www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(8): 1456-1459

www.thepharmajournal.com
Received: 07-06-2023
Accepted: 12-07-2023

Dharmendra Shah
Hemvati Nandan Bahuguna Garhwal University, A Central University, Srinagar, Garhwal, Uttarakhand, India

Shubham Chauhan
Hemvati Nandan Bahuguna Garhwal University, A Central University, Srinagar, Garhwal, Uttarakhand, India

Jitendra Singh
Hemvati Nandan Bahuguna Garhwal University, A Central University, Srinagar, Garhwal, Uttarakhand, India

Atul Negi
Hemvati Nandan Bahuguna Garhwal University, A Central University, Srinagar, Garhwal, Uttarakhand, India

Corresponding Author:
Dharmendra Shah
Hemvati Nandan Bahuguna Garhwal University, A Central University, Srinagar, Garhwal, Uttarakhand, India

Effect of aspect on reproductive phenophase of tree species in Narendranagar forest range, Uttarakhand

Dharmendra Shah, Shubham Chauhan, Jitendra Singh and Atul Negi

Abstract
The study was conducted to analyze species reproductive phenology and correlation between topographical aspect (East, West, North and Southern) in Garhwal Himalayan Region of Uttarakhand within same altitudinal range (700-900msl). 20 × 20 m quadrate were laid out for observation of the reproductive phenological events such as flowering initiation, open flower, fruit initiation and ripen fruit. In the study area dominated tree species was *Lannea coromandelica*, *Adina cardifolia*, *Acacia catechu* and *Anogeissus latifolia* are found almost all Aspect. Reproductive phenophases were monitored monthly for two season (winter and summer) and Statistical calculation Z-test, P-test, mean vector (μ) and length of mean vector (r) were carried out by using Oriana software, It may be concluded that the maximum flowering bud was found in Eastern aspect for *Lannea coromandalica* (7.822^0) and the maximum number of open flower were found in Northern Aspect for *Cassia fistula* (8.848^0). The maximum number of fruit initiation found in Eastern aspect for *Anogeissus latifolia* (20.919^0) and the mature fruits were found maximum in Northern aspect for *Adina cardifolia* (71.104^0).

Keywords: aspect, Reproductive phenology, Garhwal Himalaya.

Introduction
Phenology is the study of timing or periodicity of recurring biological events in plants, (Schimper 1903; Kolemeyer 1959) [12, 7]. Phenological behavior of the species differs from region to region and also among the genotype and phenotypic variants due to different climatic conditions. In tropical tree phenological behavior is determine by saturation of leafing, flowering and fruiting. Flowering activity partially of fully depend on leafing activity but phenology are not mutually independent in woody species (VanSchaik *et al*., 1993) [16]. There are many internal and external factor which lead to the phenological change in tree species. Rainfall variation is the main cause for the phenological change in tropical dry forest (Daubenmire 1972; Borchert 1994) [3, 2], soil water availability, Photoperiod (Borchert *et al*., 2004) [1] changes in temperature (William- Linera 1997) [17], seed dispersal (Snow 1965) [15]. Mountain forests make about 23% of the world's total forest cover (Price *et al*., 2011) [10], is the home of around 12% of the world's population, according to FAO (2002). As a result, it is important to sustainably manage and conserve mountain habitats and their distinctive biological diversity in order to ensure the livelihoods of mountain populations. Climate, terrain, aspect, slope inclination, soil type, and land use are some of the variables that determine the diversity, composition, and regeneration of forests. A variety of microclimates are created in varied landscapes as a result of differences in insulating period and intensity that vary with aspect (Holland and Steyn, 1975) [5]. According to a number of studies, even within the same height (Shank and Noorie, 1950) [13], variations between two contrasting aspects can be attributed to variations in the solar radiation received (Ghimire *et al*., 2010) [4]. Keeping in view the above importance of plant present investigation has been undertaken to find out effect in aspect variation in the reproductive phenophase of tree species. For its better cultivation and conservation.

2. Materials and methods
2.1 Study Area
Study area was located in between the Vyashi and Devpryag (30̊03' to 30˚10' north latitude

and 78˚ 30' to 78˚37' east longitude) (fig 1). The study area is usually undulating with an altitude ranging from 700 to 900 mean above sea level. Rainfall occurs through south-west monsoon from June to September and the average annual rainfall ranges from 956mm to 2449mm. The soil of the study area is dry, porous, faint yellow and consists of clay and organic matter (IEE Report, 2016) [6].

