

Affect of Canopy Stratum and Methods of Breaking Seed Dormancy on Seedling Growth of *Calliandra tetragona* Benth. and *Acacia tamarindifolia* (L.) Willd.

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ABSTRAK

Pengaruh Strata Tajuk Pohon dan Metode Pemecah Dormansi Biji Terhadap Pertumbuhan Semai Kaliandra (*Calliandra tetragona* Benth.) dan Akasia (*Acacia tamarindifolia* (L.) Willd.) Fase semai merupakan langkah awal untuk pertumbuhan suatu pohon. Diduga terdapat beberapa faktor yang mempengaruhi pertumbuhan semai yang berasal dari biji. Beberapa faktor tersebut antara lain pengaruh penerimaan cahaya matahari terhadap letak buah pada strata tajuk pohon serta metode pemecahan dormansi biji pada tipe biji ortodok menjadi sangat penting untuk diperhatikan. Sedangkan jenis-jenis pohon yang diuji pada studi ini adalah Kaliandra (*Calliandra tetragona* Benth.) dan Akasia (*Acacia tamarindifolia* (L.) Willd.). Kedua jenis pohon ini merupakan jenis tanaman multi fungsi karena dapat digunakan sebagai tanaman perintis (*pioneer species*). Tujuan penelitian ini adalah untuk mengetahui pertumbuhan semai yang paling baik dengan menentukan letak buah pada posisi strata tajuk serta menentukan metode pemecah dormansi biji yang paling tepat untuk biji ortodok. Lokasi penelitian berada di wilayah UPT Balai Konservasi Tumbuhan Kebun Raya Cibodas-LIPI. Pengujian pengambilan buah pada kedua jenis pohon dibagi menjadi 2 strata tajuk (atas dan bawah) dan metode pemecahan dormansi biji dibagi menjadi 3 (kontrol, fisik dan mekanis). Setiap satu jenis pohon terdapat 6 kombinasi perlakuan. Sedangkan setiap kombinasi perlakuan berisikan 100 biji dan hanya 20 semai yang dihitung untuk sample pada tiap kombinasi perlakuan. Penelitian ini dilakukan hingga semai berumur 3 bulan. Parameter pengamatan pertumbuhan semai ini adalah panjang batang dan panjang akar. Hasil ANOVA didapatkan hasil pertumbuhan batang kedua jenis pohon tersebut signifikan (0,026) pada level 5% untuk interaksi jenis pohon, strata tajuk pohon dan metode pemecahan dormansi. Hasil pada pertumbuhan panjang akar terlihat signifikan (4,239) pada level 5% untuk interaksi antara jenis tanaman dan strata tajuk pohon. Sedangkan interaksi antara metode pemecah dormansi dan jenis pohon signifikan (20,332) pada level 1%.

Kata kunci: Strata tajuk, Pemecah dormansi biji, Pertumbuhan semai.

INTRODUCTION

Plant propagation is the important point of species to survive and existence on the earth. Commonly, a species reproduction process result a seed. A

seed contains the embryo from which a new plant will grow under proper conditions. Seed also usually contain a supply of stored energy and it is wrapped in the seed coat or testa. The seed coat helps protect the embryo from

mechanical injury and from drying out. The seed coat also causes dormancy seed viability such as seed on Fabaceae family. Fabaceae has an orthodox seed characteristic to storage. The orthodox seed has ability to be stored the seed for years even though centuries. Seed dormancy stage has usually occurs so that the seed metabolic on ripening stage was not active (Schmidt 2002). Seeds of annual Fabaceae have physical dormancy level, which means that seeds need scarification method to open the seed coat, but under natural conditions, germination occurs in response to rainfall (Dauro *et al.* 1997 in Baskin & Baskin 2001). Some artificial softening of water-impermeable seed coats are mechanical scarification, acid scarification, enzymes, organic solvent, percussion, high atmospheric pressures, wet heat, dry heat, etc. Sahupala (2007) said that mechanical and physical scarification could be chosen to break the dormancy on Fabaceae seeds. Smith *et al.* (2003) said that seed collection activity should aim to ensure that seed had been collected at peak quality such that their longevity in the seed bank is optimal. Seed maturity was therefore an important consideration; harvest too early and losses may be incurred because the seeds have not yet acquired desiccation tolerance and because the seeds lose viability more rapidly in storage due to impaired longevity.

