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Original Research Article

Studies on flowering and fruiting habits of selected Amla (*emblica officinalis* gaertn.) cultivars in Haryana, India

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ABSTRACT
Amla, often known as the Indian gooseberry (*Emblica officinalis Gaertn. Syn. Phyllanthus emblica* L.), is a significant native fruit crop of the Indian subcontinent and a member of the Euphorbiaceae family. The study included fourteen-year-old trees of seven cultivars: Chakaiya, Local Variety (NeAPSU1), Local Variety (NeAPSU2), NA-10 (Balwant), NA-5 (Krishna), and NA-4 (Kanchan). Fruiting pattern, floral biology, and all vegetative factors are included in studies of reproductive behavior. Anthesis and its dehiscence, budding and blooming, and flowering inflorescence type and color are all included in this experiment. The cultivar also affected the length of time it took to bloom. The blooming aeon lasted 36 to 48 days (cv. Chakaiya and Krishna, respectively). NeAPSU3 had the least amount of male flowers, whereas the cultivar Balwant had the beggarly best amount. Cultivar Kanchan produced the most female flowers, while cultivar Balwant produced the most atomic blooms. The male to female sex ratio started to change, going from 77:1 (cv. NeAPSU1) to 101:1 (cv. Balwant).

1. Introduction

The Euphorbiaceae family includes the ephemeral tree *Emblica officinalis Gaertn*. Syn. *Phyllanthus emblica* L., also referred to as Amla, Aonla, or Indian gooseberry. Mostly found in parts of India, Southeast Asia, China, Iran, and Pakistan, aonla fruits are edible. This tree is the first to be "produced in the universe," according to historical legend from ancient India [1–12]. Aonla is used extensively in Indian traditional medicine to enhance liver health, improve anemia, promote the health of the male reproductive system and reproduction, ease digestion, lessen anxiety and burning sensations in the skin and eyes, and have a tonic effect on the cardiovascular system. Cultivated amla is large, smooth, and juicy, but wild amla is small. Water makes up more than 80% of the amla fruit's chemical makeup. It also includes gallic acid, a powerful polyphenol, as well as protein, carbohydrates, fiber, and minerals. For humans, vitamin C is essential [13–15]. It is essential for the intercellular cementing actuality amalgam, which is suitable for fitting the body's beef together. Compared to orange juice, amla fruit seems to have almost 20 times as much vitamin C.

The protein content and ascorbic acid content in edible amla fruit tissue are three times more and 160 times higher, respectively. The Aryuveda makes extensive use of *Emblica officinalis* fruits, which are said to strengthen immunity to illness. Cancer, diabetes, liver disease, heart problems, ulcers, anemia, and a host of other illnesses can all benefit from it. In a same vein, it can be used as a gastroprotective, cytoprotective, immunomodulatory, antipyretic, analgesic, and antioxidant. It also helps in lowering cholesterol, improving cognition, and treating ocular conditions. It also works well as an antibacterial and to neutralize snake venom. It is frequently used as Triphla, a herbal remedy made from equal parts of the fruits of Terminalia chebula, Terminalia belerica, and *Emblica officinalis*. *Emblica officinalis* is also a natural source of vitamin C. Some plants only have male, female, or Hermaphrodite flowers, while others have all three floral kinds on the same plant. The production of *Emblica officinalis* is significantly influenced by these reproductive traits [16–21].

In India, the backwoods of the Vindhyan Hills, the lower hills of Uttarakhand, Himachal Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh, Rajasthan, and Bihar offer a wide variety of Amla. Among the commercially viable Amla varieties are Krishna, Banarasi, Chakaiya, Francis (Hathijhool), Kanchan (NA-4), NA-6, NA-7, Anand-1, 2, and 3 [22–25]. The purpose of this study was to determine the flowering and fruiting habits of a few local Amla cultivars that are found in the Vindhyan region.

