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The importance of sprouting ability in conservation and development of Ironwood (*Eusideroxylon zwageri* Teijsm. & Binn.) varieties

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Abstract

Ironwood (*Eusideroxylon zwageri* Teijsm. & Binn.) is a threatened tree species which grows in tropical lowland forest. Over-exploitation caused decreasing its population. Most of mature trees were felled which leads to decreasing number of seed production and lost of genetic resources. A research on sprouting ability of ironwood varieties had been conducted to evaluate sprouting ability and its importance in ironwood conservation and development. Ironwood varieties have been recognised by local people and also reported by many scientists since in the middle of 19th century. Local people recognised four varieties of ironwood which were grow in Senami forest, Jambi Indonesia namely *daging, kapur, sirap* and *tanduk*. The meaning of those vernacular names is directly related to wood or bark structure of each variety. The research had been conducted at Senami forest using systematic plot survey. Research results obtained that all of ironwood stumps produced sprouts. *Sirap* was the most dominant variety which sprouting (85.71%) which followed by *daging* (35.71%), *kapur* (17.86%) and *tanduk* (10.71%). The number of sprouts was slightly different from one to another variety. The highest number of sprouts belonged to *daging* followed by *sirap, kapur* and *tanduk* variety. Sprouts tended to grow faster than seedlings. For the first year, they grew 2.87 and 5.64 times in diameter and height respectively. After investigating and discussing sprouting ability of ironwood, it can be concluded that sprouting is very important for ironwood since it faces very intensive threats. It is very important for regeneration, stand restoration, genetic resource conservation, propagation and development of ironwood.

Keywords: Conservation, genetic resources, ironwood varieties, sprouts and sprouting ability.

I. Introduction

1.1. Background

The pattern of sprouting generally conforms to the pattern of repair of broken tree architecture after disturbance (Halle, *et al*., 1978). Sprouting has been studied in natural forests after hurricane (Bellingham et al. 1994), after fire (Kauffman, 1991), logging (Pinard and Putz, 1996), slash-and-burn cultivation (Miller and Kauffman, 1998), or as a component of regeneration after natural gap creation (Putz and Brokaw, 1989).

Ironwood (*Eusideroxylon zwageri* Teijsm. & Binn.) belongs to the family of Lauraceae, tribus of Cryptocaryeae and subtribus of Eusideroxylineae (Kostermans, 1957). The variability of ironwood has been reported by many scientists since in the middle of 19th century (see Van Lijnden and Groll, 1851; Teijsmann, 1858; Teijsmann and Binnendijk, 1863; Heyne, 1927;

Koopman and Verhoef, 1938; De Wit, 1949; Kostermans, *et al.,* 1994, Irawan, 2002; Irawan and Gruber, 2003). The variability of ironwood is not only recognized locally but also found in many different forest areas.

The major threats to ironwood are over-exploitation, shifting cultivation, the introduction of chain saws and extensive road systems by the timber industry, selective logging, infrastructure (roads, dams, power lines etc.) and illegal logging (Peluso, 1992; Kostermans, *et al.* 1994; IUCN, 2001; Irawan, 2002). Due to those activities, ironwood population is decreasing drastically. It is categorized as threatened tree species (IUCN, 2001).

One example of ironwood degradation is ironwood population in Senami forest. Senami is one of forest areas in Jambi, Sumatra that dominated by ironwood species. Gresser (1919) reported that mean volume of ironwood was 105.6 m^3 ha^{-1}. While Masano and Omon (1983) reported that the mean volume of ironwood was 120,9 m^3 ha^{-1} for undisturbed forest and 56,45 m^3 ha^{-1} for logged over forest area. The last research in 2002 showed that the volume of ironwood just left 5.18 m^3 ha^{-1}.

These data on volume of ironwood showed that the entire forest area was disturbed and almost all of trees were felled. In this condition, sprouting ability is very important not only in term of existence of species but also in term of genetic resource conservation. However, there is no knowledge about it especially which related to ironwood varieties. The main contribution of this research is to provide knowledge on sprouting ability of ironwood varieties, which practically important for future cultivation, breeding program and management of ironwood.