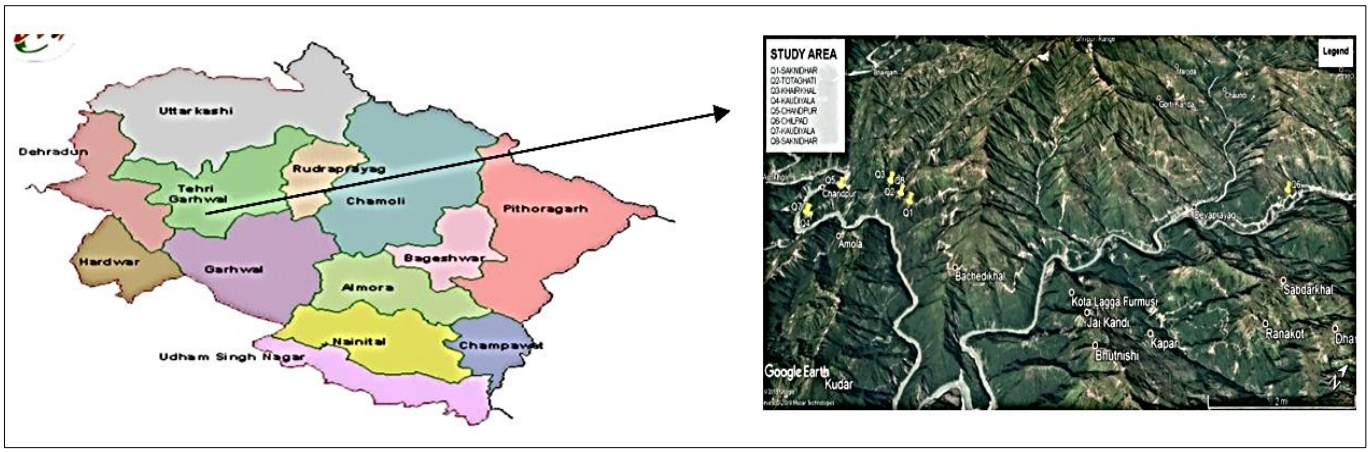


Fig 1: Map of Study Site

The climatic data of the study area were collected on each day of observation. The climatic data were taken during each observation with the help of the Forest Department, Narendranagar Range. The maximum temperature during the observation period was found in June at 33.5 °C, and the Minimum mean temperature was recorded in December 2018 and February at 12.5 °C. The maximum rainfall recorded during observation was 516 mm in July of 2019. (Fig. 2).

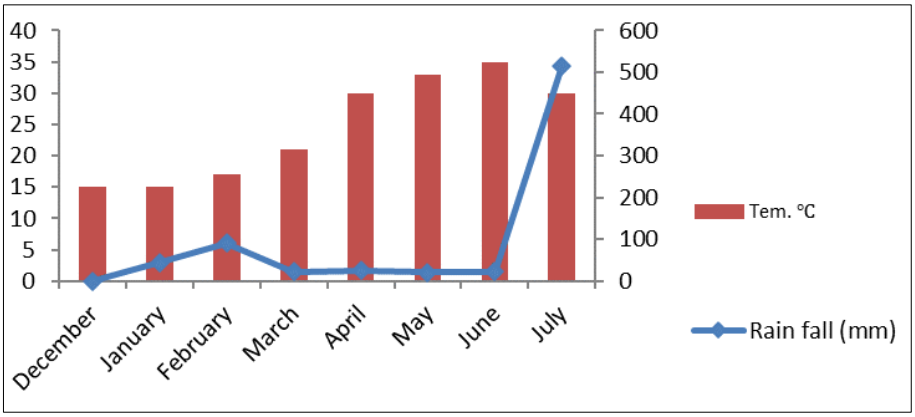


Fig 2: Meteroogical data

Data Analysis

Data were collected through random sampling method from different topographical aspects and selected the tree species which were common in different aspects. The selected species were observed monthly for flower initiation, open flower, fruit initiation and mature fruits. After that, for calculating the percentage of different reproductive phenological events, the statistical variables *viz*. Z-test, P-test, mean vector (μ) and length of mean vector (r) were calculated by using Oriana 4.02 software.