2. Materials and methods

The current study was conducted from 2019 to 2024 at the Department of Horticulture, Maharana Pratap Horticulture University, Karnal, Haryana, India. Throughout the trial period, all horticultural methods and procedures were used consistently, and amla trees of various types of the same age were chosen.

The study included fourteen-year-old trees of seven cultivars: Chakaiya, Local Variety (NeAPSU1), Local Variety (NeAPSU2), NA-10 (Balwant), NA-5 (Krishna), and NA-4 (Kanchan). Varietal descriptions, vegetative body parameters, and floral biology—including blooming, anthesis, and dehiscence—are among the resources.

Picture 1: Fruiting habits of selected Amla (*emblica officinalis* gaertn.) cultivars.

3. Results and discussion

The tree Amla (*Emblica officinalis* Gaertn.) produces both determinate (short) and indeterminate (long) shoots. The branchlets, or determinate branches, were either floriferous with embricate leaves or barren. In mid-January, when the tree is leafless, floral buds, regardless of age, emerged as tiny pin heads on slender branchlets that were created on woody branches. In all cultivars, the inflorescence was of the raceme type. While female flowers were born on the top end of the branchlet, male flowers were found in groups throughout the branchlets in the leaf axils. The perianth and androecium or gynoecium make up a typical flower. During the bud date, male flowers were tiny and barely blushed, but at anthesis, they turned a buttery white.

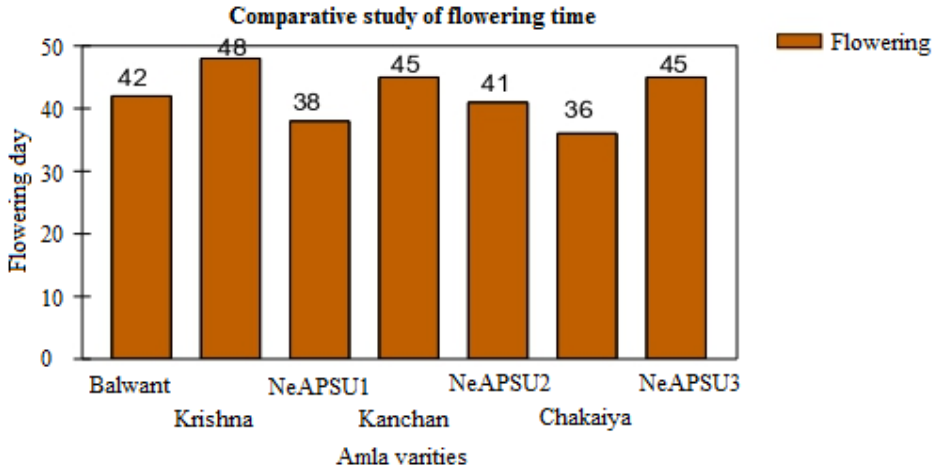

Figure 1: Flowering duration of Amla cultivars.

Table 1: Floral morphological features of Amla cultivars.

Characters	Balwant	Krishna	Kanchan	NeAPSU1	Chakaiya	NeAPSU2	NeAPSU3
Male Flowers							
Number of flower per branchlet	399-756	475-729	392-675	450-702	384-674	429-724	356-695
Number of flower per cluster	7-15	10-18	5-11	5-12	6-11	7-14	6-13
Female Flowers							
Average number of flower per branchlet	5.2	6.89	6.54	5.91	4.35	5.64	4.72
Average number of flower per cluster	1-2	1-2	1-2	1-2	1-2	1-2	1-2
Colour of inflorescence	Deep pink	Deep pink	Pinkish green	Pinkish green	Deep pink	Pinkish green	Pinkish green

Table 2: Sex ratio in different cultivars of Amla.

