

PHENOLOGICAL STUDIES OF FAMILY ZINGIBERACEAE WITH SPECIAL REFERENCE TO *ALPINIA* AND *ZINGIBER* FROM KOLHAPUR REGION (MS) INDIA

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ABSTRACT

The paper deals with phenology of 3 *Zingiber* species and 2 *Alpinia* species showing the variations in the life cycle, on rhizome sprouting to maturity, opening of flower bud to anthesis of flower, development of fruit to dehiscence are discussed. Data is very useful for knowing the phenological diversity within the two genera which are key factors for *in-situ* and *ex-situ* germplasm conservation. It is an important natural phenomenon with respect to the change in climate and physical environment. The genus *Alpinia* and *Zingiber* opening of flower is early in the morning. The natural life cycle ends in November when vegetative parts start drying. Number of flowers in genus *Zingiber* is 7-18 depending on different species. Flowering period is June to August and June to November is favourable season for development and seed production. The longevity of the flower of *Zingiber* is one day.

Key words: *Zingiber* and *Alpinia*, Phenology, Maharashtra, India

INTRODUCTION

Phenology is literally "the science of appearance." Seasonal and climatic changes are some of the non-living or abiotic components of the environment that impact the living or biotic components. Examples of springtime phenological events that interest scientists include flowering, leaf unfolding, insect emergence and bird, fish and mammal migration. The phenological studies are important for better understanding of ecological adaptations, interactions of individual species and also from the point of view of germplasm conservation (Stern and Roche 1974, Waser 1979, Thomson 1978). Observations are important and prerequisite for scientific multiplication and breeding. Phenological study is also useful for development programme as well as orchid industry and flower trade. Phenological data on forest trees have been made by various workers like Bisht *et al* 1986, Beniwal, 1987, Ganapathya and Rangorajan, 1964, Kaul and Raina, 1980, Navchoo and Kachroo, 1986, Ghate and Kumbhojkar 1991. Sagreiya (1992 ab) developed techniques of phenological data collection and also carried out notable research on phyto-geography and endemism in *Alpinia* and *Curcuma*.

The flowering and fruiting behaviors of hundreds of tropical and subtropical plants grown in the greenhouses of the National Botanical Garden of Belgium are studied by Billiet (2004) since 1993. Fourteen types of behavior are distinguished based on duration and frequency of flowering and fruiting periods. Some periods are very short; others are spread over several seasons. Few of them occur two to several times a year. The phenological data for several hundreds of tropical and subtropical

plants are studied it includes four species of *Alpinia* genus like *Alpinia calcarata*, *Alpinia purpurata*, *Alpinia vittata*, *Alpinia zerumbet* and *Zingiber papuanum*. A calendar with the periods of maximum flowering is established in Belgium.

The family Zingiberaceae is the largest monocotyledonous family in India and it was not studied systematically on phenological point of view. Many members are undergrowth in evergreen and deciduous forests and some are seen along the banks of streams and open grass lands. Most of the members of family Zingiberaceae has diversity in producing flowers. Most of them flower during the rainy season and few in summer. The present paper deals with the phenological observations of *Alpinia* and *Zingiber* grown at Kolhapur climate with metrological data.

MATERIALS AND METHODS

It is necessary to make attempt on the phenology of *Alpinia* and *Zingiber* due to its perennial and annual growth pattern. The collected plant material is maintained at Nursery for phenological observations like rhizome sprouting to maturity (plant height), bud initiation to flowering and fruiting. The leaf measurements are made with standard five leaves of each species. The inflorescence size and length of sprouting stage to flowering are also recorded. Flowering season and time, flower bud initiation and longevity of flower, specific period for fruit formation to dehiscence are noted (Table-4).

The Kolhapur district situated between 17° 17' to 15° 43' north latitudes and 73° 40' to 74° 42' east longitudes and encompassing an area of about 7865 sq. km. It is irregular belt of Deccan plateau

lying along east of Sahyadri crest and entirely in the Panchganga basin. The average height above mean sea level varies from 390 to 900 meters. The climate of District is tropical monsoon, pleasant and healthy. The western part it is always cooler than eastern. The average rainfall is 1645 mm. The climate, rainfall and humidity Kolhapur city is given in Table-1, 2

and 3.

Ecology: The genus like *Alpinia calcarata* (Haw.) Rose and *Alpinia galanga* (L.) Swartz are cultivated for ornamental purpose and both the genus are not found in the forest or in wild conditions. The genus *Zingiber* is found in deep shade in the forested region of Western Maharashtra.

Table 1: Monthly average Temperature maximum and minimum in °C.