Kaliandra (*Calliandra tetragona* Benth.) and Akasia (*Acacia tamarindifolia* (L.) Willd.), from Fabaceae family or well known as legumes, were the chosen species in this study. *C.*

tetragona species, which has white flowers, has proved to be slower growing than *C. calothyrsus*. Kaliandra trees mature rapidly and usually flower and bear fruit within their first year. In Indonesia they set flower year-round but most seed produced in June-September. Akasia leaves were used to in rations mixed with ammoniated rice straw and maize hominy, it was evaluated for growing goats in Venezuela. The role of legumes, with their nitrogen fixing capability, energy resources as fuel wood and woodland understories, should be an important component of prairie restoration or rangeland rehabilitation efforts in the future (Dittus & Muir 2010). To obtain seed for planting, the pods are collected when they turn brown. After 1 or 2 days of drying in the sun, they open to expose the seed inside. The seeds can be germinated without treatment, but they germinate more quickly if boiling water is poured over them and they are allowed to cool and soak for 24 hours or seed physical scarification (Anonymous 1983).

Seedling quality depends on the ability to produce new roots quickly, a well developed root system, a large root collar diameter and a balanced shoot: root ratio. The shoot : root ratio is an important measure for seedling survival. It relates the transpiring area (shoot) and to the water absorbing area (root) (www.worldagroforestrycentre.org/-/NurseryManuals/Community/SeedQuality.pdf). The reason to divide canopy strata for seed procurement was the difference of sunlight absorbed by canopy. van Noordwijk & Lusiana (2002)

said that sunlight as one of environmental factors that might influence tree growth such as the growth of fruits, trunks, leaves and roots. The two other factors are nutrients and water. Sitompul (2002) also said that plant biomass production including the economical part (part for harvesting) was resulted by photosynthesis process. Sunlight is as an important source for photosynthesis process on plant. Also it influenced the production of seeds as photosynthesis result. Meanwhile, the canopy stratification was the important point to know which canopy strata has good seeds to germinate. The aims of this study were to compare 2 tree canopy stratum position to collect the fruits and 3 methods of breaking seed dormancy on Kaliandra and Akasia seedlings growth as bio-energy resources.

MATERIALS AND METHODS

The research was conducted in Cibodas Botanical Garden (CBG) area for 4 months from July until November 2009. The activities included seed procurement, seed selection, observation on seed germination and seedling growth measurements (shoot and root length). The seeds were collected from stands on CBG. After seed selection has been done, the seeds were sowed into sand media in the pot-tray inside CBG's glass house. The data of seed viability were collected every 2 days. The measurement of shoot and root length were collected in the end of observation or when the seedlings was 3 months old after germination. The experimental

design consisted of 2 legume species: 1) Kaliandra (*Calliandra tertagona* Benth.) and 2) Akasia (*Acacia tamarindifolia* (L.) Willd.), 2 canopy stratification: 1) upper canopy and 2) below canopy; and 3 breaking seed dormancy methods: 1) control, 2) mechanical and 3) physical. The examined species were Kaliandra and Akasia, from Fabaceae family, were selected for this study based on their potential for rehabilitation area (Anonymous 1983). To abrasive surface of seed coat on sand paper was applied for mechanical breaking seed dormancy method. To soaking seed in to warm water (80° C) for 12 hours was done as physical scarification method. Each experimental unit consisted of combination between canopy stratification and breaking seed dormancy. There are 6 treatment units on seed observation. Each treatment unit has 100 seeds and only 20 seedlings were measured for shoot and root length. The shoot length was measured from bottom point of stem until point of growth of stem. The root length was measured from upper point of root growth until point of growth of root. One Way ANOVA was used in this data analysis to find the affect of canopy stratification and breaking seed dormancy to seedlings growth.

RESULTS

The lowest seed viability was showed by Kaliandra's seed on seed procurement from below canopy and control breaking seed dormancy (14%). The highest percentage of seed viability

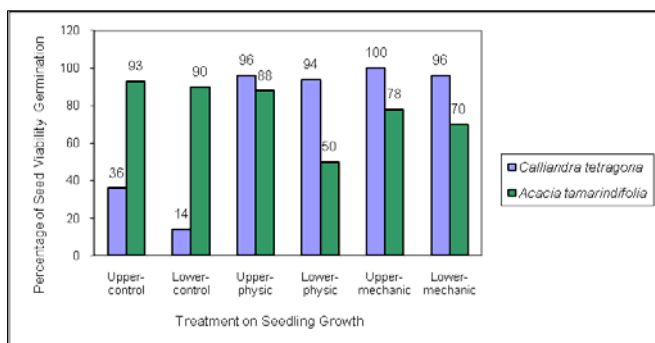


Figure 1. Graphic for percentage of seed viability versus treatment on seedling growth for Kaliandra and Akasia species

(93%) on Akasia’s seed is showed by seed procurement from upper canopy and control breaking seed dormancy. The lowest percentage of seed viability (50%) on Akasia’s seed is showed by seed procurement from lower canopy and physical breaking seed dormancy. On average the percentage of mechanical breaking seed dormancy method was lower than physical and control methods for Acacia’s seed germination.

Figure 1 showed the percentage of seed viability versus treatment on seedling growth for Kaliandra dan Akasia species.

