

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.812.267>

Pattern of Fruit Drop, Yield, Maturity and Harvesting of Different Varieties of Ber (*Ziziphus mauritiana* Lamk.) in New Alluvial Zone of West Bengal

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ABSTRACT

An investigation was carried out at Horticultural Research Station, Mondouri, North 24 Parganas, B.C.K.V., West Bengal, India during 2015-16 with fourteen cultivars of ber to understand and provide a wealth of usable information of ber breeding programme. All the varieties showed wide variation of fruit set (3.9-31.4%), fruit drop (63.085.5%) and retention (14.5-36.9%). Higher percentage of fruit set was noted in Sanur-2 (31.4%), BAU-1 Kul (26.5%), Umran (26.1%), Banarasi Karaka (24.8%). A large percentage of fruit dropped before reaching the maturity stage. However, the heaviest drop was recorded in the variety Banarasi Karaka and minimum in Umran. In all the cultivars the fruit drop was maximum up to 30 days after fruit set, declining later on. In Sanur-2 the fruit set percentage was highest but fruit retention was not up to the mark. Fruit maturity among 14 varieties was 111 to 149 days with a longer period of harvesting (21-37 days) and wide range of yield (15.96 to 46.36 kg/tree). BAU-1 Kul, Gola and Jogia were harvested earlier and Apple Kul, Banarasi Karaka Madhabpur, Mundia, Umran were harvested late. Duration of harvesting was longest in Illaichi. Umran and Topa were higher in fruit yield (46.36 kg and 43.77 kg/plant, respectively).

Keywords

Zizyphus mauritiana, Fruit-drop, Fruit retention, Maturity, Yield

Article Info

Accepted:
17 November 2019
Available Online:
10 December 2019

Introduction

Ber (*Ziziphus mauritiana* Lamk.) is one of the ancient and indigenous fruits of India. It belongs to family Rhamnaceae and order Rhamnales (2n=48). In India, cultivated ber has more than 300 varieties but only a few are commercially important (Pareek and Nath, 1996). The majority of varieties of Indian

jujube are selection from heterogeneous population. Plant breeders look for ideal plant types or ideotypes in order to combine maximum desirable traits in a cultivar. So, improvement is needed to incorporate the resistance to major pest and diseases, adapt some cultivars to particular environmental stresses and to improve the quality of fruits besides yield increase. Performance of ber in

new alluvial zone of West Bengal was previously studied by Kumar *et al.*, (2017), but this study is based on vegetative characters and fruit quality attributes. Hybridization is one of the most important methods for bringing improvement in fruit crops. For efficient and purposeful breeding programme, it is necessary to have knowledge of proper reproductive characters, this is essential prerequisite for a successful hybridization programme. High genetic variation exists in *Z. mauritiana* germplasm because of cross pollination, self-incompatible and polyploidy in nature. These genetic variability provide ample opportunities for selection of genotypes for desirable traits (Vashishtha and Pareek, 1989; Vashishtha, 2001; Khan *et al.*, 2013). Awasti and More (2009) had already studied the wide genetic diversity and status of ber in India. As no information available still now in new alluvial zone of West Bengal, an experiment was laid out by Randomized block design (RBD) with three replication and fourteen varieties (Apple Kul, Banarasi Karaka, BAU-1 Kul, Chhuhara, Dandan, Gola, Illaichi, Jogia, Kaithali, Madhavpur, Mundia, Sanur-2, Topa and Umran). For efficient and purposeful breeding programme, it is necessary to have knowledge of fruit set, fruit drop, yield, maturity and harvesting of different varieties in the specific region where the crop has grown. It is also formulate the appropriate cultural practices that may influence the fruit yield and quality. Previous study on varietal evolution of ber on yield and yield attributing parameter were studied by Tarai and Ghosh (2010) but in new alluvial zone of West Bengal no studies was yet documented. So there is an urgent need to study on such yield attributing parameter in this region.

Materials and Methods

The investigation was carried out on the ber orchard at Horticultural Research Station,

Mondouri of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during the year 2014-16. The ber orchard is situated at the eastern side of this research station having 22.43 °N latitude and 88.34 °E longitude, with an altitude of 9.75 m above the mean sea level.

