behavior were recorded as date of panicle emergence, position of inflorescence, date of male flowering, date of hermaphrodite flowering, end of flowering, duration from panicle emergence to

**Table 1.** Flowering behavior of selected mango varieties in West Garo Hills of Meghalaya. Data are represented as Mean  $\pm$  SEM. Similar alphabets denote homogeneous mean values.

Parameters	Amrapali			Dashehari		
	2017	2018	Pooled	2017	2018	Pooled
Date of panicle emergence	6 Jan-20 Jan	9 Jan-24 Jan	6 Jan-24 Jan	3 Feb-17 Feb	25 Jan-11 Feb	25 Jan-17 Feb
Date of male flowering	1 Feb-20 Feb	25 Jan-11 Feb	25 Jan-20 Feb	23 Feb-5 Mar	13 Feb-3 Mar	13 Feb-5 Mar
Date of hermaphrodite flowering	6 Feb-24 Feb	28 Jan-19 Feb	28 Jan-24 Feb	4 Mar-10 Mar	16 Feb-7 Mar	16 Feb-10 Mar
End of flowering	21 Mar-10 Apr	5 Mar-24 Mar	5 Mar-10 Apr	20 Mar-27 Mar	16 Mar-30 Mar	16 Mar-30 Mar
Duration from panicle emergence to flowering (days)	22.25 $\pm$ 1.07 <sup>b</sup>	17.51 $\pm$ 0.66 <sup>b</sup>	19.88 $\pm$ 0.89 <sup>b</sup>	18.64 $\pm$ 0.77 <sup>a</sup>	15.35 $\pm$ 0.47 <sup>a</sup>	16.99 $\pm$ 0.63 <sup>a</sup>
Duration of male flowering (days)	5.65 $\pm$ 1.02 <sup>a</sup>	3.73 $\pm$ 0.14 <sup>a</sup>	4.69 $\pm$ 0.56 <sup>a</sup>	5.99 $\pm$ 0.60 <sup>a</sup>	4.43 $\pm$ 0.53 <sup>ab</sup>	5.21 $\pm$ 0.44 <sup>a</sup>
Duration of hermaphrodite flowering (days)	18.10 $\pm$ 0.76 <sup>b</sup>	18.13 $\pm$ 0.66 <sup>b</sup>	18.11 $\pm$ 0.48 <sup>b</sup>	13.33 $\pm$ 0.66 <sup>a</sup>	14.54 $\pm$ 0.66 <sup>a</sup>	13.93 $\pm$ 0.48 <sup>a</sup>
Total flowering period (days)	24.62 $\pm$ 1.16 <sup>a</sup>	20.93 $\pm$ 1.20 <sup>ab</sup>	22.78 $\pm$ 0.95 <sup>a</sup>	20.24 $\pm$ 0.60 <sup>a</sup>	19.07 $\pm$ 0.76 <sup>a</sup>	19.66 $\pm$ 0.49 <sup>a</sup>
Number of male flowers	150.74 $\pm$ 16.94 <sup>a</sup>	217.23 $\pm$ 28.34 <sup>a</sup>	183.99 $\pm$ 18.35 <sup>a</sup>	258.97 $\pm$ 35.06 <sup>b</sup>	266.03 $\pm$ 44.12 <sup>a</sup>	262.5 $\pm$ 27.09 <sup>b</sup>
Number of hermaphrodite flowers	67.31 $\pm$ 7.84 <sup>a</sup>	87.26 $\pm$ 10.98 <sup>b</sup>	77.29 $\pm$ 7.04 <sup>b</sup>	54.26 $\pm$ 3.57 <sup>a</sup>	59.21 $\pm$ 3.38 <sup>a</sup>	56.74 $\pm$ 2.46 <sup>a</sup>
Total number of flowers	218.06 $\pm$ 20.97 <sup>a</sup>	304.49 $\pm$ 36.74 <sup>ab</sup>	261.27 $\pm$ 23.59 <sup>a</sup>	313.23 $\pm$ 35.24 <sup>a</sup>	325.24 $\pm$ 42.08 <sup>b</sup>	319.2357 $\pm$ 26.42 <sup>a</sup>
% Hermaphrodite flowers	31.07 $\pm$ 2.55 <sup>b</sup>	28.94 $\pm$ 1.81 <sup>b</sup>	30.00 $\pm$ 1.53 <sup>b</sup>	18.67 $\pm$ 2.25 <sup>a</sup>	20.08 $\pm$ 2.63 <sup>a</sup>	19.38 $\pm$ 1.68 <sup>a</sup>
% Male flowers	68.93 $\pm$ 2.56 <sup>a</sup>	71.06 $\pm$ 1.810 <sup>a</sup>	69.99 $\pm$ 1.53 <sup>a</sup>	81.33 $\pm$ 2.251 <sup>b</sup>	79.92 $\pm$ 2.63 <sup>b</sup>	80.62 $\pm$ 1.68 <sup>b</sup>
Sex ratio (Male : Female)	2.32 $\pm$ 0.22 <sup>a</sup>	2.53 $\pm$ 0.22 <sup>a</sup>	2.43 $\pm$ 0.15 <sup>a</sup>	4.92 $\pm$ 0.81 <sup>b</sup>	4.76 $\pm$ 1.00 <sup>a</sup>	4.84 $\pm$ 0.62 <sup>b</sup>

