

## Reproductive Phenology of *Sida cordifolia* L.

Dushyant K. Singh<sup>1</sup>, Showkat A. Ganie\*<sup>2</sup>, Gurpreet Singh<sup>1</sup>, Rajneesh K. Agnihotri<sup>1</sup> and Rajendra Sharma<sup>1</sup>

<sup>1</sup>Department of Botany, School of Life Sciences, Dr. B. R. Ambedkar University, Agra, India

<sup>2</sup>Department of Botany, Maharshi Dayanand University, Rohtak, Haryana, India

Correspondence: [shahidshowkat90@gmail.com](mailto:shahidshowkat90@gmail.com)

(Received: 17/02/15)

(Accepted: 11/03/15)

### ABSTRACT

*Sida cordifolia* commonly known as Indian ephedra belongs to family Malvaceae. The present paper highlights the important phenological events, associated with the reproductive success of *S. cordifolia*. The leaf fall and renewal occurs throughout the year with maximum leaf fall in the month of December, January and April-June and minimum in the month of February to March and August to September. Maximum leaf renewal was observed during the month of February to March and July to August and Minimum in the month of May to June and September to January. Flowering was observed throughout the year with maximum flowering in the month of February to April (11.8-38.3 °C) and August to September (24.4-33.9 °C) and minimum in the month of October to November and May to June. Anthesis occurs at noon during summers and in the afternoon during winters and fully open 7-10 days after the bud initiation. Number of ovules/ovary was 13 and pollen ovule: ratio 190:1 in the month of March. The unicellular and tetra radiate trichomes were found on the leaves and ovary surface. The maximum fruiting was observed in the month of November to December and March to May and fruit-set percentage was 64% recorded in the month of March. The fruits were 0.75cm in diameter. The number of seeds/fruit was 13. Fruit formation and maturation occur simultaneously and dispersal of seeds occurs accordingly. Seed matures 7-12 days after closure of flower. The seed-set percentage was 70.5%. The present study may provide the necessary information for the better cultivation and conservation of *S. cordifolia*.

**Keywords:** Conservation, floral biology, phenology, reproductive biology, *S. cordifolia*

### INTRODUCTION

Phenology is generally described as an art of observing the phase of life cycle or the activities of organisms occurring throughout the year [1]. These studies permit to construct a calendar for the growth activity of the plants especially the period of initiation of new leaf buds, appearance of mature leaves, flower bud initiation and formation of mature flowers, young fruit formation /fruiting and seed maturity for fast vegetative growth and high reproductive output for consumers within a short period of time.

Flowering and fruiting are important stages of the life history of plants, with both ecological and evolutionary consequences [2,3]. The seasonal timing of flowering and fruiting, i.e. the reproductive phenology of plants, is directly associated with resource availability to animals and consequently has effects on herbivory, pollination and seed dispersal [4-6]. For these reasons, phenological synchronization among individuals of a population is directly related to the reproductive success of the species [3].

Although phenology is a valuable scientific and economic knowledge, researches on this field especially of medicinal plants are scarce. However, some reports have been made on the investigation of the level of active principles for effective treatment during each phenophase associated with each seasonal climate [7,8].

*Sida cordifolia* L. belongs to family malvaceae, commonly known as “Indian ephedra” because of the presence of alkaloid ephedrin. In Hindi it is known as “vatya” and in English it is known as “country mallow”. It is native of tropical and subtropical part of Africa, Australia, China, Nepal, Srilanka, Bhutan and Pakistan. The whole plant of *Sida cordifolia* L. is of great medicinal value. It is used in the treatment of bronchial asthma, cold, flu, chills, headache, cough and sneezing [9], weight loose [10], bleeding piles and urinary diseases. In condition of sexual weakness, the milk of extract of *S. cordifolia* L. root is recommended as an effective remedy for sperm mobility and low sperm count disorders. Keeping in view the importance of this plant species present investigation has been undertaken to study reproductive phenology of *S. cordifolia* for its better cultivation and conservation.