Months	2008		2009	
	Max.	Min.	Max.	Min.
January	30.1	13.6	31.02	15.04
February	32.5	16.3	27.8	14.0
March	33.7	19.1	36.0	20.0
April	36.1	19.9	37.7	22.4
May	35.2	21.5	35.9	22.5
June	28.0	21.8	31.8	22.5
July	27.2	21.2	28.9	21.7
August	27.6	20.6	28.6	21.6
September	27.9	20.4	21.1	21.0
October	31.5	19.1	31.1	19.4
November	30.3	18.0	29.7	18.7
December	30.8	18.9	30.4	14.5

Table 2: Monthly average rainfall in mm.

Month	2008	2009
January	-	-
February	-	-
March	050.4	11.1
April	011.0	14.6
May	067.8	31.5
June	288.0	18.8
July	163.3	528.8
August	283.6	89.4
September	203.7	159
October	111.8	115.6
November	0132.2	109.1
December	-	-

Source: Zonal Agricultural Research Station, Kolhapur.

RESULTS AND DISCUSSION

In the family Zingiberaceae, *Alpinias* are originally from Malaya, and found throughout the tropical Pacific region. It has attractive flowers and very beautiful foliage plant, the leaves of which are excellent for cut flower arrangements. *Alpinias* are very showy and fragrant flowers, which are botanically an inflorescence forming a gigantic ball of flowers.

Alpinia can be found in colours from light pinks to deep reds. In the present study also *Alpinia calcarata* (Haw.) Rose and *A. galanga* (L.) Swartz. are cultivated in Kolhapur regions, it shows the floral development in the month of October and April. *Alpinia calcarata* (Haw.) Rose has two or more flowering periods / year as per the phenological record of Belgium. Similarly in

Fig 1: Phenological stages of three Zingiber species.

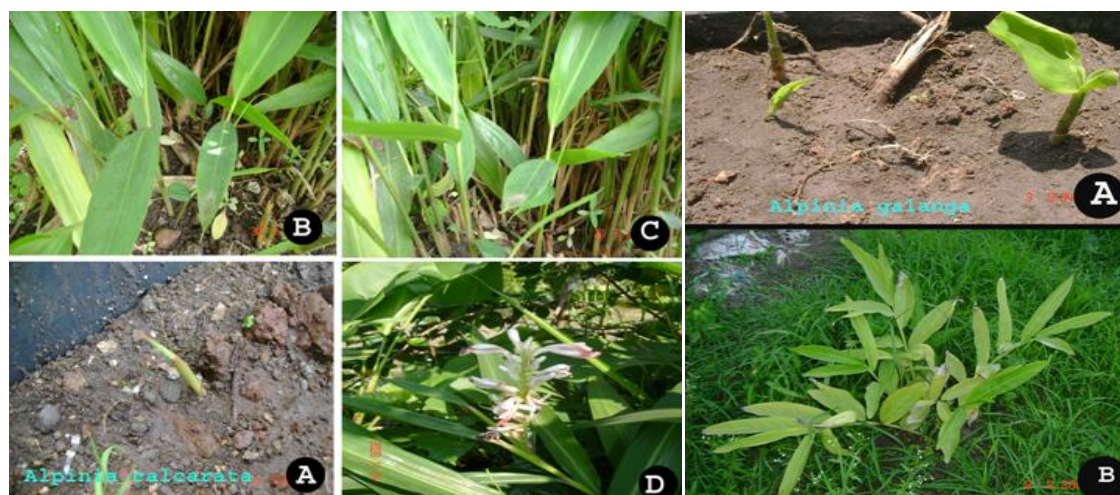
Fig 2: Phenological stages of *Alpinia calcarata* and *A. galanga*.

Table 3: Monthly average of relative Humidity (%) in Morning and Evening

Month	2008		2009	
	M	E	M	E
January	75	28	86	34
February	69	29	59	20
March	79	33	79	28
April	83	33	84	31
May	81	39	82	40
June	92	76	85	63
July	93	78	94	82
August	93	76	95	76
September	96	74	96	72
October	87	43	85	55
November	85	47	86	57
December	85	47	89	45

