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Short communication

Studies on fruit drop and cracking in bael genotypes

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ABSTRACT

Problem of fruit drop and cracking is one of the most important limiting factors in bael cultivation, which result in high yield loss. Therefore, the investigation was carried out to study the response of different genotypes of bael on fruit drop and cracking. Fourteen genotypes of bael were taken for the study. Fruit drop and cracking was recorded at monthly intervals in all genotypes. Fruit drop was recorded high in month of July in all the genotypes which continued till the harvest and again shows the peak in the month of February. The maximum fruit drop and cracking were found in Pant Sujata and the minimum in Pant Bael 4. The maximum fruit drop was recorded in the month of July and minimum in the month of December. Whereas the maximum fruit cracking was noticed in the month of January and the minimum in the month of July. The maximum total fruit drop and the minimum fruit retention were found in Pant Sujata and the minimum total fruit drop and the maximum fruit retention were observed in Pant Bael 4. The highest yield was recorded in Pant Shivani.

Key words: *Aegle marmelos*, fruit drop, fruit cracking, yield.

Among indigenous fruits of India, bael (*Aegle marmelos* Correa) occupies an important position not only because of its high religious significance but also due to its high medicinal, nutritional and pesticidal values. It is very hardy, drought tolerant and thrives well on marginal and poor fertility soils and gives good economic return even without much care and inputs. Fruit drop and cracking is a serious problem in bael and it has become a limiting factor for its commercial cultivation. The problem of bael fruit cracking was also reported in *tarai* region of Uttarakhand and arid region of Haryana and Rajasthan (Misra *et al.*, 5, Saini *et al.*, 6 and Saroj *et al.*, 7). There is balance done by nature to prevent the exhaustion of the trees by overbearing. Thus early drop of flowers and fruits are not a great matter of concern, the problem for orchardist is abnormal fruit drop when fruits approaching towards maturity causing economic losses. Fruit drop is the premature abscission of fruits before it is fully ripe. It was observed that fruit drop in bael occured due to embryo abortion, physiological imbalances, fruit borer attack, fruit rotting and fruit cracking (Uniyal and Misra, 9). However, the reasons for the variation in fruit set, extent of drop and cracking in different genotypes of bael is still unknown. Therefore, the present studies were conducted to find out response of different genotypes of bael on fruit drop and cracking under *tarai* conditions of Uttarakhand.

The investigation was carried out at Horticultural Research Centre, GBPUA&T, Pantnagar during 2009-11 on 22 years old trees of 14 genotypes of Bael viz., Pant Bael 1, Pant Bael 3, Pant Bael 4, Pant Shivani, Pant Urvashi, Pant Bael 7, Pant Aparna, Pant Bael 10, Pant Bael 11, Pant Sujata, Pant Bael 13, Pant Bael 14, Pant Bael 15 and Pant Bael 16 which were planted at 8 × 8m spacing. Three trees of each genotype were selected randomly and each treatment has one tree per replication. Thus total numbers of trees used in this experiment were 42. Uniform cultural treatments were given to these trees during the course of investigation. Twenty branches on each of three trees in all the genotypes spread over four directions were tagged to study the fruit set. Numbers of flower buds were counted on each branch in the June month. Fruits were considered to have set when their ovaries started swelling after 20 days. The fruit set was calculated on per cent basis. Fruit drop at monthly interval were calculated by counting the number of fruits in each month and subtracting it from the number of fruits at previous month and calculated on per cent basis. The data for fruit drop due to cracking was recorded by examining the dropped fruits individually at regular intervals and observation were recorded separately on per cent basis. Final retention was recorded at the time of harvest by counting the number of remaining fruits in tagged branches. The retention was calculated on per cent basis. The data generated from these investigations were appropriately computed, tabulated and pooled data of two years were analyzed by applying Randomized Block Design and Factorial Randomized Block

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Design. The level of significance was tested for different variable at 5 per cent (Gomez and Gomez, 3). Data were analysed using analysis of variance OPSTAT, HAU, Hisar, Haryana (India). The per cent data were angularly transformed and both the values are given.

