



ISSN (E): 2277-7695  
ISSN (P): 2349-8242  
NAAS Rating: 5.23  
TPI 2023; 12(1): 1970-1973  
© 2023 TPI

[www.thepharmajournal.com](http://www.thepharmajournal.com)

Received: 02-10-2022

Accepted: 08-12-2022

## Divya S

Department of Plantation Crops and Spices, College of Agriculture, Vellanikkara, Kerala Agriculture University, Thrissur, Kerala, India

## Miniraj N

Department of Plantation Crops and Spices, College of Agriculture, Vellanikkara, Kerala Agriculture University, Thrissur, Kerala, India

## Suma A

ICAR-NBPGR Regional Station, Thrissur, Kerala, India

## Aneesha AK

Department of Plantation Crops and Spices, College of Agriculture, Vellanikkara, Kerala Agriculture University, Thrissur, Kerala, India

## Gleena Mary CF

Department of Plant Pathology, College of Agriculture, Vellanikkara, Kerala, India

## Corresponding Author:

### Divya S

Department of Plantation Crops and Spices, College of Agriculture, Vellanikkara, Kerala Agriculture University, Thrissur, Kerala, India

## Flowering phenology in greater galangal (*Alpinia galanga* (L.) Wild. genotypes

Divya S, Miniraj N, Suma A, Aneesha AK and Gleena Mary CF

### Abstract

The present study was carried out at Kerala Agricultural University to understand the flowering phenology of *Alpinia galanga* (L.) Wild. Genotypes maintained at ICAR-NBPGR Regional Station, Vellanikkara. Observations were recorded from nineteen accessions, from flower bud emergence to fruit ripening. Results indicated that there are four principal growth stages from flower bud emergence to seed maturity, which were coded according to the BBCH scale. As per the observations, there are two Flowering seasons from May to July and September to October months. Flower bud initiation to complete flower opening in panicle took 35 days and from fruit set to ripening it took 180-185 days. The studied population of *Alpinia galanga* had two phenotypes, one group expressing cataflexistly and the other showing anaflexistly, which is not reported in the species so far. This study also provides complete information regarding the phenological growth stages of *Alpinia galanga* from flowering to seed maturity.

**Keywords:** principal growth stages, Cataflexistly, Anaflexistly, BBCH scale, *Alpinia galanga*

### Introduction

*Alpinia galanga* (L.) Wild is popularly known as 'greater galangal' and belongs to the family Zingiberaceae. This crop has become naturalized in several parts of South East Asia (Ravindran *et al.*, 2012) [9], and is commonly found in Egypt, Malaysia, India, Sri Lanka, Indonesia, China, and the Gulf (Jatoi *et al.*, 2006) [2]. It is one of the endemic species in the Western Ghats that grows widely in tropical and subtropical regions (Pooja *et al.*, 2020) [8]. *Alpinia galanga* is an important rhizomatous plant broadly used in dietary intake as well as in the traditional system of medicine *viz.* Ayurveda, Unani, Chinese, and Thai folk medicine. Along with aromatic rhizomes, it has vibrant green foliage and attractive flowers with great ornamental value. The plant reaches a height of about 2.5 to 3 m. The pseudo stem is erect, green, and formed by the rolling of leaves; the leaf sheath is pubescent with a robust tillering habit with more than 48 tillers per clump and 13 leaves per tiller (Trimanto *et al.*, 2021; Verma *et al.*, 2011) [11, 12]. Leaves are oblong, alternate, shiny, leathery dark green color on the dorsal surface and light green color on the ventral side with short petiole around 1cm.

Flowers are greenish white, born on the terminal compound panicle with a pleasant smell 3-4 cm long; sepals three in number, light green color; labellum is showy white with pink color markings; calyx tubular; corolla has distinctly clawed lips stamens are white/slightly yellowish in color; stigma is white flowering is seen from May to July and August to September. Fruits initially green turn dark red as they ripen.

Because of the showy foliage and fragrant flowers nowadays the crop is gaining importance as an ornamental crop also there is no clearly distinguished data on the developmental stages of the inflorescence on this crop. The present study concentrated on identifying the flowering phenology of *Alpinia galanga* inflorescence and described the phenological stages as per the BBCH (*Biologische Bundesanstalt, Bundessortenamt and Chemical industry*) scale. The extended BBCH scale is an approach for the universal coding of phenologically significant growth stages of all mono and dicotyledonous plant species. The entire crop developmental cycle (germination to senescence) is divided into ten clearly visible phases which are termed as principal growth stages and they are coded from 0 to 9. when the principal growth stages are inadequate to support the phenological data, the secondary and meso stages are used to define the advanced stages in between the principal growth stages which are coded with two-digit and three-digit numbers respectively.

