BEBERAPA METODE PEMECAHAN DORMANSI BENIH *Leucaena leucocephala* (Lmk. de Witt.) DAN BEBERAPA FUNGI PATOGENIK YANG BERASOSIASI DENGAN BENIH

Some Methods for Breaking the Seed Dormancy of Leucaena leucocephala (Lmk. de Witt.) and Some Pathoygenic Fungi Associated With the Seeds

I G. K. TAPA DARMA[1)]

ABSTRAK

Penelitian ini bertujuan untuk menentukan (1) metode pemecahan dormansi benih dan (2) menentukan fungi patogenik yang berasosiasi dengan benih.

Pemecahan dormansi dengan perendaman benih dalam asam sulfat 65-75% selama 25-35 menit sangat efektif untuk benih no. 3, kurang efektif untuk benih no. 4, tidak efektif untuk benih no. 2 dan mematikan benih no. 1. Akan tetapi untuk semua tingkat kemasakan, makin tinggi konsentrasi asam sulfat atau makin lama perendaman benih dalam asam sulfat, makin tinggi daya berkecambah benih. Terdapat interaksi antara tingkat kemasakan benih dengan konsentrasi asam sulfat.

Metode pemecahan dormansi dengan skarifikasi memakai "sample seed huller" dengan tiga kali pelewatan cukup efektif untuk benih no. 2, no. 3 dan no. 4. Perlakuan yang sama mengakibatkan semua benih no. 1 menjadi rusak. Perendaman benih dalam air mendidih selama 24 jam juga efektif, kecuali untuk benih no. 1 yang menjadi rendah daya berkecambahnya sesudah perlakuan tersebut. Pemecahan dormansi dengan penempatan benih pada 40^0 C selama 24 jam kurang efektif.

Fungi patogenik yang berasosiasi dengan benih adalah : Aspergillus sp., Penicillium sp., Colletotrichum sp., Pythium sp. dan satu jenis yang tidak dikenal (species X), menyebabkan kerusakan pada benih.

INTRODUCTION

Leucaena leucocephala (Lmk. de Witt.) (kemlandingan) is a tree, which has an important role both as forest plant and cultivated crops. In Indonesia, *L. leucocephala* has been known for along time and is used for intercrops at teak plantation or as shade plants and green manure producers in plantation (Martadiredja, 1971). This species is also very useful for erosion prevention (Martadiredja, 1971; Benge, 1976), alang-alang eradication (Knoop, 1910; Mathews, 1974, Benge, 1976) and soil amendments (Martadiredja, 1971).

One problem in management of *L. leucocephala* crop was difficulty in procurement of high quality seed in sufficiently amount. Several things have not been known yet, for instance those concerning dormancy breaking method, and proper condition for storage.

[1)] Staf pengajar dan peneliti di Lab. Patologi Hutan, Fakultas Kehutanan IPB, Kampus IPB Darmaga P.O. Box. 168 Bogor

Various fungi can develop in the seeds during in field or storage, and this can result in rapid decline of seed viability.

For the purpose of solving these problems, several factors those affect seed viability of *L. leucocephala* have been studied, which were among other things as follows:

1. Method of breaking seed dormancy.
2. Fungal pathogen, which attack seed.

Hopefully the research results can be used for developing method of handling seeds of this species, so that good quality seeds are available for planting *L. leucocephala*.

MATERIALS AND METHODS

Seeds of *L. leucocephala*

Seeds of *L. leucocephala* used in this research were those produced by the seed trees, which grew in IPB Campus of Darmaga, Bogor. Seed lots were obtained from pods with four levels of maturity, which were usually harvested for planting purposes, and they were numbered indicating its level of maturity. Explanations on pod and seed development on each number are as follows:

Seed no. 1: Seeds were succulent, and the color ranged from yellow to dark brown. Their pods were yellow and having spots of black or brown color, still fresh and succulent.

Seed no. 2: Seeds were flat and black. Nearly the whole part of the pod was black. Only the stalk and base of pod were still greenish yellow.

Seed no. 3: Seeds were flat and black. Pods were black colored. Their stalks were still fresh and greenish yellows.