**Table 1.** Continued.

Parameters	2017	Kesar 2018	Pooled
Date of panicle emergence	13 Jan-25 Jan	3 Jan-16 Jan	3 Jan-25 Jan
Date of male flowering	11 Feb-24 Feb	18 Jan-1 Feb	18 Jan-24 Feb
Date of hermaphrodite flowering	21 Feb-6 Mar	21 Jan-6 Feb	21 Jan-6 Mar
End of flowering	20 Mar-25 Mar	16 Mar-4 Apr	16 Mar-4 Apr
Duration from panicle emergence to flowering (days)	17.75 ± 0.85 <sup>a</sup>	17.98 ± 0.57 <sup>b</sup>	17.86 ± 0.49 <sup>ab</sup>
Duration of male flowering (days)	8.13 ± 0.62 <sup>a</sup>	6.65 ± 1.20 <sup>b</sup>	7.39 ± 0.68 <sup>b</sup>
Duration of hermaphrodite flowering (days)	11.69 ± 1.16 <sup>a</sup>	16.55 ± 1.15 <sup>ab</sup>	14.12 ± 1.03 <sup>a</sup>
Total flowering period (days)	29.98 ± 7.57 <sup>a</sup>	24.2 ± 0.88 <sup>b</sup>	27.09 ± 3.75 <sup>a</sup>
Number of male flowers	250.4 ± 25.22 <sup>b</sup>	161.14 ± 13.98 <sup>a</sup>	205.77 ± 18.58 <sup>ab</sup>
Number of hermaphrodite flowers	60.68 ± 6.24 <sup>a</sup>	38.86 ± 6.73 <sup>a</sup>	49.77 ± 5.35 <sup>a</sup>
Total number of flowers	311.09 ± 24.79 <sup>a</sup>	200 ± 18.16 <sup>a</sup>	255.54 ± 21.34 <sup>a</sup>
% Hermaphrodite flowers	20.30 ± 2.49 <sup>a</sup>	19.21 ± 2.12 <sup>a</sup>	19.76 ± 1.58 <sup>a</sup>
% Male flowers	79.70 ± 2.49 <sup>b</sup>	80.79 ± 2.13 <sup>b</sup>	80.24 ± 1.58 <sup>b</sup>
Sex ratio (Male:Female)	4.43 ± 0.70 <sup>ab</sup>	4.62 ± 0.64 <sup>a</sup>	4.52 ± 0.46 <sup>b</sup>

flowering, duration of each phase of flowering, total flowering period, flower composition (number and percentage of male and hermaphrodite flowers) and sex ratio (male : female). Observations of fruiting

behavior were recorded as date of fruit set, number of fruits set per panicle, flower: Fruit set ratio, percentage of fruit set, fruits retained per panicle, percentage of fruit retention, date of harvest and duration for

**Table 2.** Fruiting behavior of selected mango varieties in West Garo Hills of Meghalaya. Data are represented as Mean ± SEM. Similar alphabets denote homogeneous mean values.

