Indian J. Applied & Pure Bio. Vol. 38(2), 612-617 (2023). **ISSN: 0970-2091**
A web of Science Journal

Phenology of Primary and Secondary Host Plant Species of Muga Silkworm (*Antheraea assamensis*)

Abdul Jalil[1], Bedabati Dasgupta[2], Azizur Rahman[3] and S.I. Bhuyan[4]

[1]Department of Botany, Hatsingimari College, Hatsingimari-783135 (India)
[2]Department of Botany, University of Science and Technology, Meghalaya-793101 (India)
[3]Department of Sericulture, Government of Assam, Guwahati-781022 (India)
[4*]Department of Botany, Pandit Deendayal Upadhyaya Adarsha Mahavidalaya, Behali-784184 (India)
*Corresponding Author: safibhuyan@gmail.com

Abstract

A phenological study was carried out on primary *Persea bombycina* (Som) & *Litsea monopetela* Roxb. (Soalu) and secondary *Litseasa salicifolia* Hook. (Dighloti) & *Litsea cubeba* Lour. (Mejankori) host plant species of muga silkworm *Antheraea assamensis* in different states of North Eastern India taking monthly observations on tree height, tree girth, canopy, lowermost branch height of 5 years old tree and leaf parameters, shoots parameters, leaf initiation, leaf falling, flowering and fruiting, seed germination etc. All the plants varied significantly on most of the shoot and leaf phenological parameters. The longest leaf life span was recorded for Som 358 ± 35days. The leaf initiation started in March-June, matured in July-August and leaf falling in December-January. Shoot elongation rate was also significantly different for host plant species. Flowering bud started in November and flowering stage was longer in Som (26 days)and shorter in Soalu (20 days). Fruiting appeared from fourth week of March to first week of June in Som. The fruit attained maturity at 15 to 20 days after fruit set. The flower drop in inflorescence was 93.52% and only 6.48% of flowers set in to fruits on Som. Seed germination of Som is 25% and May- July is the seed sowing season.

Key words : Phenology, Som, Soalu, Dighloti, Mejankori.

The North Eastern Region of India which is one of the twenty five biodiversity hotspots of the world and also one of the ten distinct bio-geographical zones of India. Muga silkworm *Antheraea assamensis* is an endemic multivoltine polyphagous insect and feeds on wide range of food plant species. The leaf protein of the food plants is the source for the silkworm to bio-synthesis the silk which is made up two proteins fibroin and sericin.

Plant phenology influences the abundance of the caterpillars. The caterpillars act as true ecosystem that modifies the host plant architecture and accordingly, the diversity of species linked with the plant increases[7]. Different ecosystem processes such as biomass production, plant growth pattern *etc*.

are mostly affected by the Phenological characters. Phenological studies are important to understand ecosystem processes such as plant growth pattern, biomass production[5,12]. Lack of knowledge of phenology may cause a biological threat to a plant population[13]. Phenological differences between host plants can develop temporal separation among host-linked populations of insects and their life cycles strongly attached to plant phenology[15]. Phenological synchrony is particularly critical to leaf feeders, as the availability and suitability of newly developing foliage strongly influence their success[6]. Plant phenology influences the abundance of the caterpillars. The caterpillars act as true ecosystem that modifies the host plant architecture and, accordingly, the diversity of species linked with the plant increases[8]. As a result, it demands to investigate the effects of insect population source, elevated temperatures, and overwintering regime on the basis of phenological synchrony between insect such as silkworm egg hatch and host plant budbreak[15].

The phenological observations of the primary *Persea bombycina* Kost (Som) & *Litsea monopetela* Roxb.(Soalu) and secondary *Litsea salicifolia* Hook. (Dighloti) & *Litsea cubeba* Lour. (Mejankori) host plant species of muga silkworm *Antheraea assamensis* were carried out in Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, West Bengal 90-97° East longitude and 22-29° North latitude. Phenological changes such as tree height, tree girth, canopy, shoot extension, leaf initiation, leaf expansion, leaf maturation, leaf fall, flowering, fruiting, germination of Som, Soalu, Dighloti and Mejankori grow in plantations and natural habitat were observed and recorded by weekly/monthly intervals following the methods suggested from 1st July 2010 to 30th June 2014[9,10,11].

Statistical Analysis : All the data collected was analysed in Microsoft excel 2007 and was represented as Mean ± SD. The statistical analysis of the data was done using one way ANOVA and $P<0.05$ was considered as significant.