Seed no. 4: Seeds were flat and black colored. Pods were black colored, entirely dry, nearly open.

Method of Seed Germination Testing

Seed germination test was conducted by using between paper tests with rice straw paper as germination medium, and by using germination type IPB-2A/B. The observed data, seed germination capacity were the number of the seeds, which germinate normally at the fourth and sixth days after the seeds were placed in the germination. Each treatment comprised four replications of 100 seeds each. Seed germination test was conducted 100 seeds each.

Breaking of Seed Dormancy

Chemical method

Experiment was conducted by soaking seeds in 65%, 70%, and 75% sulfuric acid with duration of soaking for each level of sulfuric acid concentration was 25 minutes, 30 minutes, and 35 minutes, after which the seeds were washed with water. Data in the form of seed germination capacity were analyzed by using factorial design with 4 x 3 x 3 levels (seed lots, sulfuric acid concentration and duration of soaking respectively).

Physical method

Sample of seeds were treated with three treatments, namely (a) soaking in boiling water, which was put away from the heat source for 24 hours, (b) storage at 40^0 C (in incubator) for 24 hours, (c) scarification using sample seed huller with three time passing through. The treated seeds were afterwards tested for their germination capacity. As a control group, is that group of seeds, which did not receive treatment before testing of germination capacity. For this experiment, the design used was completely randomized block design.

Identification of Pathogenic Fungi

Pathogenic fungi, which commonly occurred in seeds of the four levels of seed maturity were studied. Identification was conducted on seeds right after extraction. Seeds were incubated inside Petri dishes in room conditions. After the fungi grow, isolation was conducted and the fungus was grown on PDA. Afterwards the fungus was identified under microscope.

RESULTS AND DISCUSSIONS

Seed Dormancy Breaking

Chemical method

Germination capacity of seeds from various levels of maturity soaked in sulfuric acid at various concentrations with various soaking duration can be seen in Table 1.

Effect of sulfuric acid concentration on seed germination capacity was highly significant. Relation between sulfuric acid concentration (X) and seed germination (Y) was linear with regression equation $Y = -33.80 + 0.786X$. The higher the concentration of sulfuric acid, the greater was the seed germination capacity (Figure 1).

Table 1. Germination capacity of *L. leucocephala* seeds from various levels of pod maturity (A) whose soaked in sulfuric acid in various concentrations (B) and duration (C) (in arc sin √%)

Treatment	Replication				Total
	1	2	3	4	
$a_1b_1c_1$	0.00	0.00	0.00	0.00	0.00
$a_1b_1c_2$	0.00	0.00	0.00	0.00	0.00
$a_1b_1c_3$	0.00	0.00	0.00	0.00	0.00
$a_2b_1c_1$	40.98	43.28	47.87	42.13	174.26
$a_2b_1c_2$	39.82	42.13	46.15	50.77	178.87
$a_2b_1c_3$	42.13	45.00	44.43	45.00	176.56
$a_3b_1c_1$	12.96	16.43	12.92	12.92	55.23
$a_3b_1c_2$	15.34	16.43	12.92	14.18	58.87
$a_3b_1c_3$	16.43	17.46	11.54	12.92	58.35
$a_4b_1c_1$	5.74	8.13	5.74	15.34	34.95
$a_4b_1c_2$	11.54	8.13	9.98	9.98	39.63
$a_4b_1c_3$	11.54	11.54	14.18	17.46	54.72
$a_1b_2c_1$	0.00	0.00	0.00	0.00	0.00
$a_1b_2c_2$	0.00	0.00	0.00	0.00	0.00
$a_1b_2c_3$	0.00	0.00	0.00	0.00	0.00
$a_2b_2c_1$	38.65	42.71	46.98	54.94	183.28
$a_2b_2c_2$	50.18	49.02	46.15	47.87	193.22
$a_2b_2c_3$	47.39	47.29	50.18	52.53	197.39
$a_3b_2c_1$	24.35	20.27	25.10	21.97	91.69
$a_3b_2c_2$	18.44	26.56	21.97	25.10	92.07
$a_3b_2c_3$	21.97	25.84	28.66	30.00	106.47
$a_4b_2c_1$	11.54	8.13	14.18	16.43	50.28
$a_4b_2c_2$	12.92	9.98	12.92	17.46	53.28
$a_4b_2c_3$	16.43	18.44	5.74	14.18	54.79
$a_1b_3c_1$	0.00	0.00	0.00	0.00	0.00
$a_1b_3c_2$	0.00	0.00	0.00	0.00	0.00
$a_1b_3c_3$	0.00	0.00	0.00	0.00	0.00
$a_2b_3c_1$	43.85	43.85	42.71	46.15	176.56
$a_2b_3c_2$	46.15	43.85	40.40	46.72	177.12
$a_2b_3c_3$	42.13	49.02	51.94	49.60	192.69
$a_3b_3c_1$	30.66	27.28	33.21	24.35	115.50
$a_3b_3c_2$	33.21	33.21	33.21	31.95	131.58
$a_3b_3c_3$	38.06	31.95	33.83	33.66	137.50
$a_4b_3c_1$	27.28	22.13	25.84	21.97	97.22
$a_4b_3c_2$	19.37	29.33	22.79	17.46	88.95
$a_4b_3c_3$	21.97	23.58	22.79	26.56	94.90