The data of shoot growth interactions among canopy stratification, breaking seed dormancy and two examined species was significant. The data for shoot growth of Kaliandra dan Akasia species can be seen on Table 1. Shoot growth on seedlings of two species were affected by different canopy strata of seed procurement and breaking seed dormancy methods. The seeds which were harvested from different canopy strata have different ripen physiology.

The data of root growth interactions between canopy stratification and two examined species was significant. The reason was seeds have diverse and complex responses to the environmental stress during seed development and it decreased seed quality. Dewley & Black (1994) said that stresses such as water deficits, low or high temperature, nutrient deprivation, and shading can occur at any time during seed development. The effect of these stresses on seed development may be magnified and greater than the sum of the individual stresses. Furthermore interactions between breaking seed dormancy methods and two examined species was significant choosing the right breaking seed dormancy method was important for Fabaceae’s seeds. The data for shoot growth of Kaliandra dan Akasia species can be seen on Table 2.

DISCUSSION

Seed germination rates and uniformity are important factors in establishing viable native species. Many legumes have high percentage of

Table 1. One Way ANOVA for shoots growth of Kaliandra and Akasia species.

Source	Df	Mean Square	F
Canopy strata	1	4.219	1.470ns
Breaking seed dormancy	2	81.389	28.358**
Species	1	306.241	106.704**
Canopy strata X Breaking seed dormancy	2	0.887	0.309ns
Canopy strata X Species	1	37.744	13.151**
Breaking seed dormancy X Species	2	68.909	24.010**
Canopy strata X Breaking seed dormancy X Species	2	10.883	3.792*
Error	108	2.870	

Table 2. One Way ANOVA for shoots length of Kaliandra and Akasia species.

Source	Df	Mean Square	F
Canopy strata	1	10.561	1.182ns
Breaking seed dormancy	2	174.481	19.535**
Species	1	140.833	15.768**
Canopy strata X Breaking seed dormancy	2	7.899	0.884ns
Canopy strata X Species	1	37.856	4.239*
Breaking seed dormancy X Species	2	181.592	20.332**
Canopy strata X Breaking seed dormancy X Species	2	17.980	2.013ns
Error	108	8.931	

hardseededness. The most common and successful methods for increasing water upake by legume seed includes mechanical (seedcoat abrasion), immersion in sulphuric acid, and soaking in hot water (Haferkamp and others 1984; Muir and Pitman 1987 in Dittus and Muir 2010). Kaliandra (*Calliandra tetragona* Benth.) and Akasia (*Acacia tamarindifolia* (L.) Willd.) have an orthodox seed type and they also have different ability to break the seed dormancy (Hong *et al.* 1998). Kaliandra's seeds have very low ability to breaking seed dormancy in control method for breaking seed dormancy. This

condition was different to Akasia's seeds, they could break seed dormancy in control method. the data showed that all seeds which were collected from upper canopy have higher percentage on seed viability than from the lower canopy. On Kaliandra's seed, the unit for seed procurement from upper canopy and mechanical breaking seed dormancy showed the highest percentage of viability (100%). Different canopy stratification has an affect on seed germination on Kaliandra. The upper canopy has received more sunlight radiation than lower canopy, it increases the ability of seed germination. Sitompul

(2002) said that the affect of sunlight radiation on plant growth can be seen clearly on plant that grows below another plant. The plant growth was slower than plant that grows upper the below plant. The mechanical breaking seed dormancy has the higher affect on seed viability than other breaking seed dormancy for Kaliandra's seed. Baskin and Baskin (2001) said that is caused by mechanical breaking seed dormancy method will create a small hole in the seed coat and water enters through this opening.

Baskin & Baskin (2001) said that the mechanical method did not work well for thick-coated seeds like those of *Acacia* spp.

It occurs when photosynthesis was not in good process in all canopy strata. Schmidt (2000) said that the high physiology quality was needed to gain viability capacity and high seed vigor, and it will (Bewley & Black 1994) take a longer time for very young embryos to germinate than older ones and the former dependent on the nutrient medium for survival than the latter. This is because early during development the embryos initially lack sufficient nutrients to support their development to the germination stage, and also lack nutrients and stored reserves to support germination and post-germination growth.

CONCLUSIONS

1. There were 2 canopy strata division for seed procurement, they were upper canopy and lower canopy. The highest percentage for seed viability on Kaliandra (*Calliandra tetragona*

Benth.) and Akasia (*Acacia tamarindifolia* (L.) Willd.) was on seed procurement from upper canopy.

2. There were 3 breaking seed dormancy methods, they were control, physical and mechanical. The highest percentage for seed viability on Kaliandra was on mechanical breaking seed dormancy method. And for Akasia seed was on control breaking seed dormancy method.

3. The data of shoot growth interactions among canopy stratification, breaking seed dormancy and two examined species was significant. The data of root growth interactions between canopy stratification and two examined species was significant. Also for interactions between breaking seed dormancy methods and two examined species was significant.

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