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Floral biology studies in *Bhuchanania* under semi-arid ecosystem of western India

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ABSTRACT

An experiment was conducted to study the floral biology of 15 elite genotypes of *chironji* (*Bhuchanania lanzan* Spreng.) during 2004 and 2005. Peak period of panicle emergence and flowering were recorded in January-February. Highest panicle length (35.11 cm) was noted in CPT 1. Peak period of anthesis and dehiscence was recorded between 6-11 AM and 8 AM to 12 noon respectively in all the genotypes. The stamen and pistil length varied from 1.97-2.12 mm and 1.22-1.38 mm respectively being at the top in CPT 13. Pollen viability ranged from 54.55-70.38% being highest in CPT 5. Pollen germination and pollen diameter ranged from 20.00 to 35.00 % and 49.10 to 63.18 µ, respectively. Maximum stigma receptivity was recorded in CPT 5 (35.00 %) on the day of anthesis. The peak period of fruit set was recorded in February in majority of genotypes and it was noted maximum in CPT 12 (37.50). Fruit set / panicle was found to be positively and significantly associated with panicle length and it may be observed while selecting elite genotypes. Vegetatively propagated genotypes have been planted in the field for their further evaluation.

Key words: Flowering, anthesis, dehiscence, pollen germination, stigma receptivity.

INTRODUCTION

Chironji (*Buchanania lanzan* Spreng.) of family Anacardiaceae assumes great significance due to its multifarious uses and capacity to withstand adverse climatic conditions. At present, it is growing under forest conditions as an under exploited fruit crop and gives monitory reward to the poor community of the country. It is very hardy and thrives well on rocky and gravelly soils. The kernel is highly nutritious and rich in protein and yields sweet oil, which can be used to substitute olive and almond oil. It is highly heterozygous, cross-pollinated fruit crop and as such seedlings exhibit a wide range of variations, which aids in the selection of the superior desirable genotypes. Due to cross pollination and predomination of seed propagation over a large period of time, it gives immense opportunity to locate elite trees having desirable horticultural traits. Several workers have studied floral biology of tamarind, *jamun*, *bael*, mango and guava genotypes under various climatic conditions (Singh *et al.*, 15,17,18, 9, 10; Singh and Singh, 16). No attempts to improve its varietal wealth have been made under semi-arid regions. To begin with development of new elite genotypes, the information on detailed reproductive biology is essential and, therefore, studies were undertaken.

MATERIALS AND METHODS

An extensive survey was made in Gujarat during 2004 and 2005 to identify elite types of germplasm. Fifteen elite genotypes were selected, which had fairly wide variability of various characters and they were considered as experimental materials. Thirty healthy panicles in each genotype were randomly selected to record panicle length and fruit set per panicle. Bud diameter was measured just prior to anthesis. To observe the time for anthesis and dehiscence, 50 flower buds expected to open the next day were tagged on the previous evening. The number of fully opened flowers was noted at one-hour interval (starting 4.00 AM in the next morning). Fully opened flowers were marked with indelible ink to avoid recounting. Likewise for dehiscence, fully dehisced anthers were removed to avoid confusion. The pollen viability in different genotypes was tested with two per cent acetocarmine solution (Dhaliwal and Singla, 1). The pollens which stained intensely brick red in colour and looked normal in appearance were considered viable, whereas those feebly stained or remained unstained or abnormal in appearance were considered as non-viable. Observations on pollen germinability were recorded by using hanging drop method in 15 percent sucrose solution after 24 h and expressed in percent. Percent fruit set was recorded after one week of pollination. The data were analyzed in completely randomized design with three replications using mature branches on the tree as a replication.