Climatic condition during the experimental period

The experimental site comes under sub-tropical humid climate as it is situated just south of tropic of cancer. There five distinct seasons namely summer (16th April -10th of June), rainy season (11th June to 30th September), autumn (1st October – 15th December), winter season (15th December – 15th February) and spring season (16th of February – 15th of April). During the period of investigation maximum temperature was recorded (34.3⁰C) in the month of March 2016, while minimum temperature was recorded (11.9⁰C) in the month of January 2016. Humidity was maximum (96%) in the month of September 2015, While minimum (47.4%) in the month of March 2016. Maximum rainfall (193.6 mm) occurred in August 2015. Metrological data during the research work was collected from the Department of Agricultural Meteorology and Physics, Bidhan Chandra Krishi Viswavidyalaya, Faculty of Agriculture, Mohanpur, Nadia, West Bengal. The data for the Climatic parameters has been presented in Table 1. Maximum and minimum temperature (Table 1) percentage of maximum and minimum Humidity (Table 1) average rainfall (cm) (Table 1) data has been represented graphically also.

Experimental design

The experiment was laid out with 14 varieties (Apple Kul, Bnarasi Karaka, BAU-1 Kul, Chhuhara, Dandan, Gola, Illaichi, ogia,

Kaithali, Madavpur, Mundia, Sanur-2, Topa, and Umran) in a randomised block design. Each variety was replicated thrice. Fruit set, drop and retention

Fruit set

Branchlets were tagged consisting of about 200 open flowers in all directions for each plant during peak flowering season. Remove all flower buds and tiny fruits from branchlets, if any. Fruit set were counted at fruits of lentil size.

Fruit drop

In order to ascertain the extent of drop in different varieties, branches were tagged consisting of 200 fruits of lentil size in all directions during peak fruiting season for each plant. Fruit drops were recorded at 30 days, 60 days and 90 days after fruit.

Fruit retention

The fruits left after fruit drop in December were considered as the fruit retention among different varieties.

Fruit maturity

Branchlets consisting of only set fruits of uniform lentil size were tagged. Flower buds and fruit of higher size were removed from branchlet. The days required for fruit set to its full development (edible stage) was considered as period of fruit maturity.

Harvesting

Maturity of at least first 10 fruits in a plant and last 10 matured fruits in a plant were considered as start and end of harvesting, respectively. The period between start and end of harvesting was considered as the duration of harvesting. The variety matured in the last

week of December to first week of February was considered as early variety. The variety matured in the 3rd week of January onwards up to 3rd week of February was considered as mid-season variety.

The variety harvested in between last week January to first week of March was placed under late season.

Yield

Fruit yield was recorded by weight. The quantitative or measured data obtained were analysed statistically by the analysis of variance method as suggested by Panse and Sukhatme (1978) and the significance of different source of variation was tested by error mean square by Fisher's 'F' test of probability level of 0.05 percent.

Results and Discussion

Fruit set

The data on percentage of fruit set is presented in Figure 1 A. There was a marked variation in fruit set in different cultivars which ranged from 3.9% Chuhara to 31.4% in Sanur-2.

The higher fruit set was also recorded in BAU Kul-1 (26.5 %), Umran (26.1%), Banarasi Karaka (24.8%), Dandan (23.3%), Topa (23.1%), Illaichi (21.4%), Madhavpur (20.8%) and Jogia (20.4%).

Fruit drop at 30 days after fruit set (DAFS)

There were significant differences in the extent of fruit drop in different cultivars, showed in Figure 2 B. A very heavy fruit drop occurred immediately after fruit set (30 days after fruit set), being maximum in Dandan (72.3%) and minimum in Madhavpur (41%). More than 40% fruit drop is occurred when the fruits are in pea size.

Fruit drop at 60 days after fruit set (DAFS)

As fruit development advanced, percent of fruit drop was reduced. Fruit drop was ranged from 55.4% in Umran to 81.2% in Banarasi Karaka in 60 days after fruit set (Fig. 2 B).

Mundia, Dandan and Illaichi also showed higher rates of fruit drop that was 77.9%, 77.2% and 75.7% respectively. Topa, Madhavpur and Sanur-2 showed lower rates of fruit drop that was 57.1%, 61.2% and 63.2% respectively.

Fruit drop at 90 days after fruit set (DAFS)

More than 80% fruit drop was noticed in Illaichi (81.9%), Mundia (82.8%), Dandan (84.5%), Banarasi Karaka (85.5%) and more than 70% fruit drop recorded in Madhavpur (70.2%), Sanur-2 (71.5%), Chhuhara (72.7%), Kaithali (74.5%), Jogia (76%), Apple kul (77.2%), BAU Kul-1 (77.5%), Gola (78.2%) in 90 days after fruit set (Fig. 2 B). Minimum fruit drop occurred in Umran(63%).

Fruit retention

The percentage fruit retention is very low, ranged between 14.5% in Banarasi Karaka to 36.9% in Uman (Table 1).