Parameters	Amrapali			Dashehari		
	2017	2018	Pooled	2017	2018	Pooled
Date of fruit set	1 Mar-17 Mar	2 Mar-18 Mar	1 Mar -18 Mar	9 Mar-22 Mar	8 Mar -16 Mar	8 Mar -22 Mar
Fruits set per panicle	27.97±1.09 <sup>a</sup>	28.57±1.21 <sup>a</sup>	28.27±0.78 <sup>b</sup>	25.77±1.39 <sup>a</sup>	26.57±1.08 <sup>a</sup>	26.17±0.85 <sup>ab</sup>
Flower : Fruit set ratio	7.84±0.81 <sup>a</sup>	10.60±1.09 <sup>ab</sup>	9.22±0.76 <sup>a</sup>	12.20±1.27 <sup>b</sup>	12.17±1.37 <sup>b</sup>	12.18±0.90 <sup>b</sup>
% Fruit set	13.50±1.24 <sup>b</sup>	10.25±1.37 <sup>ab</sup>	11.88±0.99 <sup>b</sup>	8.82±1.01 <sup>a</sup>	8.71±0.74 <sup>a</sup>	8.76±0.60 <sup>a</sup>
Fruits retained per panicle	2.31±0.17 <sup>b</sup>	2.00±0.20 <sup>a</sup>	2.16±0.13 <sup>b</sup>	1.89±0.20 <sup>ab</sup>	1.66±0.23 <sup>a</sup>	1.77±0.15 <sup>ab</sup>
% Fruit retention	8.27±0.49 <sup>b</sup>	6.91±0.46 <sup>a</sup>	7.59±0.37 <sup>a</sup>	7.27±0.54 <sup>ab</sup>	6.13±0.69 <sup>a</sup>	6.70±0.45 <sup>a</sup>
Date of harvest	7 Jul-28 Jul	9 Jun-18 Aug	9 Jun-18 Aug	11 Jul-22 Jul	4 Jun-28 Jul	4 Jun-28 Jul
Duration for maturity	127.33±1.93 <sup>a</sup>	136.69±2.17 <sup>a</sup>	132.01±1.90 <sup>ab</sup>	123.83±1.16 <sup>a</sup>	128.87±3.22 <sup>a</sup>	126.3±1.79 <sup>a</sup>

**Table 2.** Continued.

Parameters	Kesar		
	2017	2018	Pooled
Date of fruit set	5 Mar -17 Mar	2 Mar -10 Mar	2 Mar -17 Mar
Fruits set per panicle	24.63 ± 0.93 <sup>a</sup>	25.83 ± 0.99 <sup>a</sup>	25.23 ± 0.67 <sup>a</sup>
Flower : Fruit set ratio	12.56 ± 0.71 <sup>b</sup>	7.74 ± 0.62 <sup>a</sup>	10.15 ± 0.81 <sup>ab</sup>
% Fruit set	8.13 ± 0.49 <sup>a</sup>	13.43 ± 1.09 <sup>b</sup>	10.78 ± 0.94 <sup>ab</sup>
Fruits retained per panicle	1.63 ± 0.08 <sup>a</sup>	1.57 ± 0.18 <sup>a</sup>	1.6 ± 0.09 <sup>a</sup>
% Fruit retention	6.61 ± 0.19 <sup>a</sup>	6.08 ± 0.61 <sup>a</sup>	6.34 ± 0.31 <sup>a</sup>
Date of harvest	10 Jun-27 Jul	9 Jun-18 Aug	9 Jun-18 Aug
Duration for maturity	135.13 ± 2.78 <sup>b</sup>	136.83 ± 1.72 <sup>a</sup>	135.98 ± 1.59 <sup>b</sup>

fruit maturity. The data were subjected to statistical analysis using Fischer's one-way analysis of variance (ANOVA) by Panse and Sukhatme (1985) using SPSS version 20. The data were represented as mean  $\pm$  SEM. Observed means were compared by Tukey Post Hoc test and confidence interval were adjusted with Bonferroni at 5% significance level ( $p \leq 0.05$ ).