RESULTS AND DISCUSSION

The observations on flowering studies presented in Table 1 showed that peak period of panicle

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emergence was recorded in January for different genotypes. It was noted earliest on 14 January in CPT 1, closely followed by CPT 2, CPT 11 and CPT 3, while it was noted at the last on 24 January in CPT 7 and CPT 15. The peak period of flowering was found to be earliest in CPT 1 (6 February) closely followed by CPT 11, CPT 10, CPT 2 and CPT 3 (Table 1). Wide variability in respect of panicle emergence and period of flowering was recorded in mango and *jamun* under different climatic conditions (Singh, 10; Hoda *et al.,* 3; Singh and Singh, 13). There was marked variation in average panicle length in most of the genotypes and CPT 1 recorded the maximum panicle length (35.11cm), closely followed by CPT 12, CPT 6 and CPT 2. Least panicle length was noted in CPT 3 (15.34 cm). Variation in number of fruit set per panicle was recorded and it was found to be highest in CPT 12 (37.50), closely followed by CPT 1, CPT 7 and CPT 8. Variability in fruit set was also recorded in *jamun* genotypes (Singh *et al*., 18). Chironji genotypes differed in their time requirement to complete the bud development and it ranged from 16 to 20 days being highest in CPT 2, closely followed by CPT 9, and CPT 11 (Table 1). The variability in respect of flowering period has also been reported by Singh (10), Dobral and Misra (2), and Singh *et al*. (15) in mango, litchi and tamarind.

The data indicated that anthesis started at 4 AM and continued up to 2 PM. The peak period of anthesis was noticed from 6 to 11 AM in all the genotypes (Table 2). However, least anthesis was recorded during 1 to 2 PM, which was accounted to the tune of 1 to 3% in all the genotypes. It may be considered as negligible. None of the genotypes showed anthesis before 4 AM and after 2 PM. The anthesis was recorded 21 % and 20 in CPT 13 and CPT 12 respectively between 9 and 10 AM, while CPT 1 recorded 16 % anthesis between 9 and 10 A.M (Table 2). CPT 6 was the first to show higher rate of anthesis (6 %) followed by CPT 1, CPT 4, CPT 6 and CPT 13 between 4 and 5 AM. However, delayed anthesis was registered in CPT 3 and CPT 11, *i.e.,* 2 % during 4-5 AM. Anthesis during 1-2 PM ranged from 1 to 4 per cent in all the genotypes. These findings clarified that anthesis in chironji took place in morning hours when low temperature and high relative humidity prevailed.

Data pertaining to anther dehiscence (Table 2) reveals that anther dehiscence commenced after opening of the flower, *i.e.* at 7 AM and continued up to 3 PM. The peak period for anther dehiscence was registered from 10 AM to 12 noon in all the genotypes and it was considered as the most effective period for anther dehiscence, possibly due to the fact that temperature during these hours are usually higher than that in the morning and evening hours and fall in humidity during this period may also have accelerated the dehiscing process. Singh (11), Singh (9); and Srivastava and Singh (20) made almost same statement in guava and *bael* under north Indian conditions. None of the genotypes showed anther dehiscence before 7 AM and after 3 PM. It was recorded that CPT 1, CPT 11 CPT 13 and CPT 14 showed maximum anther dehiscence (25%) between 10 and 11 AM. Dehiscence of anthers ranged from 3-5 per cent in different genotypes during 2-3 PM. These observations are found in conformity with the findings of Srivastava and Singh (20) and Singh *et al.* (19). Peak period of anthesis and dehiscence was recorded between 6-8 AM in guava during both the seasons (winter and rainy), none of the genotypes showed anthesis before 4 AM and after 11 AM, anther dehiscence commenced just after opening of flowers *i.e.* at 5 AM and continued till 11 AM (Singh and Singh, 16). The variability in flower biology of chironji genotypes might be due to location and genotypic characteristics.