## MATERIALS AND METHODS

*Sida cordifolia* L. growing at botanical garden Khandari campus, Dr. B. R. Ambedkar University, Agra (India) and its nearby area was studied for reproductive phenology. Ten plants were marked for phenological observations. Flowering phenology was studied periodically by counting the number of flowers on marked plants throughout the flowering period. 25 flowers/plant and 25 fruits/plant were sampled to record the floral density, floral morphology, seed morphology, pollen viability, and fruit-set percentage. The length of flower, bud, calyx, corolla, stamen, fruit, seed and pistil was measured on graph paper. Number of pollen/flower and number of ovule/ovary were studied by various methods [11]. Pollen size was measured by ocular micrometer under light microscope [12]. Data on daily maximum and minimum temperature during the entire flowering period was collected from department of Environmental Sciences, Dr. B. R. Ambedkar University, Agra. The morphology of different floral parts was studied by scanning electron microscopy (SEM), carried out at department of Anatomy, All India Institute of Medical Sciences (AIIMS), New Delhi (India).

### Statistical analysis

Data were expressed as mean  $\pm$  standard deviation of ten independent samples.

## RESULTS AND DISCUSSION

*S. cordifolia* L. is a small perennial herb usually 20 cm to 1m in height. Stem was herbaceous, cylindrical, branched, solid, hairy and brown and green in colour. Leaves were simple, alternate and heart shaped 2-7 cm long (Fig. 1A). The leaf fall and renewal occur throughout the year. Maximum leaf fall was observed during the December-January, April, May and June, while the minimum leaf fall was seen in February-March and August-September. The maximum leaf renewal was observed during February-March and July-August, while the minimum leaf renewal occurred in September-January, May and June.

### Flowering phenology

Flowering was observed throughout the year with Maximum flowering recorded in the month of February-April and August-September. Minimum flowering was observed in the month of October-November and May-June. The flower opens 7-10 days after the bud initiation. Fruit formation and fruit maturation occurred throughout the year but maximum fruiting was observed in the months of November-December and March-May. Similar results were also observed by Kumar *et al.* [13] in *Abutilon indicum*.