## RESULTS AND DISCUSSION

All the three mango varieties viz., Amrapali, Dashehari and Kesar in the present study exhibited terminal flowering. Earliest panicle emergence was observed in variety Amrapali (6<sup>th</sup> - 20<sup>th</sup> January) followed by variety Kesar (13<sup>th</sup>-25<sup>th</sup> January) and variety Dashehari (3<sup>rd</sup>- 17<sup>th</sup> February) in the year 2017. In the year 2018 the earliest panicle emergence was observed in Kesar (3<sup>rd</sup>- 16<sup>th</sup> January) followed by Amrapali (9<sup>th</sup>- 24<sup>th</sup> January) and Dashehari (25<sup>th</sup> January- 11<sup>th</sup> February). In both the years Dashehari showed late panicle emergence. Similar study was conducted by Kumar *et al.* (2017) at Meerut in Uttar Pradesh where panicle emergence in Amrapali was observed during 2<sup>nd</sup>-7<sup>th</sup> February in 2015 and 4<sup>th</sup>-11<sup>th</sup> February in 2016 and in Dashehari during 1<sup>st</sup>-8<sup>th</sup> February in 2015 and 3<sup>rd</sup>-11<sup>th</sup> February in 2016. Hada and Singh (2017) recorded panicle emergence in Amrapali during 13<sup>th</sup>-18<sup>th</sup> February and in Dashehari during 12<sup>th</sup>-16<sup>th</sup> February in the year 2014 while in 2015 panicle emergence in Amrapali was observed during 10<sup>th</sup>-16<sup>th</sup> February and 11<sup>th</sup>-18<sup>th</sup> February in Dashehari at Varanasi in Uttar Pradesh. Gautam *et al.* (2019) observed first panicle emergence in Amrapali on 4<sup>th</sup> February and in Dashehari on 10<sup>th</sup> February during the year 2011; and in the year 2012 first panicle emergence was recorded on 15<sup>th</sup> February in Amrapali and 7<sup>th</sup> February in Dashehari at Modipuram, Meerut in Uttar Pradesh. Gill *et al.* (2015) recorded panicle initiation in Dashehari during 28<sup>th</sup> February-3<sup>rd</sup> March whereas in Amrapali it was noticed during 6<sup>th</sup>-10<sup>th</sup> March in Punjab. Variations in dates of panicle emergence of different varieties might be due to differences in genetic composition of varieties (Kumar *et al.* 2017). It may be noted that in the above mentioned works panicle emergence in varieties Amrapali and Dashehari were observed on different dates of February in different regions of Uttar Pradesh while in Punjab the same varieties showed late panicle initiation during

first to second week of March. In the present study panicle emergence was noted as early as 1<sup>st</sup> week of January and extended upto 3<sup>rd</sup> week of February in the three varieties studied in Rongram block of West Garo Hills district of Meghalaya. These differences in dates of panicle emergence of the same varieties in different locations may be due to the influence of prevailing agro climatic conditions of the region.