The flower diameter varied from 5.12 to 6.30 mm and it was found to be maximum in CPT 8 followed by CPT 3, CPT 1 and CPT 5. Studies indicated that the number of sepals and petals in all genotypes were found to be five. The length of sepal varied from 10.97-16.45 mm with maximum in CPT 9. Petal length varied from 2.40 to 2.71 mm with highest in CPT 8. There was variation in filament length in most of the genotypes and CPT 4 recorded maximum filament length (1.33 mm) followed by CPT 13, CPT 6 and CPT 5. The total number of anthers in each flower was ten. Stamen length varied from 1.97 - 2.12 mm and it was found to be maximum in CPT 13 followed by CPT 6, CPT 3 and CPT 8. The carpel length varied from 1.22 - 1.38 mm and it was found to be maximum in CPT13 followed by CPT 11, CPT 9 and CPT 3. Marked differences in various floral traits might be due to inherent genetic variations among the genotypes. Kaushal *et al*. (4) reported that the number of sepals of plum and apricot were found to be five and it was observed that flower size varied from 1.91 to 3.95 cm, the petal and sepal size varied from 0.90 × 1.7 cm to 0.36 × 0.81 cm respectively in different genotypes. Singh *et al.* (18) and Singh *et al*. (8) also reported variability in flower size of jamun and *bael* genotypes under semi arid ecosystem of western India..

Maximum pollen viability (70.38 %) was observed in CPT 5, which was closely followed by CPT 4, CPT10 and CPT 11, however minimum pollen viability was observed in CPT 9 (54.55 %). Kumar *et al.t algs of* Srivastava and Singh, (20) reported that pollen viability ranged from 74.90 to 94.22 per cent in different peach cultivars under Uttaranchal conditions. Singh *et al*, (19) obtained 75.60-88.00 percent pollen viability in different

Table 1. Flowering and fruit set pattern in *chironji* genotypes.

Genotype	Time of panicle emergence			Time of flowering			Time of fruit set			Panicle length (cm)	Time taken for bud development (days)	Fruit set per panicle
	Initiation	Peak	End	Initiation	Peak	End	Initiation	Peak	End			
CPT 1	3 Jan	14 Jan	28 Jan	25 Jan	6 Feb	17 Feb	10 Feb	20 Feb	1 March	35.11	18	36.20
CPT 2	4 Jan	15 Jan	27 Jan	27 Jan	10 Feb	20 Feb	12 Feb	25 Feb	3 March	25.24	20	26.40
CPT 3	4 Jan	18 Jan	28 Jan	25 Jan	10 Feb	21 Feb	10 Feb	25 Feb	2 March	15.34	18	18.10
CPT 4	3 Jan	19 Jan	26 Jan	25 Jan	12 Feb	21 Feb	10 Feb	25 Feb	2 March	20.12	17	22.20
CPT 5	6 Jan	20 Jan	27 Jan	29 Jan	10 Feb	18 Feb	12 Feb	20 Feb	1 March	25.13	17	26.00
CPT 6	5 Jan	22 Jan	1 Feb	28 Jan	16 Feb	25 Feb	12 Feb	2 March	8 March	26.00	16	27.00
CPT 7	6 Jan	24 Jan	1 Feb	29 Jan	13 Feb	20 Feb	13 Feb	27 Feb	3 March	27.10	17	28.00
CPT 8	8 Jan	22 Jan	4 Feb	27 Jan	17 Feb	27 Feb	13 Feb	2 March	9 March	26.00	18	27.00
CPT 9	7 Jan	23 Jan	3 Feb	28 Jan	18 Feb	27 Feb	13 Feb	2 March	10 March	18.13	19	20.10
CPT 10	6 Jan	20 Jan	1 Feb	27 Jan	8 Feb	22 Feb	12 Feb	27 Feb	10 March	17.34	16	18.25
CPT 11	3 Jan	15 Jan	27 Jan	24 Jan	7 Feb	18 Feb	11 Feb	28 Feb	7 March	20.11	19	21.50
CPT 12	4 Jan	23 Jan	2 Feb	29 Jan	17 Feb	26 Feb	13 Feb	3 March	9 March	32.10	18	37.50
CPT 13	4 Jan	19 Jan	1 Feb	24 Jan	11 Feb	22 Feb	12 Feb	26 Feb	4 March	20.00	17	21.00
CPT 14	3 Jan	23 Jan	6 Feb	27 Jan	19 Feb	27 Feb	14 Feb	3 March	11 March	17.10	18	18.40
CPT 15	3 Jan	24 Jan	2 Feb	28 Jan	20 Feb	25 Feb	15 Feb	2 March	9 March	22.00	18	23.10
CD (P = 0.05)	-	-	-	-	-	-	-	-	-	2.22	-	2.31

Jan = January, Feb = February.