Varieties		Number of flowers per branchlet		Sex ratio
		Female	Male	
Early	BALWANT	5.50	558.90	1:101
	KRISHNA	6.30	526.07	1:83
	NeAPSU1	6.47	501.03	1:77
Mid	KANCHAN	6.67	525.13	1:78
	NeAPSU2	5.60	520.80	1:93
Late	CHAKAIYA	6.17	512.83	1:83
	NeAPSU3	5.73	470.17	1:82
Mean		6.06	516.42	-
F-test		*	*	-
S.Em ±		0.03	1.56	-
C.D@ 5%		0.08	4.81	-

*Significant

Table 3: Time of anthesis and per cent flowers opening in different Amla cultivars.

Varieties		Percent Flowers opened						
		6pm- 8am	8am- 10am	10am- 12pm	12pm- 2pm	2pm- 4pm	4pm- 6pm	P Value
Early	BALWANT	08.04	3.20	1.101	1.16	0.38	80.69	P<0.0001
	KRISHNA	09.11	2.61	1.83	0.58	0.44	81.63	
	NeAPSU1	04.83	0.91	1.77	0.79	7.68	83.42	
Mid	KANCHAN	10.31	2.55	1.78	1.25	1.07	83.18	
	NeAPSU2	06.06	1.86	1.93	1.28	1.42	87.69	
Late	CHAKAIYA	05.00	1.58	1.83	0.97	4.46	87.15	
	NeAPSU3	07.58	1.83	1.82	0.30	1.65	82.70	
Mean		07.28	4.65	2.08	0.92	2.44	83.78	
F-test		*	*	*	*	*	*	
S.Em ±		0.12	0.10	0.04	0.02	0.15	0.15	
C.D@ 5%		0.37	0.32	0.13	0.06	0.47	0.47	

*Significant

Table 4: Profile of anther dehiscence of different Amla cultivars across two hourly intervals.

Varieties		Percent Flowers opened						
		6pm- 8am	8am- 10am	10am- 12pm	12pm- 2pm	2pm- 4pm	4pm- 6pm	P Value
Early	BALWANT	6.11	5.89	5.22	4.66	7.67	82.89	P<0.0001**
	KRISHNA	6.67	5.48	4.22	3.67	4.67	80.56	
	NeAPSU1	10.22	5.22	4.22	4.22	4.89	80.22	
Mid	KANCHAN	5.78	4.00	3.33	1.33	4.56	83.11	
	NeAPSU2	4.89	5.33	4.11	2.11	11.56	76.78	
Late	CHAKAIYA	5.22	4.78	3.89	1.78	7.44	80.78	
	NeAPSU3	5.71	5.78	5.22	1.55	8.44	79.22	
Mean		6.37	5.21	4.32	2.76	7.03	80.51	
F-test		*	*	*	*	*	*	
S.Em ±		0.10	0.04	0.04	0.08	0.15	0.13	
C.D@ 5%		0.31	1.11	0.12	0.25	0.46	0.34	

*Significant

Flowering Characters

As early as 16 days after flower initiation, the variety NeAPSU1 was in full bloom, followed by Kanchan (17 days), Krishna, and NeAPSU2 (18 days). At 20, 22, and 24 days, respectively, the cultivars Balwant, Chakaiya, and NeAPSU3 reached full bloom (Table 1, Figure 1).

Duration of flowering

Krishna had the longest blooming time (48 days), followed by NeAPSU3 & Kanchan (45 days), Balwant (42 days), and NeAPSU2 (41 days); Chakaiya had the shortest flowering time (36 days), followed by NeAPSU1 (38 days) (Table 1, Figure 1).

Floral morphology

For all cultivars, information on floral morphological features such as inflorescence color, number of flowers per branchlet, and number of flowers per cluster in both male and female flowers was gathered. The findings are shown in Table 1.

Colour of inflorescence

The cultivars of Balwant, Krishna, and Chakaiya showed deep pink inflorescence. Kanchan, NeAPSU1, NeAPSU2, and local NeAPSU3 all had pinkish green inflorescence (Table 1).