Sampling quadrate Aspect	Name of species
Eastern (Q1)	*Lannea coromandelica, Anogeissus latifolia, Adina cardifolia*
Eastern(Q2)	*Lannea coromandelica, Adina cardifolia, Mallotus phillipensis, Terminalia bellerica*
Northern(Q3)	*Lannea coromandelica, Adina cardifolia, Terminalia bellerica, Cassia fistula*
Southern(Q4)	*Lannea coromandelica, Anogeissus latifolia, Adina cardifolia, Acacia catechu*
Northern(Q5)	*Mallotus phillipensis, Acacia catechu*
Eastern(Q6)	*Adina cardifolia, Acacia catechu*
Southern(Q7)	*Lannea coromandelica, Anogeissus latifolia, Adina cardifolia, Acacia catechu, Cassia fistula*
Southern(Q8)	*Lannea coromandelica, Anogeissus latifolia*

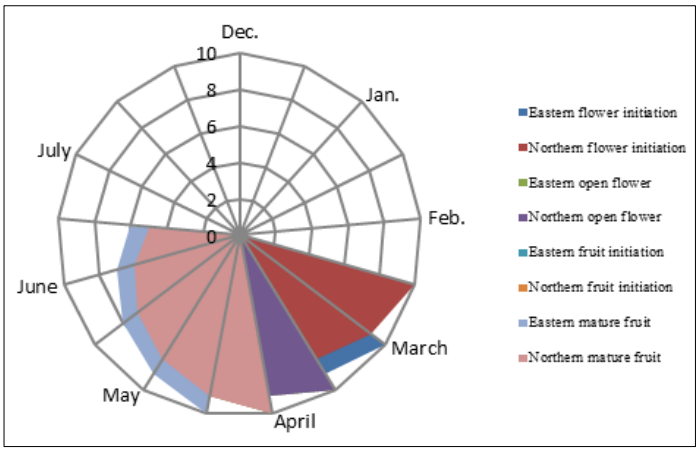
*List of species found in Different Aspect

Result and Discussion

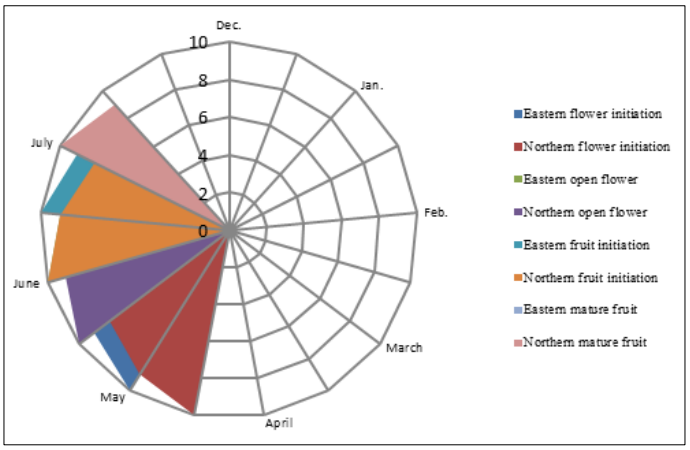
The maximum flowering bud was found in Eastern Aspect for *Lannea coromandelica (*7.822°) followed by *Mallotus philippensis* (7.335°),*Adina cardifoliya* (6.73°) respectively and minimum in *Terminalia belerica* (3.451°) followed by *Acacia catechu* (5.4°) respectively.

The maximum number of Open flower was found in Northern Aspect for *Cassia fistula (*8.848°) followed by *Lannea*

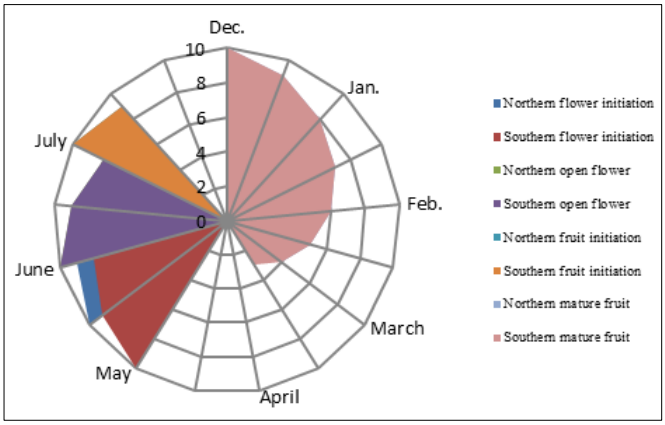
coromandelica (8.167°), *Terminalia belerica* (5.412°) respectively and minimum in *Mallotus philippensis* (3.144°) followed by *Acacia catechu* (4.16°) respectively.
The maximum number of Fruit initiation was found in Eastern Aspect for *Anogeissus latifolia* (20.919°) followed by *Terminalia belerica* (14.433°), respectively and minimum in *Lannea coromandelica* (5.451°) followed by *Mallotus philippensis* (5.532°) respectively.
The maximum number of Mature fruits was found in Northern Aspect for *Adina cardifoliya* (7.104°) followed by *Acacia catechu* (14.348°) and *Lannea coromandelica* (11.182°) respectively and minimum in *Cassia fistula* (0.047°) followed by *Mallotus philippensis* (4.357°) respectively.