## Materials and Methods

The present study was carried out at Kerala Agricultural University, Vellanikkara, during 2020-2022, to identify the flowering phenology of *Alpinia galanga* (L.) Wild. genotypes maintained at ICAR-NBPGR Regional Station, Vellanikkara. Nineteen accessions collected from different South Indian states like Kerala, Karnataka, and Tamil Nadu were utilized for the studies. Field observations were made for floral morphology, flowering phenology as well as the stigmatic moments in two different flowering phenotypes. Daily observations from flower bud initiation to fruit ripening were recorded during the peak flowering time. The principal growth stage of *Alpinia galanga* inflorescence was identified and described using the BBCH scale (Meier, 2001) [7]. The type and size of inflorescence, flowering season, anthesis time, the longevity of flowers, and the specific time period from flower emergence to fruit ripening and other floral parameters are documented (Table 1).

## Results and Discussion

As per the observations, there were two flowering seasons in *Alpinia galanga* from May to July and September to October months. Members of the genus *Zingiber* generally complete their life cycle in December and regenerates quickly after receiving monsoon showers. *Alpinia* plant does not produce flowers for the first 3 years, but when they grow up, they produce large-sized panicle with numerous flower that blooms throughout the year, Kasarkar and Kulkarni (2011) [3]. The studied population of *A. galanga* had two floral morphs that exhibit different flowering behaviors. One group expressed cataflexistylous and the other expressed anaflexistylous (Plate 1). In the cataflexistylous morph, the stigma is positioned above the dehiscent anther at the time of anthesis in the early morning and becomes curved underneath the anther in the noon time; but in the case of anaflexistylous form, the receptive stigma decurved under the indehiscent anther first and then moved into a reflexed superior position above the anther as it started to shed pollen around midday. Similar floral forms were reported in *A. kwangsiensis* by Li *et al.* (2002) [6], and also by Aswani and Sabu (2014) [5] in *Alpinia mutica* Roxb.

Flowering plants' reproductive biology is necessary in order to determine difficulties in seed and fruit set for conservation, pollination, and breeding systems that control the genetic makeup of populations (Tandon *et al.* 2003) [10]. For observing flowering phenology in *Alpinia galanga* observations were made from flower bud initiation to complete flower opening, as well as from fruit setting to ripening. Results indicated that there are four principal growth stages from flower bud emergence to seed maturity, which were coded according to the BBCH scale (Plate 2). The principal growth stage 5 (reproductive bud development) lasted 10–12 days, the principal growth stage 6 (flowering) lasted 20–25 days, and the principal growth stage 7 (fruit development) took 90-100 days from fruit set to maturation. Principal growth stage 8: From maturation to complete ripening, it took 80–85 days. The similar duration from the initiation of the flower bud to the final seed setting in *Alpinia galanga* was reported by Kasarkar and Kulkarni (2011) [3]. In the same line of phenological phases in torch ginger has been reported by Choon *et al.* (2016) [1] and Khairani *et al.* (2020) [4] in *Thaumatococcus daniellii*. Aswani (2014) [5] also reported

similar phenological stages of flowering in *Alpinia mutica* Roxb. The phenological stages of the *Alpinia galanga* inflorescence were summarized and described using an extended BBCH scale (Table 2).

### Principle growth stage 5: Inflorescence emergence

Flower bud emergence was seen in the terminal position of newly formed matured tillers. The emergence of flower buds began during the rainy season, it starts from the 2nd week of May to the last week of July in the first season then the 3rd week of August up to the last week of October in the second season. From flower bud emergence to maturity, it took 12-15 days. The secondary stages are coded with two-digit numbers and meso stages are coded with three-digit numbers are shown below.

- 50. The emergence of reproductive bud
- 500. Terminal reproductive bud visible- the emergence of light yellowish green colored reproductive bud on the leaf shoot.
- 501. The reproductive bud had grown to 10% of its full size.
- 505. The terminal reproductive bud was half its maximum size.
- 509. The reproductive bud had grown to 90% of its maximum size.
- 51. The reproductive bud begins to swell.
- 53. Slight opening of bract
- 55. Form pyramidal shape
- 56. The inflorescence bud keeps expanding
- 59. 90% of inflorescence bursts open and is clearly visible.