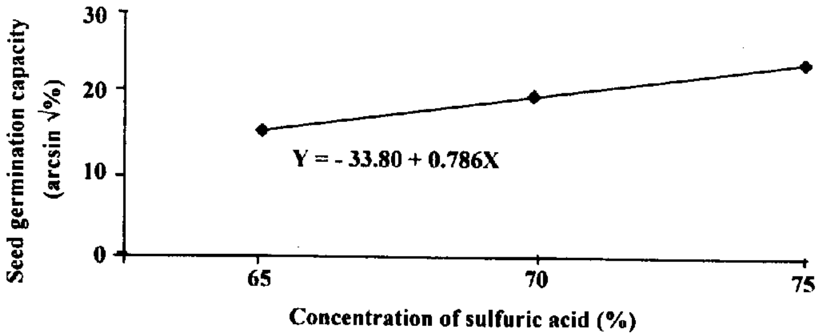

Figure 1. Relationship between concentration of sulfuric acid and seed germination capacity

Test of Honestly Significant Difference revealed that seed maturity level produced highly significant difference (Table 2). Seed germination capacity decreased with the increasing age of the seed.

Table 2. Difference in germination capacity between various levels of seed maturity (A)

Level of Factor A	Average	Value difference for			
		a_1	a_2	a_3	a_4
a_1 (seed lot no.1)	0	-	-	-	-
a_2 (seed lot no.2)	45.66	45.66**	-	-	-
a_3 (seed lot no.3)	23.45	23.45**	22.21**	-	-
a_4 (seed lot no.4)	15.77	15.77**	29.89**	7.68**	-

Remark: HSD (0.05) = 1.83; HSD (0.01) = 2.20; ** Highly significant

Results of test of Honestly Significant Difference showed that sulfuric acid concentration had highly significant effect on seed germination capacity (Table 3).

Table 3. Difference in germination capacity between seeds soaked in various concentration of sulfuric acid (B)

Levels of Factor B	Average	Value difference for		
		b_1	b_2	b_3
b_1 (65 %)	17.32	-	-	-
b_2 (70 %)	21.17	3.85**	-	-
b_3 (75 %)	25.17	7.85**	4.00**	-

Remark : HSD (0.05) = 1.42; HSD (0.01) = 1.79; ** Highly significant

Effects of soaking duration in sulfuric acid solution were highly significant on seed germination capacity. Relation between soaking duration (x) and seed germination capacity (y) was linear with the following regression equation: $y = 14.92 + 0.21x$. The longer the soaking duration in sulfuric acid, the higher was the seed germination capacity (Figure 2).