Table 2. Time of anthesis and anther dehiscence in different *chironji* genotypes.

Genotype		Flowers opened and anthers dehisced at hourly interval (%)										
		4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15
CPT 1	A	5	8	12	14	15	16	18	6	4	2	0
	D	0	0	0	8	10	20	25	19	7	6	5
CPT 2	A	4	7	14	15	14	18	17	5	3	3	0
	D	0	0	0	7	12	17	23	21	7	7	6
CPT 3	A	2	6	16	16	13	19	14	7	4	3	0
	D	0	0	0	6	13	22	22	20	7	5	5
CPT 4	A	5	4	15	17	12	18	17	6	3	3	0
	D	0	0	0	7	14	24	23	20	5	4	3
CPT 5	A	3	5	16	14	14	19	16	5	5	3	0
	D	0	0	0	6	16	22	20	23	5	4	4
CPT 6	A	4	7	14	16	15	18	15	3	5	3	0
	D	0	0	0	5	14	19	24	20	6	7	5
CPT 7	A	6	9	12	15	17	17	14	4	3	3	0
	D	0	0	0	6	13	21	21	20	8	6	5
CPT 8	A	5	8	13	16	18	15	13	4	5	3	0
	D	0	0	0	7	14	24	22	23	5	3	2
CPT 9	A	4	8	12	14	17	19	16	4	4	2	0
	D	0	0	0	6	12	22	21	25	6	5	3
CPT 10	A	3	7	13	15	15	20	17	3	4	3	0
	D	0	0	0	5	10	23	24	21	7	5	5
CPT 11	A	2	8	14	15	16	19	16	4	3	3	0
	D	0	0	0	4	11	24	25	19	6	6	5
CPT 12	A	3	6	15	13	18	20	14	5	4	2	0
	D	0	0	0	3	12	23	24	21	7	5	5
CPT 13	A	4	7	13	14	19	21	12	6	3	1	0
	D	0	0	0	4	13	20	25	22	6	6	4
CPT 14	A	3	9	12	15	20	18	11	5	4	3	0
	D	0	0	0	5	12	18	25	23	7	6	4
CPT 15	A	4	10	13	14	18	17	12	4	4	4	0
	D	0	0	0	6	13	17	24	22	8	5	5

A = Anthesis, D = Dehiscence.

pear cultivars. Pollen germination was poor irrespective of the genotypes (Table 3). The maximum pollen grain germination was recorded in CPT 5 (35.00 %) closely followed by CPT 4, CPT 10 and CPT 11, while it was found to be least in CPT 9 (20.00 %). Differences in pollen germination may be due to varying percentage of pollen viability in different genotypes. Pollen diameter varied from 49.10 to 63.18 µ. Kumar *et al*. (5) reported that pollen germination ranged from 62.12 to 78.23 per cent in different peach cultivars under Uttaranchal conditions. Pollen grain viability ranged from 91.05-97.91 per cent among different pomegranate genotypes (Sharma and Bist, 7). Dhaliwal and Singla (1), Hoda *et al*. (3), Singh *et al*. (14), and Singh and Singh (12) recorded wide variation in reproductive attributes of guava, mango, tamarind, and *Mahua* (*Bassia latifolia* Roxb.) respectively under various climatic conditions. Maximum stigma receptivity (35.00 %) was recorded in CPT 5 on the day of anthesis followed by one day after anthesis. This may be due to the fact that the stigma attains the physiological maturity after the flowers opened completely (Srivastava and Singh, 20). Date of fruit set varied from February to March in different genotypes. In majority of genotypes, peak period of fruit set was observed in the last week of February and first week of March. Fruit set / panicle was found to be positively and significantly associated with panicle length and it may be observed while

Table 3. Floral traits and pollen characters in different *chironji* genotypes.