Table 4: Phenology of *Alpinia* and *Zingiber* at Kolhapur climate

Sr. No.	Parameter	<i>Z.zerumbet</i>	<i>Z. neesatum</i>	<i>Z. cernuum</i>	<i>A. galanga</i>	<i>A. calcarata</i>
1.	Initiation to maturation days.	120- 130	163 days	140 days	180 to 200 days	250 days.
2.	Leaf Measurement of Std. five leaves	L.-13.7 cm B. 7.06 cm	L.-19.1 cm B.-5.48 cm	L.-19.26 cm B.-7.68 cm	L.-21.2 cm B.-6.46 cm	L.-26.9 cm B.-3.12 cm
3.	Inflorescence. Development period	90 to 100 days	90 days	100 days	No develop.	70 -80 days
4.	No. of flowers	10-12	17-18	7-8	-	20-30
5.	Flowing period	July to Aug.	June to July	July to Aug	-	October and April
6.	Longevity of flowers.	One day	One day	One day	-	One day Before
7.	Bud initiation	7.30 am	8.45 am	7.30 am	-	6.30 am
8.	Flower open	9.20 to 9.45 am	1.30 pm	9.45 am	-	After 5.30 pm to 9.00 pm
9.	Anthesis time	10.0 -10.15 am	4.30 pm	10.00 am	-	6.00 am
10.	Time period for fruit formation	-	One month	One month	-	No
11.	Fruit dehiscence	-	After 30 – 40 days	After 30 to 40 days	--	No.

Kolhapur region winter and summer months (October and April) are two flowering seasons. The marginal association between habitat and time was statistically significant for flowering. This significant interaction indicates a differential response of flowering phenology to the habitats (Nelson, 2002). The inflorescence and the longevity of flower is one day but they fail to develop seeds and fruits. Nearly about 40 to 50 days are required to complete the development. The leaf measurements are one of the factors of photo-synthesis. Normally, 40-50 x 2- 2.5 cm in case

of *A. calcarata* (Haw.) Rose and 60-70 x 10-15 cm in *A. glanga* (L.) Swartz. at nursery level the size of leaves in both species are reduced 26.9 x 3.12 cm and 21.2 x 6.46 cm respectively. In case of *Alpinia glanga* (L.) Swartz development of flowers is not seen. The reason behind is *Alpinia* plant does not produce flowers for the first 3 years, but when they grow, they show huge football sized flowers, blooming all year around. Members of genus *Zingiber* complete their life cycle within a particular period or months. During the end of May or 1st week of June the rhizomes start to sprout due to high temperature and pre-monsoon showers. The leaves

measurements are reported earlier are 10-35 x 5-10 cm in *Zingiber zerumbet* (L.) Rosc. ex J.E.Sm., 20-25 x 8-10 cm in *Z. cernuum* Dalz. and 15-25 x 2.5-3.5 cm in *Z. neesatum* (Grah.) Ramam. at nursery level it is reduced to 13.7 x 7.06, 19.26 cm x 7.68 cm and 19.1 x 5.48 cm respectively (Sabu 2006). This means the natural micro-climatic conditions with abundant humus are responsible of healthy growth of plants. An inflorescence development is required 90-100 days. Number of flowers in genus *Zingiber* is 7-18 depending on studied different species.

Flowering period is June to August and June to November is favourable season for development and seed production. The longevity of the flower of *Zingiber* is one day. Bud initiation period is from 7.30 to 8.45 am, flower open period is from 9.20 to 9.46 am in *Z. zerumbet* (L.) Rosc. ex J.E. Sm and *Z. cernuum* Dalz. and anthesis period is 10 to 10.15 am. *Zingiber neesatum* (Grah.) Ramam the flower opened at the afternoon i.e 1.30 pm and anthesis is 4.30 pm. One month is required for fruit formation and seed development. The temperature factor is responsible for complete life cycle of the plants i.e. 25-30 °C maximum and 20 to 22 °C minimum, average humidity at the morning is 90-91 % and evening is 60 – 70 %. Both the genus *Alpinia* and *Zingiber* opening of flower is early in the morning; it may be due to humidity in the nature. The natural life cycle ends in November when vegetative parts start drying. The ecological significance of variation in flowering time and pollinator activity should be interpreted over a regional scale because phenological patterns often vary among populations within a local area. These

variations may cause differences in pollination efficiency, resulting in different reproductive outcomes among populations (Kameyama and Kudo, 2009). Zhang and Li (2008) carried out phonological investigation of *Roscoea schneideriana* (Zingiberaceae) in Lijiang, SW China and recorded that flowering of the species occurs mainly from July to mid August which was peak period of the rainy season. Inflorescence was generally flower for 4-15 days and produces one flower after another at interval of 2-6 days. The flowers were usually anthesis in the early morning. The pollination ecology of *Curcumorpha longiflora* (Zingieraceae) was studied by Gao *et al.* (2004) and monitored phenology and flowering behavior, observing pollinator activity and the quantity and quality of pollination services. This indicates that phenological observations are important to know the ecological pattern of the region for flowering time, pollination and fruiting development.

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