### Principal growth stage 6: Flowering

The flower buds in a panicle take 20-25 days to complete opening after panicle emergence. A single branch has flower buds of three different maturity stages. The flower in the branches opens one by one in sequential order. The panicle has 5–6 open flowers every day, and each blossom lasts for 24 hours. Anthesis of the flower occurs in the early morning hours. Generally, *Alpinia galanga* flowers are pollinated by bees and wasps. The secondary growth stages under the flowering stages are explained below.

- 60. Bract separation and the complete opening of the panicle
- 61. 10% of the flowers in the panicle had finished blooming and started to wilt.
- 65. 50% of the flowers in the panicle had finished blooming and started to wilt.
- 68. 80% of the flower had completed blooming and dried off.
- 69. All flowers in the panicle had finished blooming and dried off.

### Principal growth stage 7: Fruit development

Fruit development in *Alpinia galanga* took 90- 100 days from fruit set to maturation.

- 70. Swelling of ovary-The swelling of ovary takes place after successful pollination.
- 71. Fruit grew to 10% of its full size: corolla dries off after 15 days but calyx remains on the fruit even after maturity
- 72. Fruit at 20% of its ultimate size
- 75. The fruit had grown to 50% of its full size.
- 79. Fruit reaches its full size. shows dark green color.

### Principal growth stage 8: Fruit maturity

It took 80-85 days for the complete ripening of fruits.

- 80. Fruits had grown to their full size, the fruit turned into

dark green color

81. Fruit ripening started - 53 days after final fruit maturity, and fruit wall color changes to yellowish-orange

85. Advanced level of ripening: color changes from orange to red in 32 to 35 days

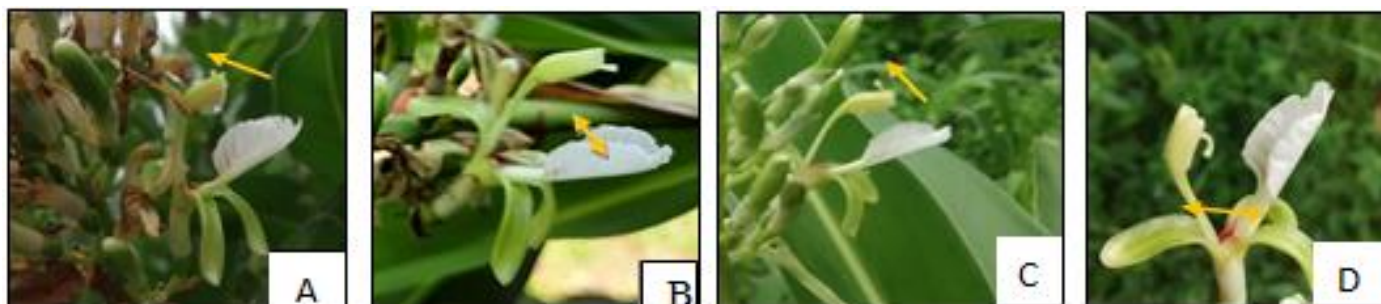
89. Fruits were completely ripe, fruit color changed to dark red.

**Table 1:** Floral parameters of *Alpinia galanga* genotypes

Parameters	Description
Inflorescence type	Panicle
Color of flower	Greenish white
Color of petal	White with pink markings in the midrib
No. of days for flower bud emergence to maturation	12-15 days
Duration of flowering	20-25 days
Number of flowers that open per day	6
Time of anthesis	Early morning (6 to 6.30)
Flower longevity	1 day
Color of stamen	White
Color of anther	Yellowish white
fruit set to ripening	180 -185 days
Time period from initiation to final fruit ripening	210-220 days

**Table 2:** Phenological growth stages of *Alpinia galanga* according to the BBCH scale

BBCH code	Description
<b>Principle growth stage 5:</b>	<b>Inflorescence emergence</b>
50	Emergence of reproductive bud
500	Visible terminal inflorescence bud
501	10% of its full length.
505	50% of its full length
509	90% of its full length
51	Initiation of reproductive bud swell
53	Slight bracts opening
55	Form pyramidal shape
56	Expanding of reproductive bud
59	90% of inflorescence bursts open and clearly visible
<b>Principal growth stage 6:</b>	<b>Flowering</b>
60	Bract separation and complete opening of the panicle
61	10% of flowers finished blooming and started to wilt
62	50% of flowers finished blooming and started to wilt.
68	80% flowers finished blooming and dried off.
69	All flowers finished blooming and dried off.
<b>Principal growth stage 7:</b>	<b>Fruit development</b>
70	Swelling of ovary
71	Fruit at 10% of its full size
72	20% of its full size
75	50% of its full size
79	90% of its full size
<b>Principal growth stage 8:</b>	<b>Fruit maturity</b>
80	Fruits reached their full size
81	Fruit wall color changes to yellowish-orange
85	Color changes from orange to red
89	Color changed to dark red