Genotype	Bud dia (mm)	Flower dia (mm)	Sepal length (mm)	Sepal breadth (mm)	Petal length (mm)	Petal breadth (mm)	Stamen length (mm)	Filament length (mm)	Anther length (mm)	Anther breadth (mm)	Pistil length (mm)	Pollen dia (µ)	Pollen viability (%)	Pollen germination (%)
CPT 1	3.00	6.12	1.25	0.75	2.60	1.11	2.05	1.30	0.75	0.42	1.25	49.10	56.20	26.80
CPT 2	2.13	5.12	1.10	0.78	2.40	1.00	2.05	1.20	0.85	0.45	1.30	50.30	55.00	26.20
CPT 3	3.30	6.16	1.16	0.89	2.70	1.15	2.09	1.26	0.83	0.43	1.35	50.00	65.20	32.00
CPT 4	3.12	6.00	1.19	0.86	2.50	1.00	2.05	1.33	0.72	0.40	1.22	52.02	68.00	32.20
CPT 5	3.16	6.10	1.28	0.90	2.63	1.10	1.97	1.30	0.68	0.39	1.23	56.10	70.38	35.00
CPT 6	2.50	5.13	1.29	0.73	2.49	1.06	2.10	1.32	0.78	0.38	1.26	59.19	62.10	28.00
CPT 7	2.80	5.18	1.10	0.75	2.46	1.16	1.99	1.26	0.73	0.43	1.28	56.00	65.10	30.20
CPT 8	3.60	6.30	1.30	0.83	2.71	1.14	2.09	1.24	0.85	0.42	1.30	58.00	58.10	24.29
CPT 9	2.50	5.13	1.31	0.84	2.51	1.10	2.04	1.23	0.81	0.43	1.36	59.20	54.55	20.00
CPT 10	2.80	5.50	1.15	0.89	2.60	1.00	2.08	1.25	0.83	0.44	1.32	62.10	66.00	27.13
CPT 11	2.86	5.14	1.10	0.79	2.63	1.12	2.10	1.26	0.83	0.43	1.36	63.18	67.13	26.00
CPT 12	2.69	5.40	1.19	0.80	2.61	1.06	1.98	1.29	0.86	0.46	1.37	61.39	62.10	24.10
CPT 13	2.63	5.30	1.26	0.81	2.59	1.08	2.12	1.32	0.82	0.39	1.38	60.00	65.00	24.90
CPT 14	2.90	5.40	1.23	0.83	2.51	1.09	2.08	1.24	0.83	0.38	1.26	59.13	66.20	25.50
CPT 15	3.11	5.41	1.29	0.82	2.52	1.10	2.05	1.23	0.82	0.37	1.29	62.00	63.00	22.10
CD (P = 0.05)	0.18	0.20	0.06	NS	0.09	NS	0.03	0.04	NS	NS	0.05	1.24	1.05	1.21

Table 4. Correlation studies in *chironji* genotypes.

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.000															
2	0.981**	1.000														
3	-0.062	-0.067	1.000													
4	0.128	0.126	0.827*	1.000												
5	0.085	0.055	0.263	0.263	1.000											
6	-0.609*	-0.558*	0.458	0.482	0.098	1.000										
7	-0.041	0.002	0.708**	0.651**	0.191	0.449	1.000									
8	0.081	0.062	0.489	0.217	0.157	-0.117	0.439	1.000								
9	0.252	0.264	0.129	0.254	0.222	-0.084	0.179	-0.105	1.000							
10	-0.222	-0.146	-0.189	-0.299	0.123	-0.042	0.157	-0.076	-0.546*	1.000						
11	-0.151	-0.097	-0.336	-0.266	0.118	0.095	-0.115	0.042	-0.350	0.164	1.000					
12	-0.482	-0.525*	0.027	-0.065	0.070	-0.056	0.184	-0.045	-0.011	0.470	-0.167	1.000				
13	-0.251	-0.155	-0.256	-0.376	-0.170	0.037	0.305	0.156	-0.245	0.706**	0.428	0.270	1.000			
14	-0.374	-0.362	0.345	0.132	-0.212	0.432	0.221	0.011	0.431	-0.385	-0.543	-0.058	-0.194	1.000		
15	-0.007	-0.030	0.302	0.468	-0.299	0.291	0.125	-0.006	0.464	-0.683**	-0.464	-0.254	-0.528*	0.626*	1.000	
16	-0.222	-0.201	0.086	0.497	0.178	0.019	0.107	0.009	-0.080	0.353	0.055	0.129	0.415	0.254	-0.498	1.000

