Comparative Phenological study of medicinal plants with special reference to *Solanum nigrum* L. and *S. myriacanthus* Dunal of Upper Assam, India

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**Abstract:** The aim of the present investigation is to study the comparative phenological pattern of *Solanum nigrum* L. and *S. myriacanthus* Dunal of Upper Assam. Three districts were selected from Upper Assam such as Sivasagar, Dibrugah and Lakhimpur. These study areas are floristically rich and tribal and non-tribal communities are fully dependent upon the medicinal plant resources utilized in different ways for treatment of various diseases/ailments. Phenological observation of *Solanum nigrum* L. and *S. myriacanthus* Dunal were carried out in three widely separated study sites. Phenological pattern of *Solanum nigrum* L. and *S. myriacanthus* Dunal were observed at least thrice in a month by visiting the respective field from the above mentioned study areas. The study reveals that phenology of *Solanum nigrum* L. and *S. myriacanthus* Dunal are varies among the different study sites. Therefore, the present study revealed that the vegetative and reproductive phenology of both these herbaceous species are adaptation to the surrounding abiotic and biotic environment.

**Keywords:** Phenology; Medicinal plants; *Solanum nigrum* L.; *S. myriacanthus* Dunal and Upper Assam.

**Introduction**

The life history of plant species involves seed germination, vegetative growth, flowering, fruit formation, seed maturation, leaf fall, seed dispersal and death. A study of the date and time of occurrence of these events is called phenology. Environmental factors influence the phenological events can be recorded diagrammatically monthwise and season wise and provide valuable information. Such a diagram is called a phenogram. Study of phenology is important from the point of view of the conservation of tree genetics resources and forestry management as well as better understanding of the ecological adaptations. The study of plant phenology provides knowledge about the pattern of plant growth and development as well as the effects of environment and selective pressures on flowering and fruiting behaviour (Zhang et al 2006). Climate changes forced deviations in the length of growing period and competition among species may changes the resources use patterns in different species (Singh & Kushwaha 2005).

Phenology on the other hand is the study of growth of buds, leaf flushing anthesis, fruiting and leaf fall in relation to seasons or years with climatic factors. It is the relationship of plant growth stages and calendar date. The calendar is based on the solar year. The information of phenology shows relationship of plant growth to seasonal changes and changes in length of daylight or photoperiod to programme their growth stages and biological activities appropriated with the seasonal condition (Manske 2006). The flowering and fruiting could be correlated with climatic conditions for offspring survival (Van schaik et al 1993). The fruiting occurred at beginning of rainy season which helps survival of seeds to the exposure to predators and provides maximum time to seedling for development of root system. It is now widely accepted that different biological interactions and phylogenetic relationships help in shaping the phenological patterns (Hamann 2004). Flowering time has...
been used as a reproductive characters in taxonomy keys and in classification (Devis and Heywood 1973).

In recent decades, the study of phenology has taken on a new legitimacy in the context of climate change research. Phenological changes in autumn and springtime events have been reported by several workers (Maak and Storch 1997, Kramer et al 2000) in many parts of the world, with linkages to an increase in temperature.

Assam is a state of North East India having rich biodiversity of herbal medicinal plant resources (Islam 2000). Most of the tribal and non tribal are fully dependent upon the medicinal plant resources for primary health care. Now a days, some important medicinal plants are going to depletion due to various factors such as increase human population, the biotic pressure on native forest is inevitable. In this context, conservation of biodiversity calls for reorientation of strategies where cultural tradition is also incorporated (Ramakrishnan 1998). For this purpose, phenological study of medicinal plant species is an important step which can help for understanding life pattern of the individual species.