### Floral Biology

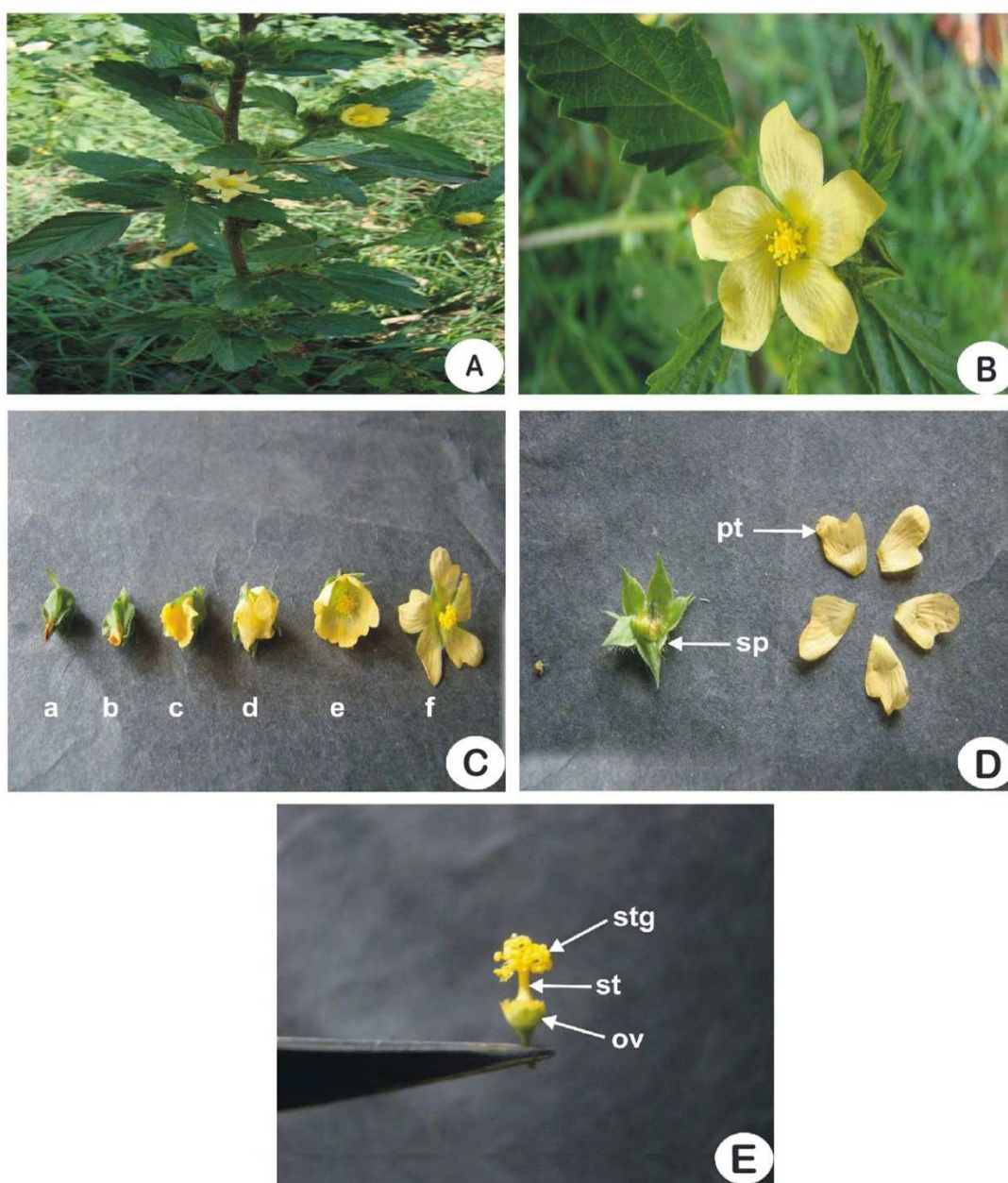
The findings on various floral parts are presented in Table 1 and 2. Flowers were small in size (1.4cm) in diameter bright yellow, axillary solitary, trumped shaped, bracteate actinomorphic, pedicellate, bisexual, pentamerous, hypogynous and cyclic (Fig.1B). The flower opens 7-10 days after the bud initiation (Fig.1C). Calyx consists of 5 sepals (0.7 cm), gamosepalous, free at the tips, small, persistent, hairy and green with valvate aestivation (Fig. 1D). Corolla consists of 5 petals (0.93cm). They were polypetalous but slightly connate at the base and adnate to staminal tube, bright yellow with twisted aestivation (Fig.1D). Stamens were (0.39cm), indefinite, yellowish in colour. Anthers were monotheous, basifixed, extrose with longitudinal dehiscence. Pistil was yellowish green (0.84 cm), differentiated into stigma, style and ovary (Fig.1E). Ovary was superior, multicarpellary, syncarpous, multilocular, one ovule in each locule with axile placentation. Unicellular trichomes were present on the outer surface of the ovary. Style single, medium, solid, yellowish green passes through staminal tube. Stigma capitate, wet, papillate and green in colour. Similar results have also been reported by Kumar *et al.* [13] in *Abutilon indicum*, Rana & Chauhan [14] in *Jacaranda mimosifolia*, sharma & Rana [15] in *Duranta repens* L. Fruit was schizocarp, capsule, and circular in shape consisting of 12-14 hairy mericarps (Fig. 2A). Seed matures 7-12 days after closure of flower (Fig. 2B). The unripe fruits were green and ripe fruit were dark brown in colour (Fig. 2C, D). The fruits were (0.75 cm) in diameter (Fig.2D). There was single kidney shaped, non-endospermic seed in each mericarp and 13 seeds/fruit (Fig.2E). The diameter of fruit was  $0.75 \pm 0.05$  cm and the weight of 10 fruits was  $0.35 \pm 0.02$  gm. The immature

seeds were greenish, while mature seeds were dark brown in colour. The seed-set percentage was 70.5%. Similar results have also been reported by Kumar *et al.* [13] in *Abutilon indicum*.

**Table 1: Showing dimensions of various floral parts of *S. cordifolia* L.**

S. No.	Parameters	Observations (cm)
1.	Length of bud	
	(a) Small	0.66 ± 0.05
	(b) Medium	0.8 ± 1.17
	(c) Large	1.03 ± 0.08
2.	Mature flower length	1.4 ± 0.13
3.	Calyx	0.7 ± 0.10
4.	Corolla	0.93 ± 0.07
5.	Length of stamen	0.39 ± 0.48
6.	Length of pistil	0.84 ± 0.11
7.	Length of staminal column	0.51 ± 0.05
8.	Pollen size (µm)	60 µm