1.2. Objectives

The objectives of this research are:

1. To examine sprouting ability among ironwood varieties
2. To identify the important of sprouts for regeneration, conservation and development of ironwood varieties.

II. Research methods

2.1.Time and study site

The research was conducted from October 2002 to November 2002 at Senami natural forest stand Jambi - Indonesia. Senami forest stand is located at Tembesi resort forest on Batanghari district forest in provincial forestry service of Jambi. According to Schmidt and Fergusson (1951) the climate type is A with annual precipitation of 2662 mm. Senami forest is dominated by ironwood associatively with medang (*Litsea* sp.) and balam (*Palaquium* sp.) (Masano and Omon, 1983).

2.2. Materials and Methods

The materials that were used were the natural forest stand of ironwood. The instruments were GPS (Geographical Positioning Systems), diameter tape, rope and stationery. The research was conducted using systematic plot survey. The ironwood varieties were recognized based on experiences and knowledge of local people and verified by comparing to other morphological structures.

III. Results and discussions

3.1. Sprouting ability of ironwood varieties

Field data show that all of ironwood stumps produced sprouts (see Fig. 1 and 2). *Sirap* was the most dominant stumps that produced sprouts followed by *daging, kapur* and *tanduk* (see Table 1). It could be found 85.71 % out of total plots where ironwood stumps sprouted. The number of sprouts per variety was slightly different. The mean number of sprouts of *daging* was the 2.05 per stump that distributed to 3.5 sprouts in seedling size, 3.71 sprouts in sapling size and one sprout in pole size and one tree size. *Sirap* had 2.16 sprouts per stump with 3.67 seedlings, 2.56 saplings, 1.40 poles in average and one tree. *Kapur* had 1.71 number of sprouts in average that distributed to 1.75 seedlings, 1.50 saplings, 2.60 poles and one tree. The last was *tanduk* variety which had one sprout in average. It consisted of two seedlings, one pole and one tree. The percentage of sprout formation of each variety and number and size of sprouts are presented in Fig.3 and 4.

Table 1. Number of sprouts of ironwood varieties

Variety	Mean Stump diameter (cm)	Percentage of sprouting	Mean number of sprouts per stump				Mean
			Seedling size	Sapling size	Pole size	Tree size	
Daging	0.51	35.71	3.50	3.71	1.00	0	2.05
Kapur	0.48	17.86	1.75	1.50	2.60	1	1.71
Sirap	0.46	85.71	3.67	2.56	1.40	1	2.16
Tanduk	0.38	10.71	2.00	0.00	1.00	1	1.00

Fig. 4 also shows that the number of sprouts is decreasing with the increasing size. It seems that self-thinning took place. This mechanism is very important in natural condition where artificial thinning has not been conducted. By self-thinning, the light, water and nutrient competition will reduce in parallel to the growth of sprouts. However, artificial thinning is necessary to conduct in managed ironwood forest to decrease lost of time and energy during self-thinning.