First flowering (male) in the present study was observed during 1<sup>st</sup>-20<sup>th</sup> February in Amrapali followed by Kesar (11<sup>th</sup>-24<sup>th</sup> February) and Dashehari (23<sup>rd</sup> February- 5<sup>th</sup> March) in the year 2017. In the year 2018 earliest male flowering was recorded in variety Kesar (18<sup>th</sup> January - 1<sup>st</sup> February) followed by Amrapali (25<sup>th</sup> January -11<sup>th</sup> February) and Dashehari (13<sup>th</sup> February-3<sup>rd</sup> March). Kumar *et al.* (2017) observed the start of flowering (male phase) in Amrapali on 10<sup>th</sup> March and in Dashehari on 9<sup>th</sup> March during the years 2015 and 2016 at Meerut in Uttar Pradesh. Gautam *et al.* (2019) observed flower initiation in Amrapali on 14<sup>th</sup> March and in Dashehari on 9<sup>th</sup> March in the year 2011 and in 2012 flower initiation was observed on 16<sup>th</sup> March in Amrapali and on 10<sup>th</sup> March in Dashehari at Modipuram, Meerut in Uttar Pradesh. Hada and Singh (2017) recorded first flowering in variety Amrapali from 26<sup>th</sup>-28<sup>th</sup> February in the year 2014 and 22<sup>nd</sup>-25<sup>th</sup> February in 2015 whereas first flowering in Dashehari was observed during 3<sup>rd</sup>-15<sup>th</sup> March in 2014 and 9<sup>th</sup>-15<sup>th</sup> March in 2015 at Varanasi, Uttar Pradesh. Hermaphrodite flowering in the present study was recorded as early as 6<sup>th</sup>- 24<sup>th</sup> February in the year 2017 in variety Amrapali, followed by Kesar (21<sup>st</sup> February - 6<sup>th</sup> March) and Dashehari (4<sup>th</sup> -10<sup>th</sup> March). In the year 2018 earliest hermaphrodite flowering was recorded in variety Kesar (21<sup>st</sup> January -6<sup>th</sup> February) followed by Amrapali (28<sup>th</sup> January-19<sup>th</sup> February) and Dashehari (16<sup>th</sup> February- 7<sup>th</sup> March). End of flowering was noted in variety Amrapali from 21<sup>st</sup> March - 10 April in 2017 and 5<sup>th</sup>-24<sup>th</sup> March in 2018 while in Dashehari flowering came to an end during 20<sup>th</sup>- 27<sup>th</sup> March in 2017 and 16<sup>th</sup>-30<sup>th</sup> March in 2018 and in Kesar flowering ended during 20<sup>th</sup>-25<sup>th</sup> March in 2017 and 16<sup>th</sup> March- 4<sup>th</sup> April in 2018. Differences in time of flowering in different varieties might be due to genetic constitution of a particular variety (Kumar *et al.* 2017). Time of flowering is an important parameter since it affects time of fruit

maturity, which in turn relates to marketing of any commodity (Hada and Singh 2017). Difference in time of flowering of same variety at different locations may be due to different agro climatic conditions. Mango exhibits wide variations in flowering and fruiting due to its strong dependency on environment (Jameel *et al.* 2018).

The duration from panicle emergence to first flowering (male) in variety Amrapali was 22.25 days in 2017 and 17.51 days in 2018, while in Dashehari it was 18.64 days in 2017 and 15.35 days in 2018 and in Kesar the duration was 17.75 days in 2017 and 17.98 days in 2018. In the year 2017 it was noted that duration required for flowering from panicle emergence were at par in variety Dashehari and Kesar while Amrapali required significantly longer duration for flowering. In 2018 the duration for flowering in Amrapali and Kesar were at par while Dashehari required significantly shorter duration for flowering. Male flowering lasted for 5.65 days in 2017 and 3.73 days in 2018 in variety Amrapali while in Dashehari variety it lasted for 5.99 days in 2017 and 4.43 days in 2018 and in Kesar variety it lasted for 8.13 days in 2017 and 6.65 days in the year 2018. There was no significant difference in the duration of male flowering among the three varieties in the year 2017. In 2018 Amrapali showed significantly shorter duration of male flowering compared to Kesar while the male phase in Dashehari was at par with Amrapali and Kesar. Hermaphrodite flowering in Amrapali lasted for 18.10 days in 2017 and 18.13 days in 2018, while in Dashehari it lasted for 13.33 days in 2017 and 14.54 days in 2018 and in variety Kesar it lasted for 11.69 days in 2017 and 16.55 days in the year 2018. The hermaphrodite flowering duration in Amrapali was significantly longer compared to Dashehari and Kesar which were at par in 2017. In 2018 the hermaphrodite flowering phase in Dashehari was significantly short compared to Amrapali while Kesar was at par with Amrapali and Dashehari. The total flowering period in variety Amrapali in the year 2017 was 24.62 days and in 2018 it was 20.93 days. In variety Dashehari total flowering period of 20.24 days was recorded in the year 2017 while in 2018 it was 19.07 days. Variety Kesar exhibited total flowering period of 29.98 days in 2017 and 24.2 days in 2018. The total