The higher fruit retention was observed in in Topa (35.4%), Madhavpur (29.8%), and Sanur-2 (28.5%).

The lower fruit retention was observed in Illaichi (18.1%), Mundia (17.2%) and Dandan (15.4%).

Fruit maturity

The detail of fruit maturity period is presented in Table 2. The number of days required for the development of fruit was longest (149 days) in Apple kul and shortest (111 days) in BAU Kul-1.

Harvesting season

Table 2 represent the harvesting season of different ber varieties. BAU Kul-1, Gola and Jogia cultivars were identified as early season cultivar as they are matured in last week of December to first week February. Chhuhara, Dandan, Illaichi, Kaithali, Sanur-2 and Topa considered as mid-season cultivar as they matured in 3rd week of January onwards up to 3rd week of February. Apple kul, Banarasi Karaka, Madhavpur, Mundia and Umran matured during the period of last week January to first week of March is considered as the late season cultivar.

Duration of harvesting

Harvesting period of ber ranged between 21days to 37 days (Table 2). The longest total time period taken for fruit harvesting was observed in BAU Kul-1 i.e., 37 days which ranged from 22nd December to 27th January. The shortest total time period for harvesting was recorded in Dandan i.e., 21 days ranging from 19th January to 8th February.

Yield

Wide and Significant variation in yields (15.96 to 46.36 kg/tree) had been observed among different ber cultivars (Figure 2 B). Highest yields are obtained from Umran (46.36 kg/tree) followed by Topa (43.77 kg/tree) and Sanur-2 (41.48 kg/ tree). Lowest yield was obtained from Chhuhara (15.95 kg/tree), Illaichi (17.44 kg/tree).

Correlation

There is a positive significant relationship between Fruit retention with fruit set (Table 3). It was found that there were high negative correlation between fruit drop with fruit set and also in fruit drop and fruit retention. Yield has both significant positive relationship with

fruit set and fruit retention but has inverse relationship with Fruit drop.

Results revealed from the present studies on reproductive variability of ber in new alluvial zone of West Bengal indicated that there was a wide variation among fourteen varieties in respect of flowering behaviour, floral bud development, flower morphology, sex ratio, intensity of flowering, fruit set, fruit drop and yield.

All the varieties showed wide variation of fruit set (3.9-31.4%), fruit drop (63.0-85.5%) and retention (14.5-36.9%). Higher percentage of fruit set was noted in Sanur-2 (31.4%), BAU Kul-1 (26.5 %), Umran (26.1%), Banarasi Karaka (24.8%). Flowering in ber, in general, was very profuse but the life of the individual flower was very short and many flowers apparently were not pollinated during their receptive period resulted in such a low fruit set. A large percentage of fruit dropped before reaching the maturity stage. However, the heaviest drop was recorded in the variety Banarasi Karaka (85.5%) and minimum in Umran (63.0%). The fruit drop in Banarasi Karaka was 85% in Delhi (Sharma *et al.*, 1990), 55% at Hissar (Singh *et al.*, 1970) and 64% in Uttar Pradesh (Teatotia and Chauhan, 1964) In all the cultivars the fruit drop was maximum up to 30 days after fruit set, declining later on. Ovule disintegration may be the major cause of fruit drop during early stage of fruit development. Teatotia and Chauhan (1963) also observed the heaviest fruit drop during early stages of fruit development. Fruit retention was much higher in Topa and Umran. It could also be observed that initially higher fruit set does not necessarily lead to higher fruit retention. In Sanur-2 the fruit set percentage was highest but fruit retention was not up to the mark. These findings are also supported by Sharma *et al.*, (1990).

Fruit maturity among fourteen varieties was 111 to 149 days with a longer period of harvesting (21-37 days) and wide range of yield (15.96 - 46.36 kg/tree). Harvesting of different varieties started from 22nd December and continued up to 2nd March. Sharif *et al.*, (2013) reported that total time period taken for fruit harvesting ranged from 20th February to 10th April BAU-1 Kul, Gola and Jogia were harvested earlier and Apple kul, Banarasi Karaka Madhabpur, Mundia, Umran were harvested late. Neeraja *et al.*, (1995) also found that in Gola fruits matured earlier than those of all other cultivars. But in Bangladesh condition, Apple kul was earliest to harvest (Islam, 2007). Sharif *et al.*, (2013) also reported that the longest time period of 27 days for fruit harvesting was observed in Bahawalpur Selection 2 (25th February to 23rd March). The shortest time period of 8 days for harvesting was recorded in Ajooba (11th March to 19th March). It was found that duration of harvesting was longest in case of Illaichi 35 days (12th January to 15th February) and shortest in case of Dandan 21 days (19th January to 8th February). Umran and Topa were higher in fruit yield (46.36 kg and 43.77 kg/plant, respectively). Mandal *et al.*, 2009 and Kumar *et al.*, 2017 also found similar yield pattern of different ber varieties (50.8 kg/plant to 42.8 kg/plant) in alluvial zone of West Bengal. In contrast much higher yield was obtained by Teatotia and Chauhan (1963), Bakhshi and Singh (1974) and Kumar *et al.*, (1986). However almost similar yield of Umran in the present studies was also obtained by Rao and Subramanyam (2010).