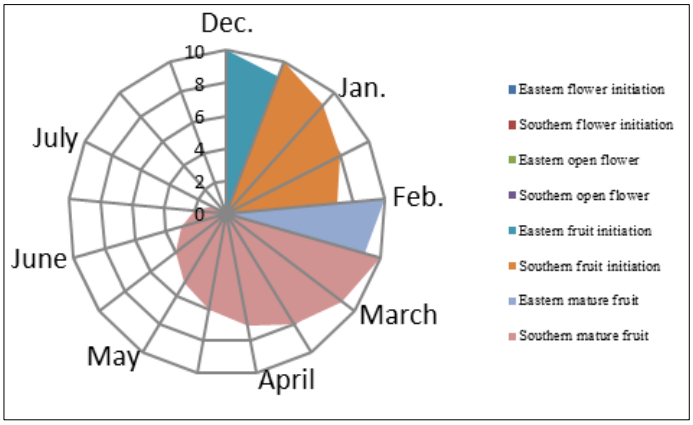
Mallotus phillipensis



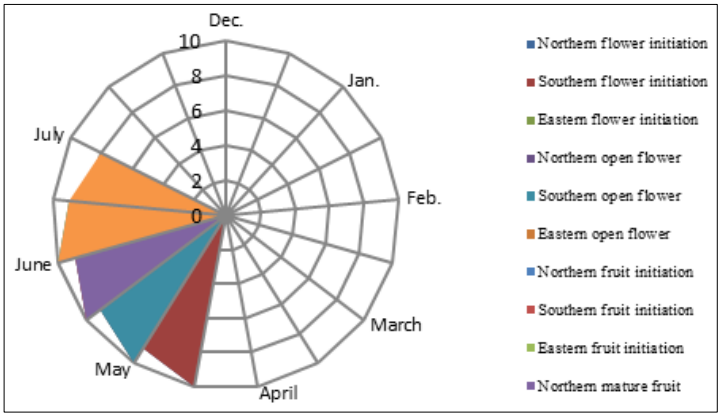
Terminalia bellerica



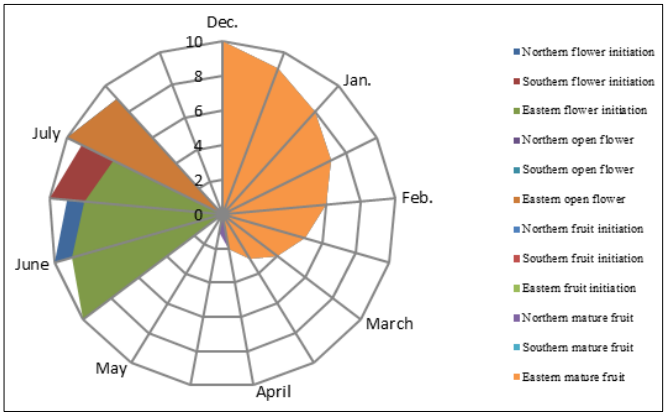
Cassia fistula



Anogeissus latifolia



Lannea coromandelica



Adina cordifolia

In the present investigation, it was observed that the maximum flowering occurs for *Lannea coromandelica* (7.822°) and *Cassia fistula* (8.848°) in the premonsoon, while the maximum fruiting occurs for *Mallotus philippensis* (5.532°) and *Terminalia belerica* (5.412°) in the monsoon season. The present study is supported by Nanda *et al.* (2014) [8], who conducted a phenological study on a tropical dry deciduous forest in southern India's Bhadra Wildlife Sanctuary and discovered that leafing and flowering activities take place in the summer or before monsoons, while fruiting patterns develop during monsoon to post-monsoon seasons. The seasonality of several phenophases shows that fruit fall, flower start, and leaf senescence all have significant seasonality. Later, a similar study conducted by Nanda *et al.*