flowering period in all the three varieties were at par in the year 2017 while in 2018 the total flowering period of Dashehari was significantly low compared to Amrapali and Kesar which were at par. Azam *et al.* (2018) reported total flowering duration in Dashehari and Kesar to be around 32.00 days in their study conducted at Sabour, Bhagalpur in Bihar. Kumar *et al.* (2017) recorded a total flowering period of 15-16.33 days in Amrapali and 13.33-15 days in Dashehari at Meerut, Uttar Pradesh. Kumar *et al.* (2017) stated that duration of flowering in mango is dependent on maturity of shoot and prevailing weather conditions, which could be the reason for difference in flowering periods of the same variety at different locations.

The average number of male flowers in a panicle recorded in the present study in the year 2017 was 150.74 in Amrapali, 258.97 in Dashehari and 250.4 in Kesar. In the year 2018 the number of male flowers was 217.23 in Amrapali, 266.03 in Dashehari and 161.14 in Kesar. The number of male flowers in Amrapali was significantly low compared to Dashehari and Kesar which were at par in 2017 while in 2018 there was no significant difference in the number of male flowers in a panicle in the three varieties. In the year 2017 the average number of hermaphrodite flowers in a panicle of variety Amrapali was 67.31 followed by Kesar (60.68) and Dashehari (54.26) whereas in 2018 the number of hermaphrodite flowers was 87.26 in Amrapali followed by Dashehari (59.21) and Kesar (38.86). The number of hermaphrodite flowers in the three varieties did not show any significant difference in the year 2017 while in 2018 Amrapali exhibited significantly high number of hermaphrodite flowers in a panicle compared to Dashehari and Kesar which were at par. Total number of flowers in a panicle of variety Amrapali was 218.06 in 2017 and 304.48 in 2018, while in Dashehari it was 313.23 in 2017 and 325.24 in 2018 and in Kesar total flowers recorded was 311.085 in 2017 and 200 in 2018. Total number of flowers in all three varieties were at par in the year 2017, while in 2018 the total number of flowers in Kesar was significantly low compared to Amrapali and Dashehari which were at par. Percentage of male flowers in Amrapali was 68.93% in 2017 and 71.06% in 2018 while in Dashehari it was 81.33% in 2017 and 79.92% in 2018 and in Kesar it was 79.70%



in 2017 and 80.79% in 2018. Percentage of male flowers was significantly low in variety Amrapali compared to Dashehari and Kesar which were at par during both the years of observation. In 2017 percentage of hermaphrodite flowers was highest in Amrapali (31.07%) followed by Kesar (20.30%) and Dashehari (18.67%). In 2018 highest percentage of hermaphrodite flowers was recorded in Amrapali (28.94%) followed by Dashehari (20.08%) and Kesar (19.21%). During both the years of observation percentage of hermaphrodite flowers was significantly high in Amrapali compared to Dashehari and Kesar which were at par. The highest sex ratio (male:female) was recorded in variety Dashehari (4.92 in 2017 and 4.76 in 2018) followed by Kesar (4.43 in 2017 and 4.62 in 2018) and Amrapali ( 2.32 in 2017 and 2.53 in 2018). Sex ratio in 2017 was significantly low in Amrapali compared to Dashehari and Kesar which were at par. In 2018 sex ratio did not show any significant difference in the three varieties. Singh *et al.* (2014) stated that sex ratio is a variable component within panicles, trees and among genotypes and the variability in ratio is governed by physiological and environmental conditions. Higher sex ratio indicates the presence of more number of male flowers per hermaphrodite flower.