±: Standard deviation



**Fig. 1: Floral morphology and flower maturation in *S. cordifolia***

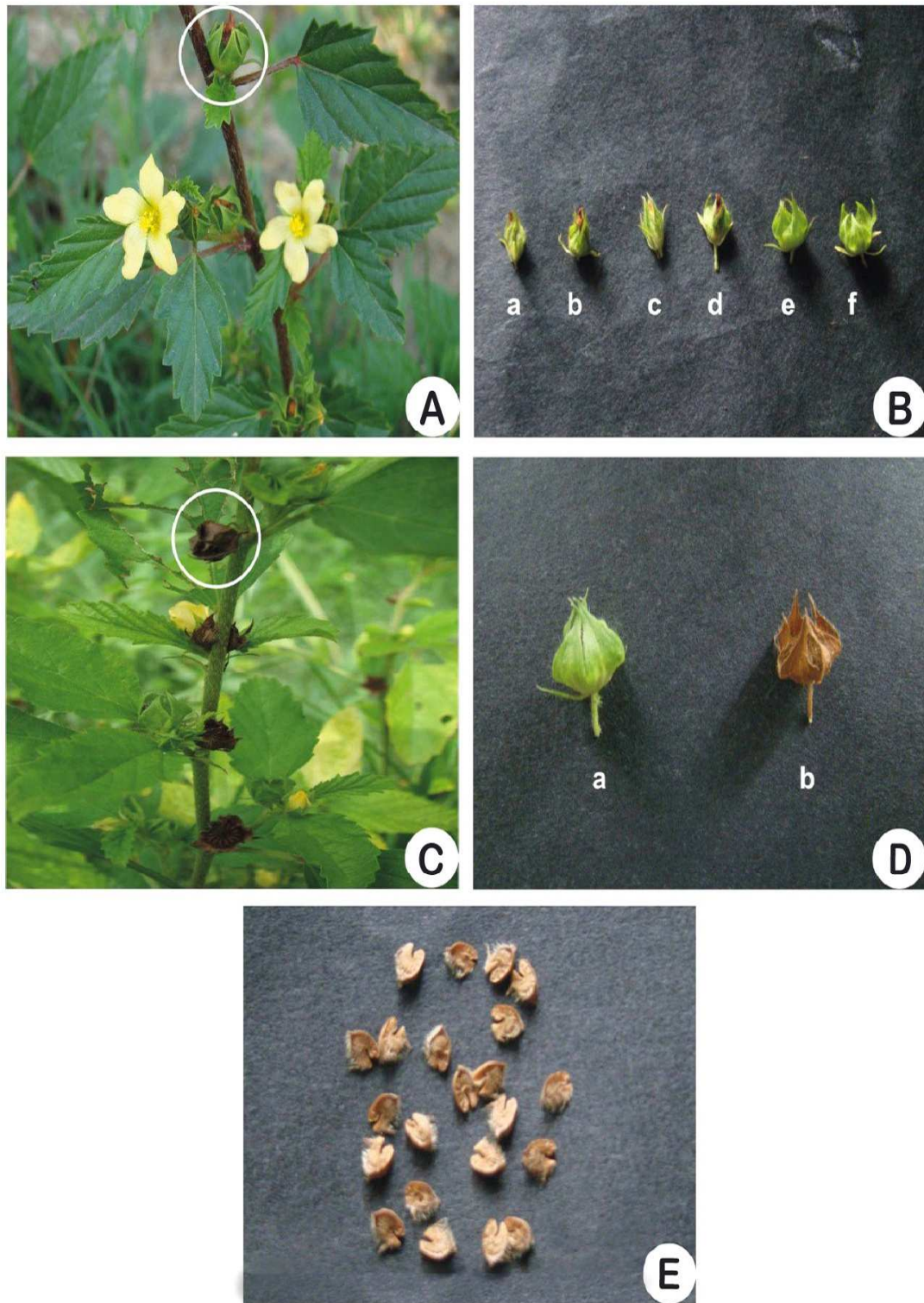


Fig. 2: Stages of fruit development and seed maturation in *S. cordifolia*.

#### Pollen biology

The pollen grains were spiny, spherical, 3-colporate and 60  $\mu\text{m}$  in diameter. Present observations are in agreement with that of Kumar *et al.* [13] in *Abutilon indicum*. The maximum number of pollen/anther was 190 and pollen/flower was 11400 in the month of March. The number of ovules per ovary was 13 and pollen/ovule: ratio was 190: 1 (Table 2). This is in accordance with the results reported by Rana and Chauhan [14] in *Jacaranda mimosifolia*, Sharma & Rana [15] in *Duranta repens*, Ahmad *et al.* [16] in *Tribulus terrestris*.