Figure 1. one-year old sprouts

Figure 2. Old stump with several sprouts

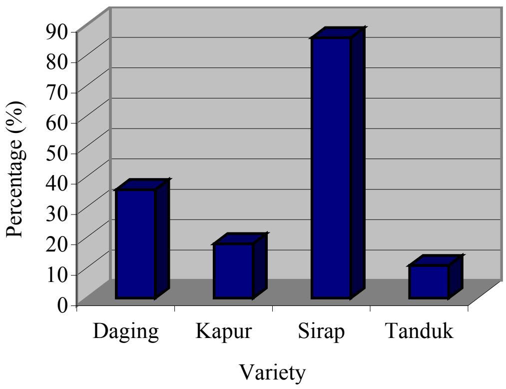


Figure 3. Percentage of sprout formation among ironwood variety

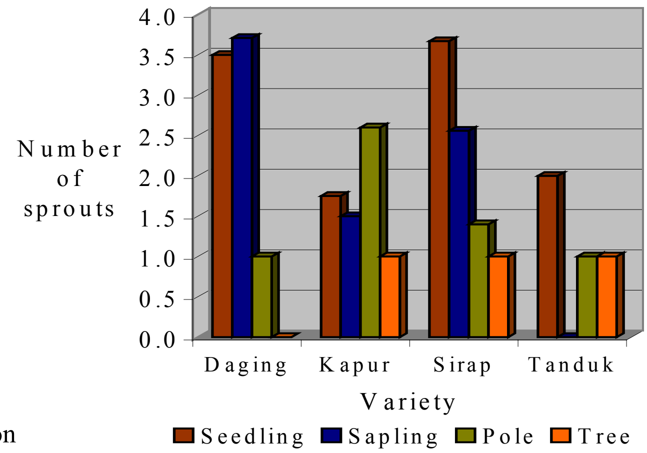
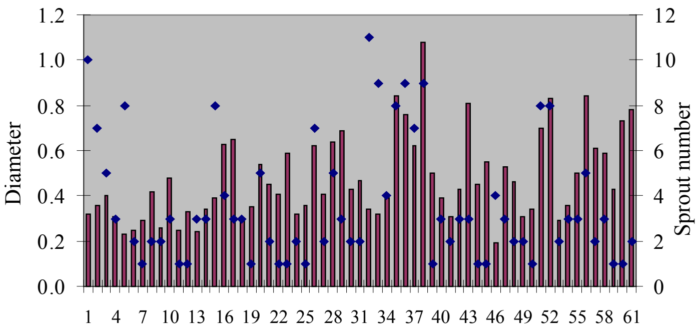


Figure 4. Mean number of sprouts according to size for each ironwood variety

The number of sprouts that was produced by each variety seems to be not influenced by stump diameter (see Fig. 5). It is different from results of other research works. Many research works found that there is any relationship between stump diameter and sprout ability. They believe that sprouting ability is influenced by amount of accumulate reserves in the stump and/or activity of underground buds. Bigger stump has much amount of reserves and/or more active underground buds therefore, bigger stump tends to produce more sprout (see Cirne and Scarano, 2001; Miura and Yamamoto, 2003; Ickes, *et al*., 2003). However, Putz and Brokaw (1989) found that there is a tendency for the proportion of sprouted tree decrease with increasing tree size in a neotropical rainforest (see also Yamada, *et al*., 2001).



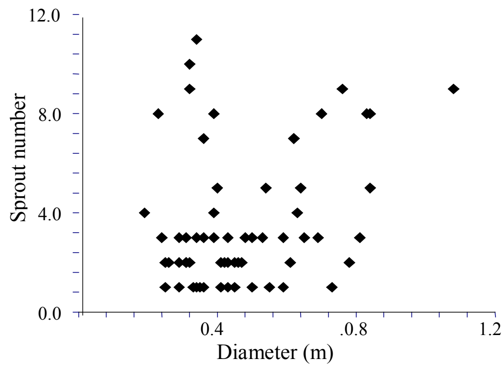


Figure 5. Showing relationship between sprout number and stump diameter

3.2. Comparison of growth rate between sprouts and seedlings

The comparison of growth rate between sprouts and seedlings of ironwood varieties is presented in Fig. 6 and 7. The different growth rate between sprouts and seedlings is very clear. The biggest diameter of one-year seedling is 0.88 cm with height of 0.56 m while the sprouts could reach 2.72 cm in diameter and 3.15 m in height.