All the varieties showed wide variation of fruit set (3.9-31.4%), fruit drop (63.0-85.5%) and retention (14.5-36.9%). Higher percentage of fruit set was noted in Sanur-2 (31.4%), BAU-1 Kul (26.5%), Umran (26.1%), Banarasi Karaka (24.8%).

Table.1 Meteorological data of experimental area during period of investigation

Year	Month	Temperature (⁰ C)		Relative humidity (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.	
2015	August	33.4	26.8	94.8	76.8	193.6
	September	34.0	26.1	96.0	71.0	227.3
	October	33.4	23.7	94.2	62.5	41.6
	November	31.4	18.8	93.3	52.9	0.0
	December	26.3	15.0	93.1	56.3	6.6
2016	January	25.8	11.9	92.8	53.3	3.0
	February	30.3	18.4	92.8	53.9	28.0
	March	34.3	21.8	91.7	47.4	35.8

Source: Department of Agro-Meteorology and Physics, BCKV, Mohanpur, Nadia, West

Table.2 Fruit maturity harvesting of different varieties of ber

Variety	Fruit Maturity (days)	Harvesting			
		Start of harvesting	End of harvesting	Duration of harvesting (Days)	Harvesting season
Apple kul	149	04.02.2016	02.03.2016	28	Late
Banarasi Karaka	144	31.01.2016	28.02.2016	29	Late
BAU Kul-1	111	22.12.2015	27.01.2016	37	Early
Chhuhara	128	26.01.2016	17.02.2016	23	Mid
Dandan	119	19.01.2016	8.02.2016	21	Mid
Gola	141	07.01.2016	30.01.2016	24	Early
Illaichi	113	12.01.2016	15.02.2016	35	Mid
Jogia	110	11.01.2016	01.02.2016	22	Early
Kaithali	119	18.01.2016	08.02.2016	22	Mid
Madhavpur	147	07.02.2016	01.03.2016	24	Late
Mundia	146	01.02.2016	27.02.2016	27	Late
Sanur-2	128	18.01.2016	08.02.2016	22	Mid
Topa	121	12.01.2016	8.02.2016	28	Mid
Umran	148	01.02.2016	29.02.2016	29	Late
SEm(±)	-	-	-	-	-
LSD (0.5)	-	-	-	-	-

Fig.1 Variation in Fruit set and Fruit retention among all the varieties of ber. Vertical bars represent \pm S.E. of means for 3 replicates (A). Linear regression relationship between Fruit firmness and Fruit Set (B)