**Plate 1:** Flowering behavior of two floral morphs in *Alpinia galanga*. a) anaflexistylous flower before noon, in which the stigma is below the undeheisced anther b) anaflexistylous flower afternoon, with the stigma now erect above the anther c) cataflexistylous flower before noon, in which the stigma is above the deheisced anther d) cataflexistylous flower afternoon, with the stigma below the anther



**Plate 2:** Phenological growth stages of *Alpinia galanga* according to the extended BBCH scale

## Conclusion

*Alpinia galanga* inflorescence showed four of the 10 principal growth stages according to the BBCH scale. The growth stages began with flower bud emergence, continued with flowering, and fruit maturation, and ended with fruit ripening. The results of this study came out with a clear picture of the inflorescence development which is valuable information for the crop improvement work in this crop.

## Reference

1. Choon Sea Y, Ding Phebe, Mahmud TMM, Shaari, Khozirah. Phenological growth stages of torch ginger (*Etilingera elatior*) inflorescence. 2016;39:73-78.
2. Jatoi SA, Kikuchi A, San SY, Naing KW, Yamanaka S, Watanabe JA. Use of rice SSR markers as RAPD markers for genetic diversity analysis in Zingiberaceae. *Breed. Sci.* 2006;56(2):107-111.
3. Kasarkar AR, Kulkarni DK. Phenological studies of family zingiberaceae with special reference to *Alpinia* and zingiber from Kolhapur region (Ms) India. *Biosci. Discovery.* 2011;2(3):322-32.
4. Khairlani, Nurul, Abdullah, Mohdyusoff, Abdullah, Shamsiah. *Thaumatococcus daniellii* phenology and growing degree days requirement under different irradiance and fertilizer levels. *Ann. Appl. Biol.* 2020, 176. 10.1111/aab.12564.
5. Kunnath, Aswani. Reproductive biology of *Alpinia mutica* (Roxb.) (Zingiberaceae) with special reference to flexistylous pollination mechanism. *Int. J. Plant Reproductive Biol.* 2015;7:48-58.
6. Li QJ, Kress WJ, Xu ZF, Xia YM, Zhang L, Deng XB. Mating system and stigmatic behaviour during flowering of *Alpinia kwangsiensis* (Zingiberaceae). *Plant Syst. Evol.* 2002;232(1):123-132.
7. Meier U. Growth stages of mono- and dicotyledonous plants. BBCH monograph. Berlin: German Federal Biological Research Centre for Agriculture and Forestry, 2001.
8. Pooja DA, Shetty GR, Rajashekharan PE, Bhat R, Ganapathy M, Nadukeri S. Variability, heritability and genetic advancement for yield and yield contributing characters in *Alpinia galanga* (L.) Wild. *J. Pharmacognosy and Phytochem.* 2020;9(5):2296-2299.
9. Ravindran PN, Pillai GS, Balachandran I, Divakaran M. Galangal. In *Handbook of herbs and spices*. Woodhead Publishing; c2012. p. 303-318.
10. Tandon R, Shivanna KR, Mohan RHY. Reproductive biology of *Butea monosperma* (Fabaceae). *Ann Bot.* 2003;92(5):715-23.
11. Trimanto T, Hapsari, Lia, Dini D. *Alpinia galanga* (L.) wild: Plant morphological characteristic, histochemical analysis and review on pharmacological. AIP Conference; c2021. Proceedings.[Online]. Available: [https://www.researchgate.net/publication/351857747\\_Alpinia\\_galanga\\_L\\_wild\\_Plant\\_morphological\\_characteristic\\_histochemical\\_analysis\\_and\\_review\\_on\\_pharmacological](https://www.researchgate.net/publication/351857747_Alpinia_galanga_L_wild_Plant_morphological_characteristic_histochemical_analysis_and_review_on_pharmacological) [05 Oct. 2022].
12. Verma RK, Mishra G, Singh P, Jha KK, Khosa RL. Anti-diabetic activity of methanolic extract of *Alpinia galanga* Linn. aerial parts in streptozotocin induced diabetic rats. *Ayu.* 2015;36(1):91-95.