Number of male flowers per branchlet

Balwant (399–756) had the most male flowers per branchlet, followed by Krishna (475-729), NeAPSU2 (429–724), NeAPSU1 (450–702), NeAPSU3 (356–695), and Kanchan (392–675). Chakaiya (384-674) had the fewest flowers per branchlet (Table 2).

Number of male flower per cluster

Krishna (10–18) had the widest variety of male flowers per cluster, followed by Balwant (7–15), NeAPSU2 (7–14), NeAPSU3 (6–13), and NeAPSU1 (5–12). Kanchan (5–11) had the smallest variety of male flowers per cluster, followed by Chakaiya (6–11) (Table 2).

Average number of female flowers per branchlet

Krishna (6.89) had the most female flowers per branchlet on average, followed by Kanchan (6.54), NeAPSU1 (5.91), NeAPSU2 (5.64), Balwant (5.2), and NeAPSU3 (4.72); Chakaiya (4.35) had the fewest female flowers per branchlet (Table 2).

Average number of female flower per cluster

All six amla cultivars, including the local variation, had an average of one to two female flowers per cluster (Table 2).

Sex expression and sex ratio

A few female flowers (6.02) and several hundred male flowers (516.42) are produced by the monoecious amla tree on a short branchlet (i.e. determinate shoot). In amla, only a few branchlets on a branch gave birth to female flowers, but male flowers were present on every branchlet (Table 2).

Sex ratio

Balwant (101:1) had the largest male-to-female sex ratio, followed by NeAPSU2 (93:1), Krishna (83:1), Chakaiya (83:1), NeAPSU3 (82:1), and Kanchan (78:1), while NeAPSU1 (77:1) had the lowest (Table 2).

Anthesis

Hourly records of the time of anthesis and the percentage of flowers that opened are shown in the table. At a 5% probability level, the F-test was determined to be significant at various time intervals. According to statistical study, all flower opening times varied significantly from one another ($P < 0.0001$***) (Table 3, 4, Figure 2, 3).

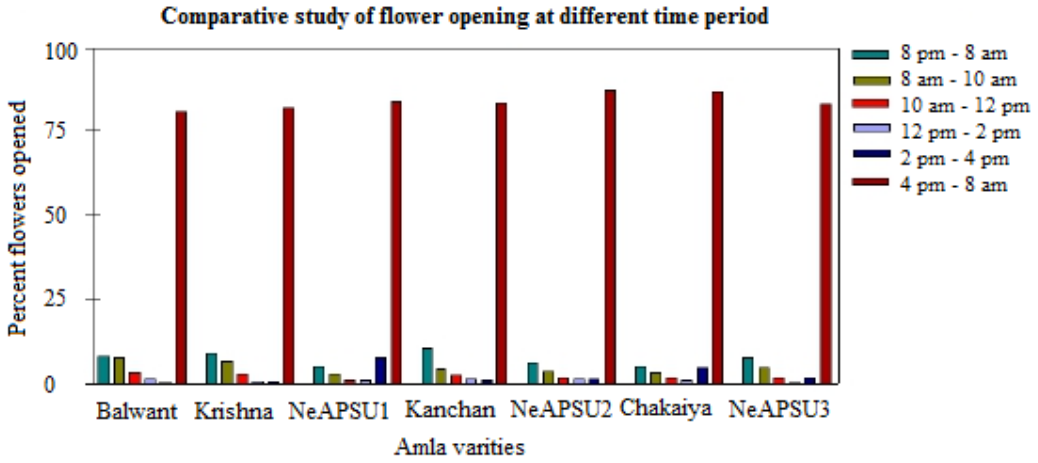

Figure 2: Time of anthesis and per cent flowers opening in different Amla cultivars.