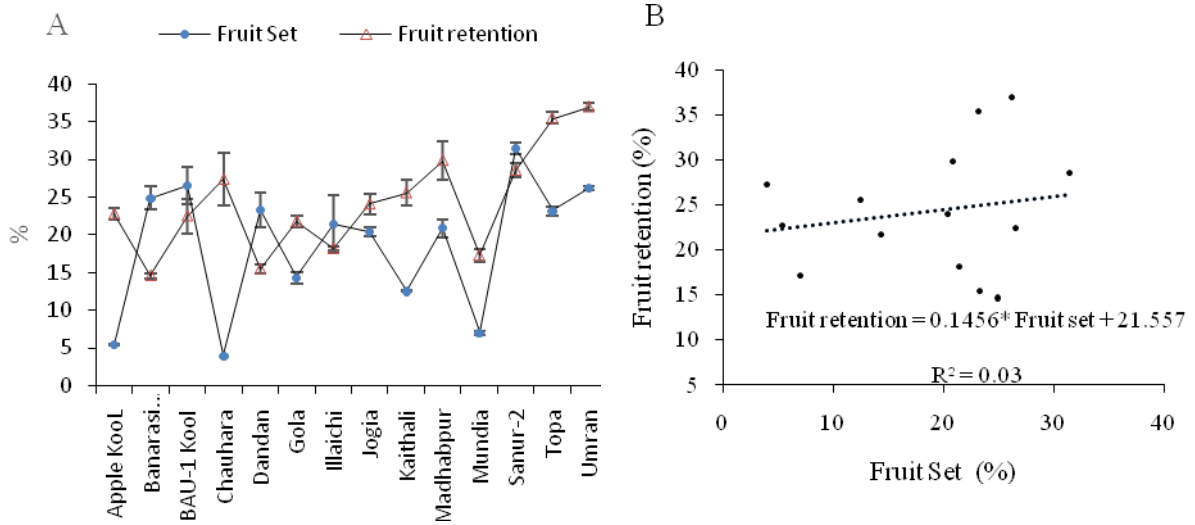


Fig.2 Variation in Fruit yield among different varieties of ber. Vertical bars represent \pm S.E. of means for 3 replicates (A). Fruit drop pattern in different days interval among different varieties (B)

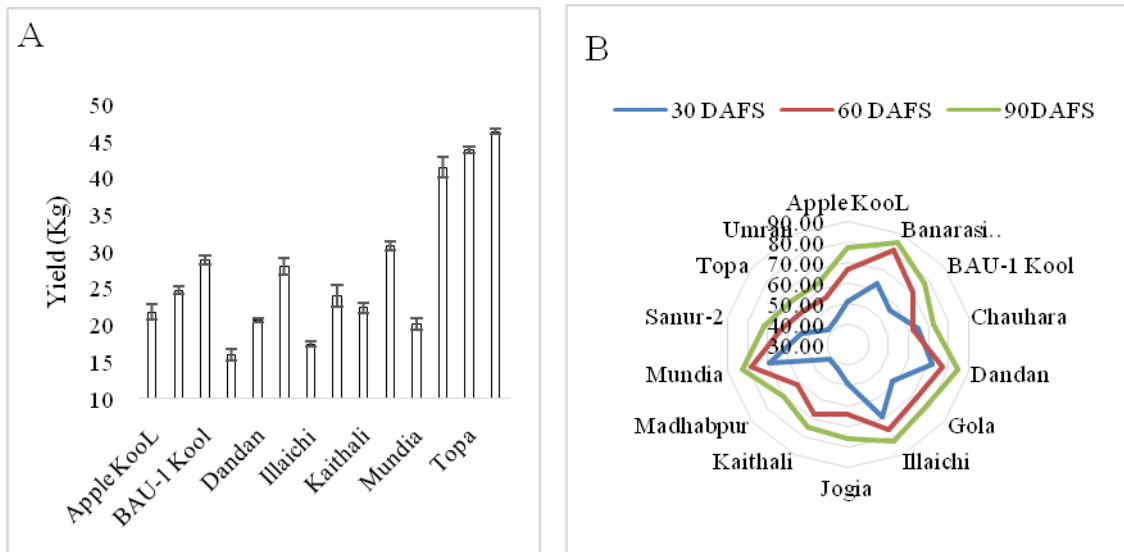


Table.3 Pearson’s correlation coefficients among different parameters

	Fruit Set	Fruit retention	Fruit drop	Yield
Fruit Set	1			
Fruit retention	0.182	1		
Fruit drop	-0.167	-0.955	1	
Yield	0.631	0.757	-0.710	1

Significant at P < 0.01 level

A large percentage of fruit dropped before reaching the maturity stage. However, the heaviest drop was recorded in the variety Banarasi Karaka and minimum in Umran. In all the cultivars the fruit drop was maximum up to 30 days after fruit set, declining later on. In Sanur-2 the fruit set percentage was highest but fruit retention was not up to the mark. Fruit maturity among 14 varieties was 111 to 149 days with a longer period of harvesting (21-37 days) and wide range of yield (15.96 to 46.36 kg/tree).

BAU-1 Kul, Gola and Jogia were harvested earlier and Apple Kul, Banarasi Karaka Madhabpur, Mundia, Umran were harvested late. Duration of harvesting was longest in Illaichi. Umran and Topa were higher in fruit yield (46.36 kg and 43.77 kg/plant, respectively). It is concluded that there is a wide variation of reproductive characters among different varieties. This knowledge of reproductive characters will be useful for efficient and purposeful breeding programme as well as for using these varieties as desirable parent.

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How to cite this article:

Adhikary, T., S. Kundu, S. Shivakumar and Ghosh, B. 2019. Pattern of Fruit Drop, Yield, Maturity and Harvesting of Different Varieties of Ber (*Ziziphus mauritiana* Lamk.) in New Alluvial Zone of West Bengal. *Int.J.Curr.Microbiol.App.Sci.* 8(12): 2249-2257.
doi: <https://doi.org/10.20546/ijcmas.2019.812.267>