**Table 2: Floral biology of *S. cordifolia* L.**

S. No.	Parameters	Observations
1	Time of anthesis	1410 – 1500 h (October) 1320 – 1400 h (June)
2	Time of anther dehiscence	1440 – 1450h (October) 1400 – 1430 h (June)
3	Time of Stigma receptivity	1410 – 1500 h (October) 1320 – 1400 h (June)
4	Number of Pollens per anther	190 ± 3.33
5	Number of Pollens per flower	11400 ± 23.57
6	Number of ovules per ovary	13
7	Pollen ovules ratio	
	March	190:1
	June	90 : 1

**Fruit and seed-set**

The maximum fruit-set was 70-90% in the month of February and March (11.8-27.4°C), while the minimum fruit-set was (45–55%) in the month of October -November (18.9-35.0°C) and May-June (26-42.3 °C) (Table 3). Similar results have also been reported by Kumar *et al.* [13] in *Abutilon indicum*. The number of seeds per fruit was 12 and the seed-set percentage was 70.5% (Table 4).

**Table 3: Fruit morphology and fruit set percentage of *S. cordifolia* L.**

S. No.	Parameters	Observations
1.	Fruit/inflorescence	01
2.	Fruit-set percentage	45-90%
	(a) Maximum	70-90% (Feb, March)
	(b) Minimum	45-55% (October – November and May- June)
3.	Fruit type	Capsule
4.	Fruit shape	Circular
5.	Fruit Colour	
	(a) Unripe	Green
	(b) Ripe	Dark Brown
6.	Diameter of fruit (cm)	0.75 ± 0.05
7.	Weight of 10 fruits (gm)	0.35 ± 0.02

**Table 4: Seed morphology and seed-set percentage of *S. cordifolia* L.**

S. No.	Parameters	Observations
1	Number of seeds/fruit	12.0 ± 1.0
2	Seed-set percentage	70.5 ± 24.6
3	Seed shape	Kidney shaped
4.	Seed size (cm)	0.3±0.16 length, 0.2 ± 9.2 width
5.	Seed colour	Dark brown.
6.	Weight of 100 seeds (gm)	0.22 ± 0.004

**CONCLUSION**

The findings on the present study reveal that February and March is the best time for the plant to set fruits, when the temperature generally ranges from 11-27 °C. February-April and August-September is the optimum blooming time for the plant species. The different phenological characters vary considerably with the temperature. The present study could aid in the better cultivation and conservation of this important medicinal plant species.

**REFERENCES**

- [1] H Leith. Phenology in productivity studies In: David E Reichle (Ed.) Chapman and Hall Ltd. London Springer Verlag Berlin-Heidelberg, New York, **1973**, 29-46.
- [2] B Rathake and E P Lacey. *Annual Review of Ecology and Systematics*, **1985** 16: 179-214.
- [3] S Sakai. *Population Ecology*, **2001** 43: 77-88.
- [4] S A R Mduma, A R E Sinclav and R Turkington. *Journal of Ecology*, **2007** 85: 184-196.
- [5] P R Stevenson, M C Castellanos and A L Cortes. *Biotropica*, **2009** 40: 559-567.
- [6] C P Van Schaik, J W Terborgh and S J Wright. *Annual Review of Ecology and Systematics*, **1993** 24: 353-377.
- [7] F O Santos, A J Moreira, E M Franzotti, A R Antonniolli and R H V Mourao. Anti-inflammatory activity and acute toxicity studies from the brute aqueous extract of *Kalanchoe brasiliensis*. In: Reuniao Annual da Federacao da Sociedade de Biologia Experimental Caxambu, MG, **1998**, 103.

- [8] F M Maria, B O Ricardo and P A Sandra. *BMC pharmacology*, **2002** 2: 1–12.
- [9] S Pole. *Ayurvedic medicine*. Elsevier Health Sciences, **2006**, 137.
- [10] C I F Franco and R A Marias Almeida. *Journal of Ethnopharmacology*, **2005** 98: 275-279.
- [11] C A Kearns and D W Inouye. University Press of Colorado, Niwot. Colorado, 1993.
- [12] M J Mckone and C J Webb. *Australian Journal of Botany*, **1988** 36(3): 331-337.
- [13] P Kumar, S Chauhan and A Rana. *International Journal of Plant Reproductive Biology*, **2011** 3(1): 1-8.
- [14] A Rana and C Chauhan. *International Journal of Plant Reproductive Biology*, **2012** 4(1): 79-84.
- [15] D Sharma and A Rana. *International Journal of Plant Reproductive Biology*, **2009** 1(1): 5-9.
- [16] Ahmad S, A Rana, R Sharma and S Dar. *Agricultural and Biological Research*, **2011** 27(2): 140-145.