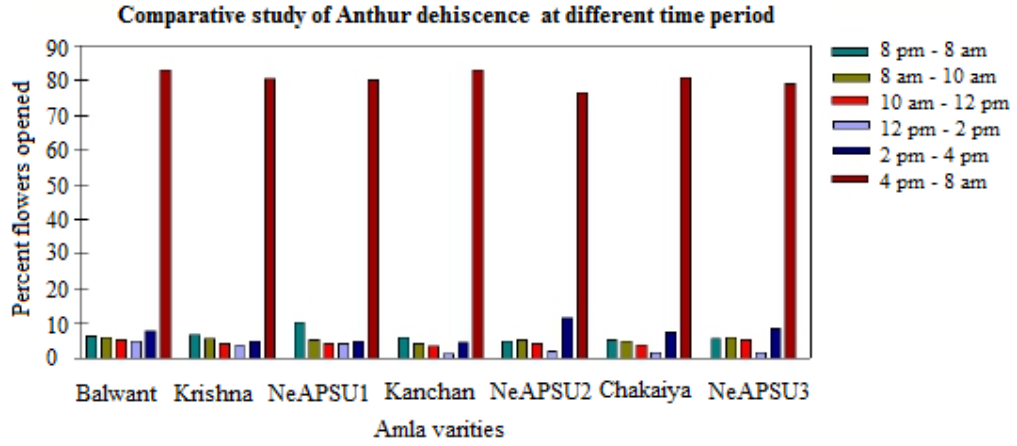

Figure 3: Time of anthesis in different Amla cultivar.

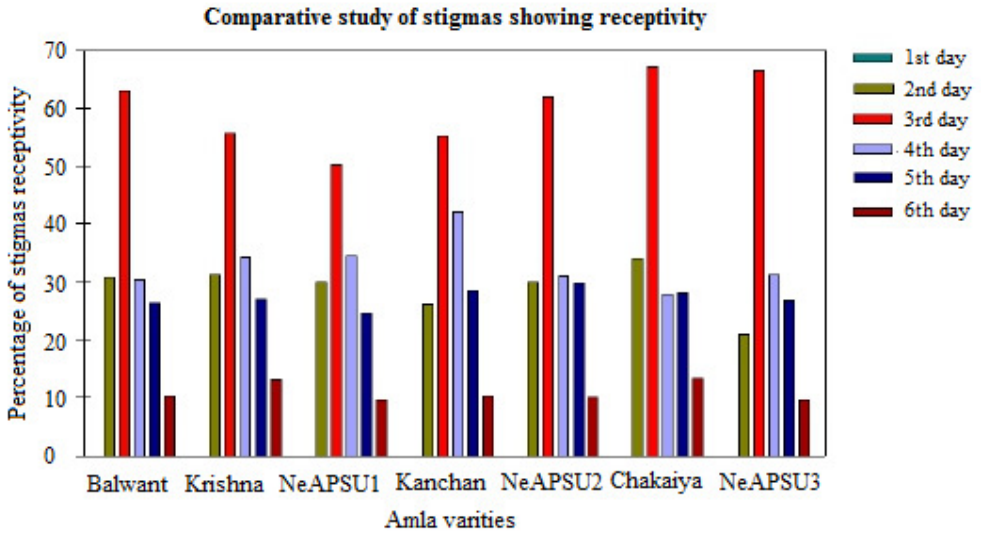

Figure 4: Receptivity of stigma at different periods after anthesis in Amla cultivars.

Time of anther dehiscence

Table 4 displays the information pertaining to the "time of anther dehiscence." Flower opening and anther dehiscence were noted at the same time. The dehiscence of anthers was seen to occur as the perianth segments started to split apart. All seven of the cultivars under investigation had the same dehiscence method. Between 4 and 6 p.m., the highest proportion of dehiscence (83.11 %) was observed. During the morning and afternoon, there was little dehiscence. Table 3, 4, Figure 2, 3 provide the average rate.

Stigmatic receptivity

Table 5 shows the stigmatic receptivity of Amla cultivars at various time points during the day. Significant differences in stigma sensitivity were noted at various times throughout the day.

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