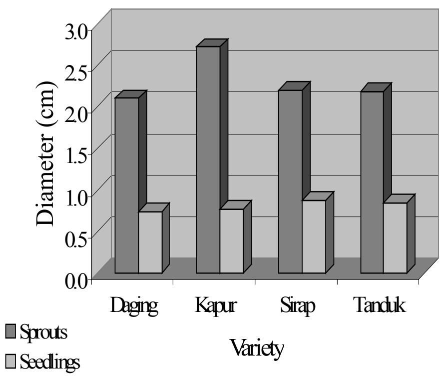


Figure 6. Showing diameter of 1 year old sprouts and seedlings

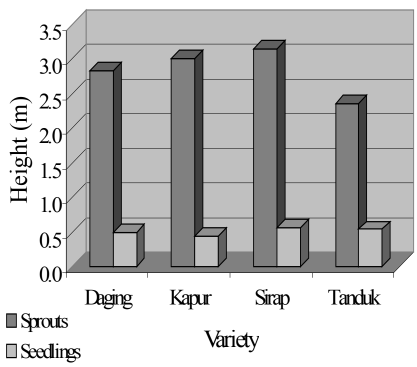


Figure 7. Showing height of 1 year old sprouts and seedlings

These results are parallel to information from local people. They believe that trees which come from sprouts will grow faster than tree from seedlings. It can be understood because the sprout trees have received a better support of sufficient nutrients and water from the already developed root systems. In contrast the organ systems of the seedling trees develop simultaneously with the growth of the trees (Beekman, 1949; Irawan, 2002; Miura and Yamamoto, 2003).

3.3. The importance of sprouting

3.3.1. Regeneration and stand restoration

Ecologically, sprouting is very important for the survival of ironwood species since it faces very intensive exploitation. Field observation found that all of ironwood's stumps produce sprouts. 65 % out of plots that obtained ironwood was also obtained sprouting stumps. It means that the important of sprouts is not only for survival of individual tree but also important for the dynamic of forest stand (see Putz & Brokaw 1989; Kammesheidt, 1998; Miura and Yamamoto, 2003).

The important of sprouting for ironwood becomes clearer since the growth rate of this species is very slow for mature as well as juvenile trees (Beekman, 1949; Ashton, 1981; Kostermans *et al.*, 1994; Kiyono and Hastaniah, 2000). By sprouting, the time for juvenile trees to reach mature stage are much shorter than those of regeneration by seedling since sprouts grow faster than seedlings (see sub chapter 3.2).

3.3.2. Genetic resource conservation

One of the many consequences of deforestation and forest degradation is a dramatic loss of biological diversity. Biodiversity consists of variation at many levels: diversity between ecosystems, species and genes (Convention on Biological Diversity, 1992). Severely degradation of forests may cause an important genetic response in terms of offspring with poor stem form and reduced commercial value (Savolainen & Kärkäinen, 1992).

The degradation of ironwood in the research area is in ultimate level. Almost all of trees were cut. Genetic resources on specific area are extinct and there is no way to take them back. The only way to save those genetic resources is by tending the sprouts that grow from each stump. Sprouts do not only replace felled trees but also keep the genetic resources of the individual tree species since the sprouts always have the same genetic code as the felled trees.

The ideal of genetic resource conservation has to conserve all of genetic resources of specific species. It can be done by protecting certain number of samples within practical limits with maximum amount of genetic variation (Allard, 1970) or by protecting whole population since future fate of such collection is uncertain, particularly due to small size (Finkeldey and Gregorius, 1994).

3.3.3. Propagation and development of ironwood

Irawan (2002) reported that there were three methods for ironwood propagation. The first is by seedling, the second is by sprouting and the last is by cutting. The cutting propagation method becomes more important since the number of mother trees to provide seeds were drastically declining due to over exploitation.

The sprouts also could be used as propagation materials for regeneration (Beekman, 1949; Irawan, 2001). Direct way to use sprouts is by collecting sprouts from the forest and use them as propagation materials. Early experiment that conducted by Irawan (1999) showed that sprouts can be used as cutting materials, however the results were not good enough yet. Another method to use sprouts to propagate is by developing hedge orchards. Since, ironwood has high sprouting ability, the need of shoots for cutting propagation can be full filled by developing hedge orchards.

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