Kandelia candel (L.) Druce Reproductive Organ Phenology, in Berbak and Sembilang National Park, South Sumatra

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Abstract. A field observation has been done to know Kandelia candel reproductive organs phenology, at Berbak and Sembilang National Park, South Sumatra, from November 2018 until January 2019. This study aimed to find out the phenology of the K. candel in South Sumatra. The results of this study showed that flower initiation occurred in April, mature from November to January; 290 days period is needed by flower initiation until the mature propagule. Keywords: phenology, Kandelia candel, propagule, Sumatra

1. Introduction
The occurrence of Kandelia candel in Gujarat India; As it has not been reported earlier from that region, it is a new distributional record for the northwest coast of India [1]. Previous research at East Sumatra done by [2] showed that based on vegetation inventory, there were 20 mangrove species, and Avicennia marina was the dominant species in seedling and sapling stages. The tree stage was not found in the area. The environment conditions were suitable for mangrove growth and replantation except for pyrite content in the mangrove soil. The average mangrove green belt was 25 m with a range from 10 to 80 m in KJP (Kajapah) land system and 30 m with range 10 to 50 m in PTG (Puting) land system. The abrasion rate in the area was high, i.e., 6 m per year in KJP land system and 10 m per year in PTG land system.

The main species found at Tanjung Bungin, Banyuasin were Rhizophora apiculata and Bruguiera gymnorrhiza. Both species are the most economically important trees which have been intensively exploited for their valuable wood and tannin since the Dutch colonization in the 16th century [3]. The mangrove forest areas of Tanjung Bungin, Banyuasin District, South Sumatra is the production forest.

Not all researchers found Kandelia candel around those sites, like [4] there were 57 species of plants recorded inside and outside sample plots; 24 species among them were tree species, and the remaining were shrubs and herbs. Out of 57 species, 15 species (26.32%) were known as true mangrove species, and 18 species (31.58%) were categorized as associate mangrove species. The rest of them further classified as 12 species (21.05%) of plants commonly found in swamps and 12 species (21.05%) of secondary terrestrial vegetation plants.
The propagules of *Kandelia candel* collected from the Zhangjiang estuary and planted in mangrove habitats along the intertidal gradient [5]. The rooting rates of *K. candel* propagules varied spatially. The lowest rate occurred in *Avicennia marina* forest (69.7%). The rates were higher in *K. candel* forest (90.0%), at the fringe of the mangrove forest (89.3%), and on the bare tidal flat outside the mangrove forest (82.7%). After one year, the survival rates of seedlings planted under *A. marina* forest, *K. candel* forest, at the fringe of the mangrove forest, and on the bare tidal flat were 13.7%, 54.7%, 76.0%, and 34.7%, respectively.

Among the surviving *K. candel* seedlings, those at the fringe of the mangrove forest and on the bare tidal flat had greater height, stem diameter, leaf number, leaf area, and biomass than those under *A. marina* and *K. candel* forests. These results demonstrated that the establishment and growth of *K. candel* seedlings occurred successfully at the fringe of the mangrove forest, but were the worst under *A. marina* forest. All of the above information had led to beginning a study on the reproductive organs phenology of *K. candel* in Berbak & Sembilang National Park, South Sumatra.

2. Methods

The study was conducted from November 2018 to January 2019, carried out at Berbak & Sembilang National Parks, South Sumatra. Purposive sampling is used to select the main trees and tagged to marking the flowering and fruiting periods. Selected flowers were effeminate flowers, with the selected fruits were hard fruits (nuts). A native person is used as a guide and worker for helping data collection.

3. Results

The results of the research were written in Table 1.

**Table 1. Summary of reproductive organ phenology of Kandelia candel**

| Reproductive phase | Images | Period (weeks/month) | Duration (weeks) | Size      |
|--------------------|--------|----------------------|------------------|-----------|
| Flower initiation  |        | 3th-4th Apr          | 2                | 1 mm diameter |
| Small immature bud |        | 4th Apr - 1st Jun    | 6                | 3 mm long  |
| Stage                  | Dates                  | Number | Size            |
|-----------------------|------------------------|--------|-----------------|
| Mature bud            | 1st Jun – 3rd Jun      | 3      | 8 mm long       |
| Blooming flower       | 3rd Jun                | 1      | 30 mm diameter  |
| Immature fruit        | 4th Jun – 1st Sept     | 9      | 150 mm long     |
| Mature fruit          | 1st Sept – 1st Oct     | 5      | 175 mm long     |
4. Discussion

It is found that flower initiation occurred in April, mature in November until January; 290 days period is needed by flower initiation until the propagule becomes mature. [6] reported the periods of three other Rhizophoraceae species; *Rhizophora apiculata* was 22 months, *R stylosa* was 22 months too, and *R. mucronata* needed 19 months to overcome reproductive period from flower initiation until mature propagule. Kamal studied those Rhizophoraceae at Unggas Island, Pasaman, West Sumatra. Nine months are a smaller period than 19 and 22 months, and these data should be proposed as a consideration in the selection of species for restoration of beach vegetation.

[7] wrote about the flower of *K candel* in Vietnam and said that the inflorescence cyme consists of 10-20 white flowers with a composite flower stalk and racemes 5-6, 1.2 cm long. It is just like the same as these objects, where the flowers could be seen as below (Figure 2). [8] said the petal length is 14 mm, and it looks very same as these investigation photos.

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**Figure 1.** Flower (left) Immature fruit emerging (right)
[9] reported on other species of Kandelia, K obovata, that the highest recruit leaves existed in July, and the highest leaf death was overcome in August in Japan. It is better to do further research on the leaves of K. candel too, whether the changing of immature fruit to mature fruit from July to August, related to the existence of leaves also.

5. Conclusion
Flower initiation occurred in April, mature from November to January; 290 days period is needed by flower initiation until the propagule becomes mature. The reproductive period of K. candel is smaller than Rhizophora spp., and should be considered as the main species for restoration.

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