Solanum nigrum L. and S. myriacanthus Dunal are also important expects of medicinal plant resources for primary health care. Certain authors have reported medicinal importance of both species for treatment of various diseases/ailments such as antioxidant activities, cough, liver problem, stomach-ache, skin diseases, inflammation, jaundice, toothache (Atanu et al 2011, Gogoi and Islam 2012, Srivastava and Nyishy community 2010). Solanum nigrum L. commonly known as Black nightshade is a dicot weed belonging to Solanaceae family. In Assamese, Solanum nigrum L. is known as Loskoshi. It is an annual herbaceous plant of 1-1.4 m tall with young parts, hirsute pilose or glandular hairy, stem hooked, leaves opposite, ovate, acute, sinuate or pinnatifid and prickly on both surface, petiole prickly, flowers white in sessile or sub-sessile few flowered lateral cymes, berry globose, yellow when ripe. It is frequent to common along roadsides, river bund, in waste places, infrequent to frequent in cultivated fields and in tea fields. A plant of Solanum nigrum L. and S. myriacanthus Dunal have shown in the fig 4 & 5.

Several workers have been worked on different phenological events from time to time from different parts of the world. Attempt was made by various workers (Sagreiya 1942, Beniwal 1987) to collect phenological data of the flora from various regions. Certain tropical forest on the basis of number of structural and functional features such as seasonality of flowering, pollination mechanism, evergreen or deciduous etc and emphasized the relevance of such features in characterizing the vegetation of even smaller areas (Loveless and Sprey 1957).

The need of studying flowering phenology at four levels; the single flower (which is the basic unit of all flowering processes) the individual plant (the unit upon which natural selection operates), the population and community (Primark 1985).

Some extensive reports are available on phenological studies of tropical tree species in forest ecosystems of Central Himalaya (Ralhan et al 1985, Sundriyal 1990) North-Eastern India (Boojh & Ramakrishnan 1981, Shukla and Ramakrishnan 1982, Kikim and Yadav 2001), Western Ghats (Bhat & Murali 2001).

Materials and methods

Study area

Upper Assam is a part of Upper Brahmaputra Valley with luxuriant growth with very rich herbaceous vegetation in North Eastern Region. Three districts were selected such as Sivasagar, Dibrugarh and Lakhimpur and the different localities are also selected from each district in Upper Assam.

Sivasagar district is located on 25.45° and 27.15 North latitude and 94.25° and 95.25° East longitude. It lies at an altitude of 86.6 meters and located at an elevation of 95 meters or 311 feet. It is bounded on East side by Dibrugarh district, on West side by Jorhat district, on North side by river Brahmaputra and on South side by Nagaland and Arunachal Pradesh. The climate of the area is warm humid type with maximum temperature 33°C in summer and minimum 8°C in winter. The soil is acidic in nature.

The Dibrugarh district extended from 27° 30’ to 27°42’ 30 ‘N latitude and 94°33´46´´ to 95°29.8´´ E longitude. It is bounded by the river Brahmaputra in the North, Dhemaji district on the North, Tinsukia district on the East, Tirap district of Arunachal Pradesh of South East and Sivasagar district on the North and South East. The maximum temperature 30.5°C in summer and minimum 8.2°C in winter. The soil is mainly alluvial, deposited by the river Brahmaputra and its tributes.

The Lakhimpur district lies between 26°48´ and 27°53´ Northern latitude and 93°42´ and 94°20´ East longitude. The district is bounded on the north by Arunachal Pradesh and on the East by Dhemaji district; Jorhat district stands on the South and Sonitpur district is on the West and covers an area of 2,977 sq.km. The climate of the area is humid in nature. The average temperature in summer season 28.45 °C and in winter season 17.33°C. The soil is sandy and acidic in nature.

Methods

The phenological survey was conducted during the year 2009-10 in different localities from districts of Upper Assam. The phenology of two medicinal plants Solanum nigrum L. and S. myriacanthus Dunal had been observed in three widely separated study sites. Phenological observation had been at least thrice in a month by visiting the respective field from the above mentioned study areas.

In Figure 1, a phenogram with different phenological stages were shown where number 1 indicate sprouting of buds in rhizomes or root-stock or germination of seeds; 2.Vegetative phase; 3.Flowering phase; 4. Fruiting phase; 5. Seed maturation; 6. dyeing or death of species and P-perrenation for phenological observation.