(2016) [9] on the phenology of tree species in a Tropical evergreen forest concluded that the maximum flower bud initiation occurs during the winter season, the maximum fruit initiation occurs during the late summer season, and fruit maturity occurs in the winter season. The average flowering occurs in *Lannea coromandelica*, increasing with increasing length of the mean vector (0.984), which is significant to the other species because the distribution of species indicates the ability to grow in a wide range of habitats differs with environmental factors in *Rhododendron arboreum*, as supported by Singh *et al*. (2014) [14]. For all other species, the seasonality differs in aspect, which results in the timing of seasonality and biological responses to environmental changes demonstrated for plant communities shifted from one place to another (Ralhan *et al*., 1985) [11]. From the current study, it may be concluded that the maximum flowering bud was found in the eastern aspect of *Lannea coromandalica* (7.822^0) and the maximum number of open flowers were found in the northern aspect of *Cassia fistula* (8.848^0). The maximum number of fruit initiations was found in the eastern aspect for *Anogeissus latifolia* (20.9190), and the mature fruits were found at their maximum in the Northern aspect for *Adina cardifolia (*71.104^0). Thus, the changes in various Reproductive phenophases changed in different aspects for different species, which were partially affected by environmental factors such as temperature (ranges from 12.5^0 to 33.5 °C) and rainfall (9.40 mm).

References

1. Borchert R, Meyer SA, Felger RS, Porter-Bolland L. Environmental control of flowering periodicity in Costa Rican and Mexican tropical dry forests. Global Ecology and Biogeography. 2004 Sep;13(5):409-25.
2. Borchert R. Soil and stem water storage determine phenology and distribution of tropical dry forest trees. Ecology. 1994 Jul;75(5):1437-49.
3. Daubenmire R. Phenology and other characteristics of tropical semi-deciduous forest in north-western Costa Rica. The Journal of Ecology. 1972 Mar 1:147-70.
4. Ghimire B, Mainali KP, Lekhak HD, Chaudhary RP, Ghimeray AK. Regeneration of Pinus wallichiana AB Jackson in a trans-Himalayan dry valley of north-central Nepal. Himalayan Journal of Sciences. 2010;6(8):19-26.
5. Holland PG, Steyn DG. Vegetational Responses to Latitudinal Variations in Slope Angle and Aspect Journal of Biogeography. 1975;2:179-183.
6. IEE Report. Uttarakhand Emergency Assistance Project. Project Number: 47229-001. Redirected from internet. 2016; http://www.adb.org/projects/47229-001/main#project-documents
7. Koelmeyer KO. The periodicity of leaf change and flowering in the principle forest communities of Ceylon (Part 1). Ceylon forester. 1959;4:157-189
8. Nanda A. Krishnamurthy YL, Suresh HS. Phenology of a tropical dry deciduous forest of Bhadra wildlife sanctuary, Southern India. Centre for Ecological science, Indian institute of science, Banglore; c2014.
9. Nanda A, Krishnamurthy YL, Suresh HS. Phenology of tree species in a Tropical Evergreen Forest of Southern India. Journal of Global Ecology and Environment. 2016;6(1):1-12.
10. Price MF, Georg G, Lalisa AD. Thomas K. Daniel M and Rosalaura R. Mountain Forests in a Changing World: Realizing Values, Addressing Challenges; c2011.
11. Ralhan PK, Khanna RK, Singh SP, Singh JS. Phenological characteristics of the tree layer of Kumaun Himalayan forests Vegetatio, 1985, 91-101, 10.1007/BF00040351
12. Schimper AFW. Plant geography upon a physiological basis. (transl. form german). Clarendon press. Oxford, 1903, 839.
13. Shank RE, Noorie EN. Microclimate vegetation in a small valley in eastern Tennessee. Ecology. 1950;11:531-9
14. Singh N. Flowering phenology of tree Rhododendron arboreum along an elevation gradient in different sites of Kumaun Himalayas. International Journals of Science and Nature. 2014;5(3):572-576.
15. Snow DW. A possible selective factor in the evolution of fruiting seasons in tropical forest. Oikos. 1965;15:274-281.
16. VanSchaik CP, Terborgh JW, Wright JS. The phenology of tropical forests: Adaptive, significance and consequences for primary consumers. Annual Review of Ecology and Systematic. 1993;24:353-377.
17. Williams LG. Phenology of deciduous and broad leaf evergreen tree species in a Mexican tropical lower mountain forest. Global Ecology and Biogeography Letters. 1997;6:115-127.