The phenological observations (tables 1-7) on the primary (*Persea bombycina* Kost (Som) & *Litsea monopetela* Roxb. (Soalu) and secondary *Litsea salicifolia* Hook. (Dighloti) & *Litsea cubeba* Lour. (Mejankori) host plant species of muga silkworm show interesting results. The highest tree height was recorded 5.600±0.063m in Som and lowest 3.017±1.246m in Mejankori; the maximum tree girth 0.45±0.003m and canopy 3.97±0.099 in Soalu and minimum girth 0.12±0.008m and canopy 2.53±0.02 in Dighloti (Table-1).

Table 1. General phenological characters of primary and secondary food plant species of muga silkworm

Name of the host plant species	Vernacular name	Family	Mean values of tree height (m) of 5 years	Mean values of tree girth (m) of 5 years	Mean values of tree canopy (m) of 5 years
P. bombycina Kost	Som	Lauraceae	5.600±0.063	0.43±0.002	3.850 ±0.018
L. monopetela Roxb	Soalu	Lauraceae	4.859±0.097	0.45±0.003	3.97±0.099
L. salicifolia Hook	Digloti	Lauraceae	3.257 ±0.751	0.12±0.008	2.53±0.02
L. cubeba Lour.	Mejankori	Lauraceae	3.017±1.246	0.156±0.98	2.682±1.135

The highest lamina length 19.31±3.063c.m. in Dighloti, lowest 11.43±2.541c.m. in Mejankori; Lamina width highest 6.891±0.680cm in Soalu lowest in 3.16±1.070cm; Apex length 0.796±0.105cm in Som lowest 1.27±0.700cm in Dighloti; Petiole length 1.680±0.278cm in Som lowest 0.90±0.200cm in Mejankori; leaf area 121 ± 11.200sqc.m., lowest 23.12±12.500 sqc.m. in Mejankori (Table-2).

Table-2. Leaf phenological parameters of primary and secondary food plant species of muga silkworm

Name plant	Leaf persistence and growth form	Lamina length (cm)	Lamina width (cm)	Apex length (cm)	Petiole length (cm)	Leaf area (sq cm)
Som	Evergreen	13.900±2.222	4.916±0.412	0.796±0.105	1.680±0.278	37.630±9.569
Soalu	Evergreen; sub-canopy	12.6±2.870	6.891±0.680	0.358±0.675	1.15±0.210	121 ± 11.200
Digloti	Evergreen	19.31±3.063	4.16±0.570	1.27±0.700	1.01±0.130	41.55±8.530
Mejankori	Evergreen; sub-canopy	11.43±2.541	3.16±1.070	2.28±0.660	0.90±0.200	23.12±12.500

The leaf initiation occurred during March–April when temperature increased steadily and became favorable for growth. Inter-specific variation in the leaf initiation period was greater for evergreen species Som and Dighloti (March–June) compared to the Soalu and Mejankori (March–April). Most of the species showed rapid leaf development during the first two months of leaf initiation, the leaf expansion rate in the first week was recorded highest in Som 1.37 ± 0.310cm^2 leaf^{-1} day^{-1} and lowest for Soalu0.263 ± 0.251cm^2 leaf^{-1} day^{-1}. The leaf expansion rate during the first week was greater in Som than Soalu. The leaf expansion periods for evergreen and semi green species were not significantly different (Table-3).

Leaf fall started during the autumn or in the beginning of winter season. Som and Dighloti retained their leaves of the first growing season until new leaf initiation in the next growing season and leaf fall in them started during next summer or during post monsoon. Soalu and Mejankori species became semi leafless during January–February. Production of leaves during the early, dry summer would seem, on energetic grounds, to be the worst possible time for leaf expansion[2].

Table-3. Leaf phenological parameters of primary and secondary food plant species of muga silkworm

Name plant	Leaf Initiation	Leaf of expansion rate (cm^2 leaf^{-1} day^{-1})	Full Expan-sion	Total leaf Expan-sion (%)	Leaf Matur-ation	Leaf fall Started	Mean annual Peak leaf fall (%)	Mean annual leaf fall rate (leaf no./ shoot/month)
Som	Mar–Jun	1.37 ± 0.310	May	89	Aug	Oct-Nov	Dec–Jan	3 ± 1.5
Soalu	Mar–Apr	0.401±0.354	May	86	July	Oct-Nov	Dec–Jan	4 ± 1.8
Digloti	Mar–Jun	0.462±0.413	May	75	Aug	Oct-Nov	Dec–Jan	4 ± 1.2
Mejankori	Mar–Apr	0.263 ± 0.251	May	71	July	Oct-Nov	Dec–Jan	4 ± 1.7