Results

The results of different phenological observation from emergence of seedlings to plant death are represented Table 1 and 2 and their phenogram presented in Figure 2 & 3. Solanum nigrum L. and S. myriacanthus Dunal are an annual herb found throughout the year and complete their life cycle in one year.

From the present findings, it is observed and recorded that germination percentage of Solanum nigrum L. is maximum from Sep-
tember to October in Sivasagar and Dibrugarh, and during September in Lakhimpur. On the other hand, percentage of germination of *S. myriacanthus* Dunal is maximum during May to June in Dibrugarh and Lakhimpur, and during June in Sivasagar.

The timing of vegetative growth as related to flowering depends to a great extent on the nature of buds (Kummerow1983). Active vegetative growth of *Solanum nigrum* L. occurs in October to November and June to August for *S. myriacanthus* Dunal in three different study sites. This may be to variation of nutrition in soil and suitable climatic condition in during this period.

**Table 1**: Phenological observation of *Solanum nigrum* L. from Districts of Upper Assam.

<table>
<thead>
<tr>
<th>Phases</th>
<th>Sl No</th>
<th>Phases</th>
<th>Study sites</th>
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<tr>
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<td></td>
<td>Sivasagar</td>
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<tr>
<td>Vegetative phases</td>
<td>1</td>
<td>Germination</td>
<td>Sept-Oct</td>
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<td>2</td>
<td>Active vegetative</td>
<td>Oct-Nov</td>
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<td></td>
<td></td>
<td>(a) Emergence of inflorescence</td>
<td>Nov-Dec</td>
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<tr>
<td></td>
<td>3</td>
<td>(b) Inflorescence of full bloom</td>
<td>Nov-May</td>
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<tr>
<td>Reproductive phases</td>
<td>4</td>
<td>(c) Mode of pollination</td>
<td>Entomophilous &amp; Anemophilous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) Fruit formation</td>
<td>April-May</td>
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<td>(b) Fruit maturation</td>
<td>May-June</td>
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<tr>
<td>Post Reproductive Phases</td>
<td>5</td>
<td>Dispersal of seeds</td>
<td>June-July</td>
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<td></td>
<td>6</td>
<td>Plant death</td>
<td>July-August</td>
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**Table 2**: Phenological observation of *S. myriacanthus* Dunal from Districts of Upper Assam.

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<thead>
<tr>
<th>Phases</th>
<th>Sl No</th>
<th>Phases</th>
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<td>(b) Inflorescence of full bloom</td>
<td>Entomophilous &amp; Anemophilous</td>
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<td>Reproductive phases</td>
<td>4</td>
<td>(c) Mode of pollination</td>
<td>Nov-Dec</td>
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<tr>
<td></td>
<td></td>
<td>(a) Fruit formation</td>
<td>Jan-Feb</td>
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<tr>
<td>Post Reproductive Phases</td>
<td>5</td>
<td>Dispersal of seeds</td>
<td>Feb-March</td>
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<td></td>
<td>6</td>
<td>Plant death</td>
<td>April-May</td>
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**Figure 2**: Phenogram of *Solanum nigrum* L. of different districts of Upper Assam.
The emergence of inflorescence of *Solanum nigrum* L. starts from November to December in Sivasagar, and during December to January in Dibrugarh and Lakhimpur. On the other hand for *S. myriacanthus* Dunal, the emergence of inflorescence was occurred from July to September in Lakhimpur and Dibrugarh and during July to August in Sivasagar.

The inflorescence are in full bloom in case of *Solanum nigrum* L. seen maximum from November to May in Sivasagar and during December to April in Dibrugarh and Lakhimpur but in case of *S. myriacanthus* Dunal, maximum flowering was observed in September to November in Sivasagar, and during October to December in Lakhimpur and Dibrugarh which may probably be due to certain ecophysiological factor.