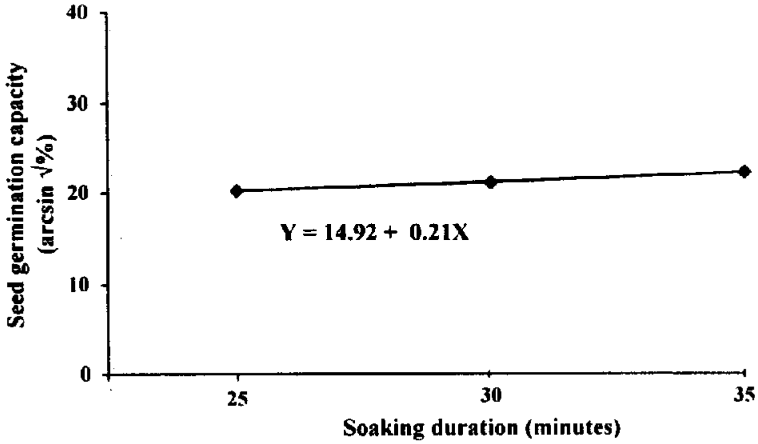

Figure 2. Relationship between soaking duration in sulfuric acid concentration and seed germination capacity.

Results of Honestly Significant Difference test showed that germination capacity of seeds soaked in sulfuric acid for 25 minutes differed in highly significant magnitude with those soaked for 35 minutes (Table 4).

Table 4. Difference in germination capacity between seeds soaked for various duration in sulfuric acid solution (C)

Levels of Factor C	Average	Value difference for		
		c_1	c_2	c_3
c_1 (25 minutes)	20.25	-	-	-
c_2 (30 minutes)	21.12	0.87	-	-
c_3 (35 minutes)	22.30	2.05**	1.18	-

Remark : HSD (0.05) = 1.42; HSD (0.01) = 1.79; ** Highly significant

For first and second level, only interaction between seed maturity level (A) and sulfuric acid concentration (B), which had highly significant effect. After further examination, it turned out that interaction between sulfuric acid concentration and seed lot no.3 and 4 had highly significant effect (Table 5).

Table 5. Analysis of variance for the effect of interaction between seed maturity level (A) and sulfuric acid concentration (B) on seed germination capacity

Source of Variation	Degree of Freedom	Sum of Square	Mean Square	F computed
Between B within a_1	2	0	0	-
Between B within a_2	2	30.40	15.20	1.78
Between B within a_3	2	916.37	458.19	53.78^{**}
Between B within a_4	2	533.21	266.61	31.29^{**}

Remark: ** Highly significant; P (0.01) = 4.82

Observation results showed that soaking in various concentration of sulfuric acid concentration, produced better germination capacity for seed lot no.3 and no.4, as compared to seed lot no.1 and no.2. Soaking in sulfuric acid damaged all seeds from seed lot no. 1.

Effects of sulfuric acid concentration on germination capacity of seed lot no. 3 and 4 were linear (Figure 3). The increase in sulfuric acid concentration, enhanced seed germination capacity.

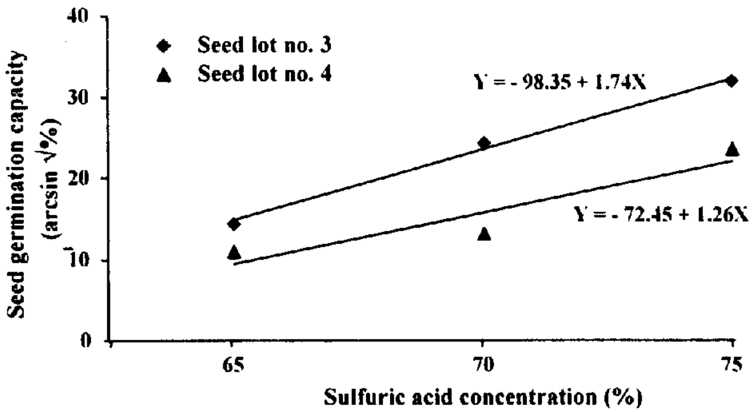

Figure 3. Relationship between sulfuric acid concentration and seed germination capacity

Results of Honestly Significant Difference test showed that for seed lot no. 3, concentration of sulfuric acid produced highly significant difference for germination capacity. For seed lot no. 4, there were no significant difference between seeds soaked in sulfuric acid 65% and those of 75%. Difference in germination capacity between seeds soaked in sulfuric acid 65% and those of 75% appeared significant (Table 6).