Leaf area per mature shoot is highest 1452±352 cm^2 in Soalu and lowest in Mejankari 254.32±367 cm^2. The leaf recruitment period (4 ± 0.2-4 ± 0.4 months), Leaf recruitment rate (3 ± 0.2-3 ± 0.5 new leaves/month) and leaf pool stable period (4 ± 0.2-5 ± 0.3 months) for all the species were not significantly different. The longest leaf life span was recorded for Som 358 ± 35 days and the lowest by 301 ± 21 days in Mejankori; Leaf fall rate higher in Mejankori (Table-4). Similar to the findings was observed in the present study the average leaf life span of evergreen species was longer[9,10,11]. Evergreen can minimize biomass loss through longer leaf life span and can photosynthesize for a longer period[4]. It also reported that the Himalaya retain the leaves of evergreen species during the long dry season, until formation of new leaves. It has been observed that leaf shedding in the evergreen species was generated by new shoot growth[2].

Table-4. Shoot phenological parameters of primary and secondary food plant species of muga silkworm

Name of the plant	Leaf area per mature shoot (cm^2)	Leaf recruitment period (months)	Leaf recruit-ment rate (new leaves/ month)	Leaf pool stable period (months)	Leaf life span (days)	Leaf fall rate (leaves per month per shoot)
Som	602.08±250	4 ± 0.3	4 ± 0.3	5 ± 0.3	358 ± 35(315–529)	1.7±0.4
Soalu	1452±352	4 ± 0.4	3 ± 0.5	4 ± 0.4	328 ± 32(212–509)	1.8 ± 0.4
Digloti	373.95±212	4 ± 0.2	3 ± 0.2	4 ± 0.6	338 ± 33(290–519)	1.7±0.3
Mejankori	254.32±367	4 ± 0.3	3 ± 0.4	4 ± 0.2	301 ± 21(201–463)	1.9±0.5

Annual shoot elongation 15±3cm in Soalu and 8±2 cm in Dighloti, average shoot diameter gain were not significantly different between the two groups. The shoot diameter increment rate was greater for Soalu (Table-5). Present findings are in conformity that reported that initiation of leaf fall coincides with the onset of the post-monsoon low temperature dry period and can be a mechanism for maintaining turgidity of shoots[13]. It also reported leaf fall during cool and dry winter months[14]. It has been found that the leaf fall during the dry season was directly influenced by the decline in soil moisture and increasing water stress conditions[1].

Table-5. Shoot phenological parameters of primary and secondary food plant species of muga silkworm

Host plant	Mean annual shoot elongation (cm)	Mean annual shoot diameter gain (cm shoot-1)	Shoot elongation rate (cm day-1 shoot-1)	Shoot diameter increment rate (mm day-1 shoot-1)
Som	15 ±2	0.95±0.27	0.07±0.02	0.007±0.001
Soalu	16±3	1.0± 0.28	0.09 ± 0.01	0.008 ± 0.001
Digloti	8±2	0.71±0.25	0.03±0.01	0.004±0.001
Mejankori	9±3	0.85±0.16	0.04±0.01	0.006±0.001

The changes in the leaf pool size during the study period were strongly correlated with climate for the semi green species. In terms of leaf pool size, the maximum leaf population per mature shoot was recorded for Som (16 leaves per shoot) and minimum was recorded for Dighloti. On a fully elongated shoot the leaf numbers per shoot were greater in Som. The density of leaves on the shoot (number of leaves per 10 cm shoot length) of Soalu was higher than Dighloti. The average leaf area per mature shoot was also greater for Soalu than for Dighloti (Table-6). It also reported that the density of leaves on shoot (leaves/10 cm shoot length) was higher for evergreen species than that of deciduous species (average 15.0 and 4.7, leaves, respectively[9].

Table-6. Shoot phenological parameters of primary and secondary food plant species of muga silkworm

Host plant	Leaf pool size per mature shoot (leaves	Leaf expansion period (days) per shoot)	Leaf expansion rate (cm^2 day^{-1} $leaf^{-1}$) in the first week of leaf Expansion	Relative Leaf expansion rate (cm^2 day^{-1} $leaf^{-1}$)	Leaf density
Som	16±3	39 ± 2 (28–49)	0.8 ± 0.3 (0.1–4.5)	2.0 ± 0.8 (0.4–10)	10 ± 0.4
Soalu	14±2	36±3 (30-50)	0.9±0.4 (0.1-4.4)	2.8 ± 0.7 (0.5–10)	9 ± 0.5
Digloti	9±3	38±3 (29-48)	0.8±0.2 (0.1-4.2)	2.1 ± 0.6 (0.4–8)	6 ± 0.4
Mejankori	11±2	37±3 (29-49)	0.6±0.5 (0.1-4.1)	1.8 ± 0.6 (0.4–8)	7 ± 0.6