The fruit formation of *Solanum nigrum* L. is found maximum from April to May in Sivasagar and Lakhimpur but May in Dibrugarh district. On the other hand for *S. myriacanthus* Dunal, fruit formation was occurred from the month of November to December in three different study sites.

It is observed from the present investigation that the fruit formation of *Solanum nigrum* L. and *S. myriacanthus* Dunal may be due to influenced of environmental conditions of different study sites which is also reported (Van Schaik et al 1993). On the other hand, fruiting duration is related to flowering time, fruit type is independent of flowering time, especially in species flowering during the dry part of the year.

The present investigation reveals that fruit maturation of *Solanum nigrum* L. takes place in May to June in three different study sites but for *S. myriacanthus* Dunal, it was occurred from Jan to February in Sivasagar, Dibrugarh and December to February in Lakhimpur. This may be due to the later part of rainy season and continued up to end of cool and dry winter period.

Dispersal of seeds of *Solanum nigrum* L. takes place from June to July as compared to *S. myriacanthus* Dunal which occurs from February to March of three different study sites. The dispersal of seeds of both species may be due to wind, rainfall, animal etc.

The death of plant species of *Solanum nigrum* L. occur during July to August in Sivasagar and Lakhimpur and August in Dibrugarh but for *S. myriacanthus* Dunal from March to April in Dibrugarh, Lakhimpur and April to May in Sivasagar. It may be due to completion of their life span in required period of time.

**Discussion**

The result of the present investigation suggest that there is a strong seasonal variation in phenology of *Solanum nigrum* L. and *S. myriacanthus* Dunal in their natural habitats. A correlation of phenological activity with seasonal events is best exemplified by patterns in leaf fall and leaf flushing (Frankie et al., 1974). The flowering of *Solanum nigrum* L. are maximum between November to May in Sivasagar and December to April in Dibrugarh and Lakhimpur. The flowering of *S. myriacanthus* Dunal was observed maximum from July to December in Lakhimpur whereas from July to...
November in Sivasagar and August to November in Dibrugarh. Flowering showed negative correlation with rainfall, such a seasonal activity could be attract pollinators. Reproductive events generally occur during the period of low photosynthetic activity or after the period of high rates of reserve accumulation (Fernner1998). Fruiting of both species occurs in cool and dry winter. The phenological timing of both species seems to set during the transition of winter and spring seasons so that summer rainfall facilitates recruitment of plants through germination. The study on phenology of Solanum nigrum L. and S. myriacanthus Dunal provides information about the growth and behaviour of Solanum nigrum L. and S. myriacanthus Dunal in different seasons of the experimental sites.

The variations of different phenophases are due to fluctuation of environmental condition, habitat and availability of the soil nutrients and adapt to the habitats accordingly with the adaphic factors observed in the present study. Phenological studies have been made by several authors like Srivastava (1982), Islam (1996) and others.

**Conclusion**

Phenology is one of the important phenomenon in the life cycle of the plant species. Germination of Solanum nigrum L. starts from September to October but for S. myriacanthus Dunal, germination starts from May to June. Active vegetative growth of Solanum nigrum L. occurs within October to November and for S. myriacanthus Dunal from June to August.

Emergence of inflorescence and full bloom appears in the month of November to May for Solanum nigrum L. as followed by July to December for S. myriacanthus Dunal. Fruit formation of Solanum nigrum L. are found within in the month of April to May as followed by the month of November to December for S. myriacanthus Dunal. Fruit maturation of Solanum nigrum L. were found from the month of May to June whereas it occurs from December to February for S. myriacanthus Dunal. Dispersal of seeds takes place for Solanum nigrum L. from June to July as followed by February to March for S. myriacanthus Dunal. Plant death of Solanum nigrum L. occur from the month of July to August whereas it was occurred from March to May for S. myriacanthus Dunal. The study concludes that there is a significant variation between phenological event of Solanum nigrum L. and S. myriacanthus Dunal in different experimental sites of Upper Assam due to the climatological and ecological factors.

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