1 = Panicle length (cm), 2 = Fruit set per panicle, 3 = Bud diameter at flower opening (mm), 4 = Flower diameter (mm), 5 = Sepal length (mm), 6 = Sepal breadth (mm), 7 = Petal length (mm), 8 = Petal breadth (mm), 9 = Filament length (mm), 10 = Anther length (mm), 11 = Anther breadth (mm), 12 = Stamen length (mm), 13 = Pistil length (mm), 14 = Pollen viability (%), 15 = Pollen germination (%), 16 = Pollen diameter (micron).

r = 0.541 and 0.641 at 5 and 1 percent, respectively. *Significant at 5 % level, ** Significant at 1 % level.

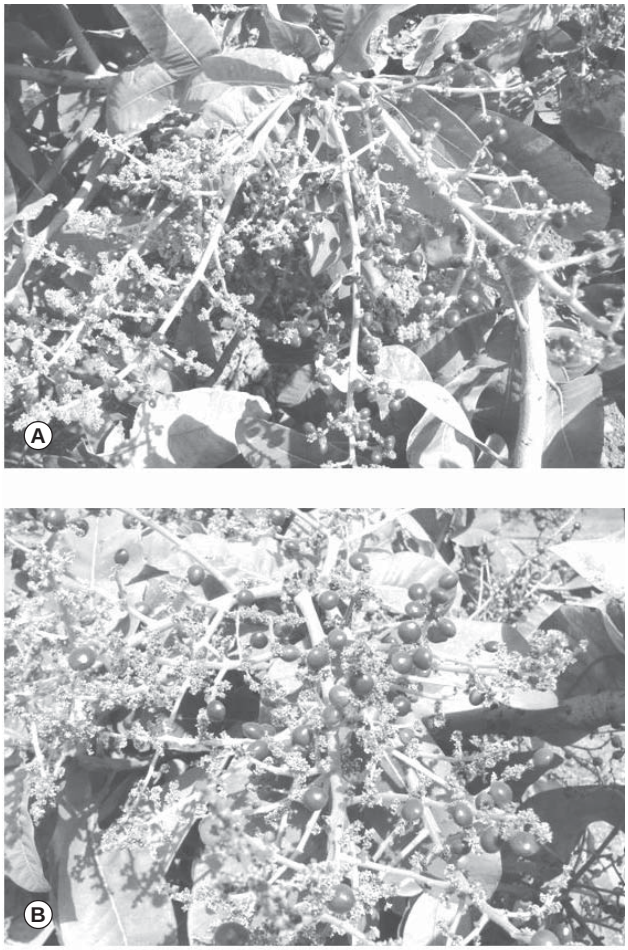

Fig. 1. Fruit set patterns in Chironji (a) CPT-1, and (b) CPT-2.

selecting elite genotypes. Machewade *et al.* (6) surveyed the *chironji* growing areas of Maharashtra and studied correlation and path analysis, and concluded that there was highest significant positive association of number of panicles and total number of fruits per tree with fruit weight.

With respect to different traits studied on these genotypes, CPT 1, CPT 2, CPT 3, CPT 5, CPT 6, CPT 7, CPT 8 and CPT 12 were found to be promising on the basis of desired horticultural characters. Selection of desirable plant types is the first essential step and it opens new ground for developing high yielding stable genotypes. Soft wood grafted plants of promising genotypes have been planted in the field for their further evaluation.

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