It is evident from the data presented in Table 1 that there was significant difference among the genotypes for fruit set in two years of experiment. The maximum fruit set (85.57%) was observed in Pant Bael 11 followed by Pant Aparna while the minimum fruit set (67.82%) was observed in Pant Shivani. This variation in fruit set among the various genotypes of bael might be attributed to their inherent characters. Similar finding have been reported under foot-hills region of Uttar Pradesh (Misra *et al.,* 5). Further, it was observed that there was significant effect of genotypes, monthly intervals and their interaction on fruit drop percentage (Table 2). The maximum fruit drop (23.25%) was found in Pant Sujata and the minimum fruit drop (15.36%) was found in Pant Bael 4. While data on fruit drop at monthly intervals were recorded the maximum fruit drop (48.00%) in the month of July and the minimum fruit drop (3.67%) in the month of December. Among, interaction, maximum fruit drop (54.87%) was found in Pant Bael 1 in the month of July and minimum fruit drop (2.44%) was found in Pant Bael 4 in the month of December. Srivastava and Singh (8) also reported the maximum fruit drop after one week of fruit setting (second week of July) in all the genotypes, which was significantly more than drop of later weeks. Highest fruit drop in the month of July might be due to the embryo abortion, high temperature, strong winds and extreme of soil moisture and humidity. However, it was observed that fruit drop continue to occur during all the months and again shows the peak in the month of February which is due to fruit cracking, fruit rotting, frost damage and fruit borer attack. A number of internal and external factors at different stages (failure of fertilization, embryo abortion, strong winds and insect-pests) have been found to be associated with fruit drop (Kumar, 4).

Data presented in Table 3 clearly indicate that fruit cracking is significantly differed in different genotypes, in different months and their interaction in both the years of experiment. Among the genotypes, the maximum fruit cracking (53.12%) was found in Pant Sujata followed by Pant Urvashi and minimum fruit cracking (42.45%) was found in Pant Bael 4. Data on fruit cracking at monthly intervals recorded the maximum fruit cracking (70.54%) in the month of January and the minimum fruit cracking (2.25%) was found in the month of July. Among interactions, the maximum fruit cracking (76.57%) was found in Pant Sujata in the month of January and the minimum fruit cracking (0.44%) was found in Pant Bael 3 in the month of July. The problem of bael fruit cracking was also reported in *Tarai* and arid regions of Haryana and Rajasthan (Misra *et al.*, 5, Saini *et al.*, 6 and Saroj *et al.*, 7). In young fruit, fruit cracking occurs due to boron deficiency but fully grown fruits crack due to temperature fluctuation or soil moisture imbalances (Abd El-Rhman, 1). One

Table 1. Effect of genotypes on fruit set, fruit drop, fruit retention and yield.

S.N.	Genotypes	Fruit Set (%)	Fruit Drop (%)	Fruit Retention (%)	Yield (kg/tree)
1.	Pant Bael 1	71.02 (57.44)	97.60 (81.10)	2.40 (8.91)	39.26
2.	Pant Bael 3	75.02 (60.03)	93.16 (74.84)	6.84 (15.16)	33.51
3.	Pant Bael 4	80.13 (63.53)	91.74 (73.31)	8.26 (16.70)	33.05
4.	Pant Shivani	67.82 (55.44)	98.06 (81.99)	1.94 (8.01)	95.61
5.	Pant Urvashi	69.13 (56.25)	98.31 (82.53)	1.69 (7.47)	60.99
6.	Pant Bael 7	81.08 (64.22)	95.79 (78.16)	4.21 (11.84)	33.66
7.	Pant Aparna	84.30 (66.66)	96.67 (79.51)	3.33 (10.49)	69.32
8.	Pant Bael 10	82.59 (65.35)	96.06 (78.55)	3.94 (11.46)	34.36
9.	Pant Bael 11	85.57 (67.69)	94.44 (76.37)	5.56 (13.64)	46.35
10.	Pant Sujata	79.74 (63.25)	98.87 (83.97)	1.13 (6.03)	69.06
11.	Pant Bael 13	69.00 (56.17)	96.93 (79.91)	3.07 (10.09)	36.44
12.	Pant Bael 14	70.42 (57.05)	96.97 (79.99)	3.03 (10.02)	37.95
13.	Pant Bael 15	75.14 (60.11)	97.12 (80.22)	2.89 (9.78)	25.09
14.	Pant Bael 16	74.48 (59.67)	98.28 (82.54)	1.72 (7.47)	52.75
	C.D. (p=0.05)	(1.49)	(0.93)	(0.93)	2.03

Table 2. Effect of genotypes on fruit drop at monthly intervals (pooled data of 2009-11).