Flowering bud started from 4th November and last up to 1st week of February, flowering started from January and last to May, the fruiting time in March- June, fruiting duration 3-4 months, fruits in cluster 10.2±1.549 Nos. Wt of fresh fruit 0.415±0.004 gm of Som and the fruiting time Soalu, Dighloti and Mejankori in May to July. Higher germination found in Som and lowest in Mejankari. The seed sowing season of Som is May-June and Soalu, Dighloti and Mejankori in June to July.

Table-7. Flowering phenological parameters of primary and secondary food plant species of muga silkworm

Host plants	Flowering	Flowering period (days)	Fruiting time	Fruiting Duration (m)	Fruits in cluster No	Wt of fresh fruit gm	Germination (%)	Sowing Season (m)
Som	Jan- Mar	26	Mar-Jun	3-4	10.2±1.549	0.415±0.004	25	May-Jun
Soalu	Mar-May	20	May-Jul	3	8±2	0.650±0.025	22	Jun-Jul
Digloti	Feb-May	24	May-Jul	3	3±2	0.721±0.057	20	Jun-Jul
Mejankori	Mar-May	23	May-Jul	3	2±1	0.396±0.014	15	Jun-Jul

(Jan –January, Feb- February, Mar- March, Apr. April, Jun-June, Jul-July, Aug—August, Sep—September, Oct—October, Nov-November, Dec-December)

From the economic point of view, it is difficult to maintain the plantations of food plants. So pruning will be very essential every year in the month of October-November whereby the full utilization of the host plant and increase the productivity of North Eastern India.

The authors are thankful to Sri Ramananda Phukan, ACS, Director of Sericulture and Government of Assam for providing permission for the study. We also thank to all the Directors of Sericulture and muga farmers of different states of North Eastern India for their helpful comments during the study.

References :

1. Devi A. F. and S. C. Garkoti (2012) Leaf Phenology of Some Important Forest Trees in Southern Assam in Glimpses of Forestry Research in the Indian Himalayan Region, BSMPS, pp. 75-81.
2. Devi A.F. and S.C. Garkoti (2013) Variation in evergreen and deciduous species leaf phenology in Assam, India, Trees, vol. *27*(4) 985–997.
3. Garkoti. S.C. and S.P. Singh (1995) *Journal of Vegetation Science, 6*(1): pp. 23-28 https://doi.org/10.2307/323625.
4. Hallik L., U. Niinemets, and I.J. Wright (2009) *New Phytol. 184:* pp. 257–274.
5. Jeffrey M. Diez, Inés Ibáñez, J. Abraham Rushing Miller, Mazer Susan J., Crimmins Theresa M., Crimmins Michael A., Bertelsen C. David, and Inouye David W. (2012) *Ecology Letters, 15:* 545–553.
6. Johnny A. Uelmen Jr., Lindroth Richard L., Tobin Patrick C., Reich Peter B., Schwartzberg Ezra G. and Raffa Kenneth F. (2016) *Forest Ecology and Management, 362:* 241–250.
7. Marcel, E. V. and P. Gienapp (2019) *Nature Ecology & Evolution, 3:* 879–885.
8. Mariana, V. and Claro Kleberdel, (2016) *Ecolo. Entomol, 41:* 421-430.
9. Negi G.C.S., and S.P. Singh (1992) *Int J Biometeorol., 36:* 233–242.
10. Ralhan P.K., R.K. Khanna, S.P. Singh, and J.S. Singh (1985a) *Vegetatio. 60:* 91–101.
11. Ralhan P.K., R.K. Khanna, S.P. Singh, and J.S. Singh (1985b) *Vegetatio, 63:* 113–120.
12. Richardson A.D., T.A. Black, P. Ciais, N. Delbart, M.A. Friedl, and N. Gobron (2010) *Phil Trans R Soc B Biol Sci. 365:* 3227.
13. Thomas E. Marler, Matananea Frankie C. and Terry L. Irene (2020) *Communicative & Integrative Biology, 13*(1): 74–83.
14. Yadav R.K., and A.S. Yadav (2008) *Trop Ecol. 49:* 25–34.
15. Zhang, L., G.R. Hood., J.R. Ott and S.P. Egan (2019) *Biol. Lett. 15:* 1-6, doi:dx.doi.org/10.1098/rsbl.2019.0572.