Fruit set in the seven replications of Amrapali variety was noted from 1<sup>st</sup> -17<sup>th</sup> March in the year 2017 and 2<sup>nd</sup>-18<sup>th</sup> March in 2018 while in Dashehari fruit set was recorded from 9<sup>th</sup> – 22<sup>nd</sup> March in 2017 and 8<sup>th</sup> -16<sup>th</sup> March in 2018 and in Kesar the fruit set was observed from 5<sup>th</sup>-17<sup>th</sup> March in 2017 and 2<sup>nd</sup> -10<sup>th</sup> March in 2018. Gill *et al.* (2015) observed fruit set in Amrapali during 3<sup>rd</sup> -5<sup>th</sup> April and in Dashehari during 29<sup>th</sup> -31<sup>st</sup> March in Punjab. Hada and Singh (2017) recorded fruit set in Amrapali from 15<sup>th</sup> -19<sup>th</sup> March in 2014 and 17<sup>th</sup> -20<sup>th</sup> March in 2015 and in Dashehari during 24<sup>th</sup>-26<sup>th</sup> March in 2014 and 22<sup>nd</sup>-27<sup>th</sup> March in 2015 at Varanasi, Uttar Pradesh. Highest number of fruit set was recorded in Amrapali (27.97 and 28.57) followed by Dashehari (25.77 and 26.57) and Kesar (24.63 and 25.83) during the years 2017 and 2018 respectively. The number of fruits set did not show any significant difference in the three varieties during both the years. Highest flower: Fruit set ratio in the year 2017 was observed in Kesar (12.56) followed by

Dashehari (12.20) and Amrapali (7.84). In the year 2018 highest flower: Fruit set ratio was recorded in Dashehari (12.17) followed by Amrapali (10.60) and Kesar (7.74). The flower: Fruit set ratio in Amrapali was significantly high compared to Dashehari and Kesar which were at par in the year 2017. In 2018 flower: Fruit set ratio in Kesar was significantly high compared to Dashehari, while Amrapali was at par with Dashehari and Kesar. During the year 2017 highest percentage of fruit set was recorded in Amrapali (13.50 %) followed by Dashehari (8.82%) and Kesar (8.13%). In 2018 the highest percentage of fruit set was observed in Kesar (13.43%) followed by Amrapali (10.25%) and Dashehari (8.71%). The percentage of fruit set in Amrapali was significantly high in 2017 compared to Dashehari and Kesar which were at par. In 2018 the percentage of fruit set in Dashehari was significantly low compared to Kesar, while Amrapali was at par with Dashehari and Kesar. Similar study was conducted at Varanasi in Uttar Pradesh by Hada and Singh (2017) where they recorded 38.18% and 36.44% fruit set in Amrapali and 39.22% and 39.58% in Dashehari during the year 2014 and 2015 respectively. Hada and Singh (2017) stated that fruit set is a varietal character depending upon several factors such as time of flowering, sex ratio, efficient cross pollination and intensity of drop and varieties differ from one another in these aspects leading to varying fruit set in different varieties.

In the present study variety Amrapali exhibited highest number of fruit retention per panicle (2.31 and 2.00) followed by Dashehari (1.89 and 1.66) and Kesar (1.63 and 1.57) in 2017 and 2018 respectively. Average number of fruits retained per panicle in 2017 was significantly high in variety Amrapali compared to Kesar, while Dashehari was at par with Amrapali and Kesar. In 2018 numbers of fruits retained per panicle were at par in all the three varieties. Similarly the highest percentage of fruit retention (8.27 % and 6.91%) was recorded in Amrapali followed by Dashehari (7.27% and 6.13%) and Kesar (6.61% and 6.08%) in the years 2017 and 2018 respectively. The percentage of fruit retention in Kesar was significantly low in the year 2017 compared to Amrapali, while Dashehari was at par with Amrapali and Kesar. In 2018 no significant difference was observed in