Genotypes	July	August	September	October	November	December	January	February	March	Mean
Pant Bael 1	54.87 (47.79)	32.82 (34.95)	26.58 (31.04)	11.81 (20.09)	6.21 (14.43)	2.90 (9.81)	7.70 (16.11)	19.75 (26.39)	12.25 (20.49)	19.43 (24.57)
Pant Bael 3	46.26 (42.86)	26.80 (31.18)	20.90 (27.21)	9.52 (17.98)	6.77 (15.06)	3.69 (11.08)	8.85 (17.30)	18.24 (25.28)	11.36 (19.69)	16.93 (23.07)
Pant Bael 4	43.23 (41.11)	26.30 (30.85)	21.53 (27.64)	6.77 (15.08)	4.11 (11.70)	2.44 (8.98)	6.11 (14.30)	16.93 (24.29)	10.81 (19.19)	15.36 (21.46)
Pant Shivani	52.20 (46.26)	34.79 (36.15)	29.17 (32.69)	11.85 (20.13)	7.03 (15.38)	4.80 (12.65)	11.24 (19.59)	26.85 (31.21)	20.66 (27.03)	22.07 (26.79)
Pant Urvashi	50.34 (45.19)	37.16 (37.56)	28.42 (32.21)	11.24 (19.59)	7.51 (15.91)	4.68 (12.48)	11.72 (20.01)	27.55 (31.66)	19.84 (26.45)	22.05 (26.79)
Pant Bael 7	47.60 (43.62)	26.69 (31.10)	23.15 (28.76)	10.06 (18.49)	5.66 (13.75)	4.37 (12.05)	5.86 (14.02)	18.24 (25.28)	16.49 (23.96)	17.57 (23.44)
Pant Aparna	49.00 (44.43)	28.15 (32.05)	21.93 (27.92)	6.33 (14.57)	4.41 (12.07)	2.36 (8.84)	9.28 (17.74)	23.64 (29.09)	17.41 (24.66)	18.06 (23.49)
Pant Bael 10	45.18 (42.23)	28.85 (32.48)	23.79 (29.19)	6.98 (15.32)	4.28 (11.93)	3.64 (10.98)	8.00 (16.42)	18.12 (25.19)	16.34 (23.85)	17.24 (23.07)
Pant Bael 11	41.03 (39.83)	30.73 (33.67)	21.55 (27.65)	6.74 (15.05)	4.61 (12.41)	2.93 (9.83)	8.58 (17.03)	18.05 (25.14)	15.73 (23.37)	16.66 (22.66)
Pant Sujata	52.62 (46.51)	37.63 (37.84)	29.11 (32.63)	13.11 (21.22)	7.68 (16.08)	4.41 (12.12)	12.65 (20.83)	28.75 (32.41)	23.29 (28.85)	23.25 (27.61)
Pant Bael 13	44.34 (41.75)	30.74 (33.67)	27.42 (31.58)	9.77 (18.22)	5.63 (13.72)	3.49 (10.77)	11.85 (20.14)	21.18 (27.39)	16.32 (23.83)	18.97 (24.56)
Pant Bael 14	49.54 (44.73)	33.13 (35.14)	23.57 (29.04)	7.93 (16.35)	5.62 (13.71)	5.37 (13.39)	10.16 (18.58)	21.26 (27.45)	18.95 (25.81)	19.50 (24.91)
Pant Bael 15	48.09 (43.90)	35.59 (36.62)	26.57 (31.03)	10.28 (18.68)	4.69 (12.50)	2.84 (9.71)	11.31 (19.65)	23.16 (28.77)	17.22 (24.52)	19.97 (25.04)
Pant Bael 16	47.71 (43.69)	30.80 (33.71)	28.03 (31.97)	8.77 (17.23)	6.43 (14.69)	3.50 (10.78)	10.93 (19.31)	20.81 (27.14)	18.45 (25.44)	19.49 (24.88)
Mean	48.00 (43.85)	31.44 (34.07)	25.12 (30.04)	9.37 (17.71)	5.76 (13.81)	3.67 (10.96)	9.59 (17.93)	21.61 (27.62)	16.79 (24.08)	
C.D.(p=0.05)		Genotypes (G)			Months (M)			Interaction (G × M)		
		(0.28)			(0.22)			(0.83)		

Table 3. Effect of genotypes on fruit cracking at monthly intervals (pooled data of 2009-11).

Genotypes	July	August	September	October	November	December	January	February	March	Mean
Pant Bael 1	1.06 (5.90)	25.08 (30.05)	41.20 (39.93)	39.14 (38.73)	58.66 (49.99)	67.04 (54.96)	69.68 (56.59)	60.96 (51.33)	60.89 (51.29)	47.08 (42.09)
Pant Bael 3	0.44 (3.11)	22.98 (28.69)	31.71 (34.27)	36.69 (37.28)	52.97 (46.70)	66.05 (54.37)	67.79 (55.42)	58.08 (49.65)	55.74 (48.29)	43.61 (39.75)
Pant Bael 4	1.15 (5.03)	21.27 (27.46)	30.70 (33.65)	37.72 (37.88)	50.86 (45.49)	64.74 (53.57)	64.99 (53.72)	57.05 (49.05)	53.54 (47.03)	42.45 (39.21)
Pant Shivani	1.53 (6.57)	36.31 (37.05)	46.08 (42.75)	45.30 (42.30)	61.46 (51.63)	73.50 (59.02)	75.32 (60.21)	69.80 (56.67)	63.21 (52.66)	52.50 (45.43)
Pant Urvashi	2.24 (8.59)	39.47 (38.93)	45.26 (42.28)	46.04 (42.73)	62.15 (52.03)	73.71 (59.15)	75.81 (60.54)	68.91 (56.11)	64.45 (53.40)	53.12 (45.97)
Pant Bael 7	2.66 (7.68)	27.05 (31.33)	35.12 (36.34)	37.65 (37.85)	55.89 (48.34)	66.66 (54.73)	67.32 (55.14)	61.32 (51.55)	52.65 (46.52)	45.15 (41.06)
Pant Aparna	3.18 (9.60)	37.16 (37.56)	43.88 (41.48)	46.76 (43.14)	61.92 (51.89)	71.22 (57.57)	72.33 (58.26)	68.10 (55.61)	64.43 (53.39)	52.11 (45.39)
Pant Bael 10	0.78 (4.69)	21.90 (27.90)	35.75 (36.72)	38.09 (38.11)	56.31 (48.63)	70.05 (56.82)	67.78 (55.42)	58.62 (49.96)	56.62 (48.81)	45.10 (40.78)
Pant Bael 11	2.89 (9.75)	22.37 (28.23)	33.63 (35.44)	36.57 (37.21)	53.70 (47.11)	67.82 (55.44)	65.91 (54.28)	59.78 (50.64)	57.57 (49.35)	44.47 (40.83)
Pant Sujata	3.83 (11.18)	39.56 (38.97)	47.33 (43.46)	45.98 (42.69)	61.13 (51.43)	73.46 (58.99)	76.57 (61.05)	69.91 (56.73)	63.90 (53.07)	53.52 (46.40)
Pant Bael 13	1.33 (6.18)	29.40 (32.83)	40.11 (39.29)	40.53 (39.54)	56.46 (48.71)	67.69 (55.36)	68.22 (55.68)	60.22 (50.89)	62.32 (52.13)	47.36 (42.29)
Pant Bael 14	1.50 (6.95)	30.66 (33.62)	41.63 (40.18)	43.40 (41.21)	58.35 (49.81)	69.99 (56.78)	70.46 (57.07)	62.57 (52.28)	56.95 (48.99)	48.39 (42.99)
Pant Bael 15	4.09 (11.61)	36.13 (36.95)	45.90 (42.65)	43.24 (41.11)	59.99 (50.76)	71.46 (57.71)	72.73 (58.53)	65.85 (54.24)	60.72 (51.19)	51.12 (44.97)
Pant Bael 16	4.84 (12.71)	38.31 (38.24)	46.09 (42.76)	44.96 (42.11)	62.41 (52.18)	73.21 (58.83)	72.63 (58.46)	67.63 (55.33)	63.52 (52.84)	52.62 (45.94)
Mean	2.25 (7.83)	30.55 (33.41)	40.31 (39.37)	41.58 (40.14)	58.02 (49.63)	69.76 (56.67)	70.54 (57.17)	63.49 (52.86)	59.75 (50.64)	
C.D.(p=0.05)		Genotypes (G)			Months (M)			Interaction (V × M)		
		(0.56)			(0.45)			(1.69)		

of the reasons for fruit cracking is also thought to be the differential growth rates of the peripheral and cortex tissue.

It is clear from the data (Table 1) that there was significant variation among the genotypes for total fruit drop and fruit retention percentage during both the years of experiment. The maximum total fruit drop (98.87%) and the minimum fruit retention (1.13%) was observed in Pant Sujata followed by Pant Bael 16 while the minimum total fruit drop (91.74%) and the maximum fruit retention (8.26%) were observed in Pant Bael 4. Variation in fruit drop and fruit retention percentage in Bael was also reported at various places where Bael is grown (Misra *et al.,* 5 and Saroj *et al.*, 7). This variation in fruit drop and fruit retention percentage among the various genotypes of Bael might be attributed to their inherent characters.

Yield in terms of fruit weight per tree also differed significantly among the genotypes of Bael (Table 1). The yield varied from 25.09 to 95.61 kg fruits per tree. The maximum yield was observed with Pant Shivani which was significantly higher than all other genotypes. The minimum yield in terms of weight of fruits per tree was recorded in Pant Bael 15. Variation in yield in terms of fruits weight per tree was recorded in different clones of Bael (Bhawna and Misra, 2). This variation in yield might be due to the difference in the genetic constitutions of tree, tree size and age, prevailing agroclimatic conditions, variation in the absorption of nutrients from soil, its translocation and distribution within plant system, translocation of photosynthate from leaf to developing fruits, amount of photosynthates formed and rate of synthesis of various plant hormones by the various clones.

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