percentage of fruit retention in the three varieties. Fruits of variety Amrapali attained harvest maturity from 7<sup>th</sup>-28<sup>th</sup> July in 2017 and 9<sup>th</sup> July–18<sup>th</sup> August in 2018, while variety Dashehari was harvested during 11<sup>th</sup>-22<sup>nd</sup> July in 2017 and 4<sup>th</sup> June-28<sup>th</sup> July in 2018. Variety Kesar reached harvest maturity during 10<sup>th</sup> June–27<sup>th</sup> July in 2017 and 9<sup>th</sup> June–18<sup>th</sup> August in 2018. Fruits of variety Kesar required longer duration to reach full maturity (135.13 and 136.83 days) followed by Amrapali (127.33 and 136.69 days) and Dashehari (123.83 and 128.87 days) during the years 2017 and 2018 respectively. Duration to reach full maturity in varieties Amrapali and Dashehari were at par in 2017 which were significantly low compared to variety Kesar. In 2018 the three varieties did not show any significant difference in the duration to reach maturity. Hada and Singh (2017) reported that variety Amrapali required 114.33 and 111 days while Dashehari required 112.33 and 109.67 days to reach full maturity during the years 2014 and 2015 respectively at Varanasi, Uttar Pradesh. The differences in maturity of fruits of different cultivars might be due to difference in date of panicle emergence and prevailing environmental conditions, besides their genetic makeup (Kundu *et al.* 2009).

## CONCLUSION

Knowledge and understanding of flowering and fruiting behavior of mango variety under a specific climatic condition can help growers to schedule manuring, irrigation and other cultural practices during cultivation to obtain optimum yields of quality fruits.

## REFERENCES

- Anonymous (2017) Horticultural Statistics at a Glance. Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, pp 147.
- Azam K, Mir H, Kumar R, Ahmad A (2018) Study on flowering behavior of elite mango cultivars in subtropical conditions of Bihar. *Int J Chem Stud* 6 (2) : 2913–2917.
- Barui FK, Ghosh SN (2002) Performance of different available mango cultivars for semi-arid region of West Bengal. *Environ Ecol* 20 (3): 588–592
- Gautam DK, Kumar A, Kumar M, Kumar V, Prakash S (2019) Studies on flowering behavior and bio-chemical attributes of commercial mango cultivars with special reference to Ratol. *J Pharmacogn Phytochem* 8 (1): 1105–1111.
- Gill MS, Navpreem S, Singh N, Gill PPS (2015) Performance of Mango Cultivars under Sub-Mountane Zone of SubTropics of India. *Acta Hort.* 1066: 27-33. DOI: 10.17660/Acta Hort.2015–1066
- Hada TS, Singh AK (2017) Evaluation of mango (*Mangifera indica* L.) Cultivars for flowering, fruiting and yield attributes. *Int J Bio-Resour and Stress Manag* 8 (4):505–509.
- Jameel MA, Naik SMR, Madhumathi C, Reddy DS, Venkataramana KT (2018) Physiology of flowering in mango. *J Pharmacogn Phytochem* 7(6): 2375–2382.
- Kumar A, Malik S, Chaudhary P, Kumar N (2017) Studies on the growth and flowering of different mango (*Mangifera indica* L.) cultivars under Western Uttar Pradesh conditions. *J Pharmacogn Phytochem* 6 (SP1): 439–442.
- Kundu S, Sanyal N, Datta P (2009) Studies on potentiality of some mango varieties in West Bengal. *J Crop and Weed* 5 (2): 68–71.
- Loay AA, Harbinson J, Kooten OV (2005) General introduction: Mangoes. Wageningen agricultural university papers. 1-21. <https://www.researchgate.net/publication/312328710>.
- Maiti RG, Das PC (2007) Fruit Crops of India. Kalyani Publishers. New Delhi, pp. 236.
- Panse VG, Sukhatme PV (1985) Statistical Methods for Agricultural Workers. I.C.A.R. New Delhi.
- Singh A, Singh CP, Singh AK (2015) Flowering behavior of mango genotypes under tarai conditions of Uttarakhand. *Int J Basic Appl Agric Res* 13 (3): 400–406.
- Singh A, Srivastav M, Singh AK, Dubey AK, Lal SK (2014) Flowering attributes of parental mango genotypes *Ind J Hort* 71(4):458–463.