Table 6. Difference in germination capacity of seeds for maturity level no. 3 (a_3) and those of no. 4 (a_4) soaked in sulfuric acid 65% (b_1), 70% (b_2), and 75 % (b_3)

Factor Level	Average	Difference		
a_3b_1	14.37	-	-	-
a_3b_2	24.19	9.82**	-	-
a_3b_3	31.80	17.43**	7.61**	-
a_4b_1	10.78	-	-	-
a_4b_2	13.20	2.42	-	-
a_4b_3	23.34	12.56	10.14**	-

Remark: HSD (0.05) = 4.02; HSD (0.01) = 4.68; ** Highly significant

Physical method

Germination capacity of seeds which had received physical treatments, namely soaking in boiling water for 24 hours, storage at 40°C for 24 hours, scarification with "sample seed huller" with three times of passing through, and control treatment, were presented in Table 1. Results of variance analysis showed that treatments did not have any significant effect toward seed germination capacity (Table 7).

Table 7. Analysis of variance for the effect physical treatments on seed germination capacity

Source of Treatment	Degree of Freedom	Sum of Square	Mean Square	F computed
Block	3	718.55	239.52	0.34 (2.94)[1)]
Treatment	3	1,243.56	414.52	0.58 (1.72)
Treatment error	9	6,408.82	712.09	
Total	15	8,370.93		

[1)] ( ) : 1/F computed

For getting information from each maturity level concerning the effect of various treatments on seed germination capacity, variance analysis was conducted and that the treatments had significant effect.

Results of Honestly Significant Difference test for seed germination capacity from each maturity level treated with various physical means were shown in Table 8.

Table 8. Difference in germination capacity between treatments (T) at various level of seed maturity (A)

Treatment		Average	Value difference with			Remarks
			t_0	t_1	t_2	
a_1 (seed lot no. 1)	t_0	73.58	-	-	-	HSD (0.05) = 9.97
	t_1	40.16	33.42**	-	-	
	t_2	58.86	14.72**	17.30**	-	
	t_3	0.00	73.58**	40.16**	58.86**	
a_2 (seed lot no. 2)	t_0	40.25	-	-	-	HSD (0.05) = 9.70 HSD (0.01) = 12.71
	t_1	47.01	6.06	-	-	
	t_2	16.00	24.75**	31.01**	-	
	t_3	71.96	31.01**	24.95**	55.96**	
a_3 (seed lot no. 3)	t_0	17.06	-	-	-	HSD (0.05) = 6.93 HSD (0.01) = 9.08
	t_1	48.74	31.68**	-	-	
	t_2	9.84	7.22**	38.90**	-	
	t_3	59.38	42.32**	10.64**	49.54**	
a_4 (seed lot no. 4)	t_0	11.45	-	-	-	HSD (0.05) = 5.71 HSD (0.01) = 7.48
	t_1	45.58	34.13**	-	-	
	t_2	8.73	2.72	36.85**	-	
	t_3	45.86	34.41**	0.28	37.13**	

Remark: * Significant at HSD (0.05); ** Highly significant at HSD (0.01);
t_0: Control (without treatment); t_1: Soaking in boling water for 24 hours;
t_2: Storage at 40°C for 24 hours; t_3: Scarification with sample seed huller

Relation between seed maturity level and seed germination capacity for various physical treatments showed that soaking in boiling water for 24 hours could increase germination capacity of seed lot no. 2, no. 3, and no. 4. However, germination capacity of seed lot no. 1, could not be increased, even it was lower than that of control. Also, storage at 40°C for 24 hours caused a decrease in germination capacity for each maturity level. The older the seed, the lower was the germination capacity after storage at 40°C for 24 hours. Seed scarification with sample seed huller with three times of passing through, increased the germination capacity of seed lot no. 2, no. 3, and no. 4. Germination capacity of seed lot no. 2 was higher than that of no. 3, and that of no. 3 was higher than that of no. 4. On the other hand, seed scarification with sample seed huller made the seed lot no. 4 unable to germinate (Figure 4).

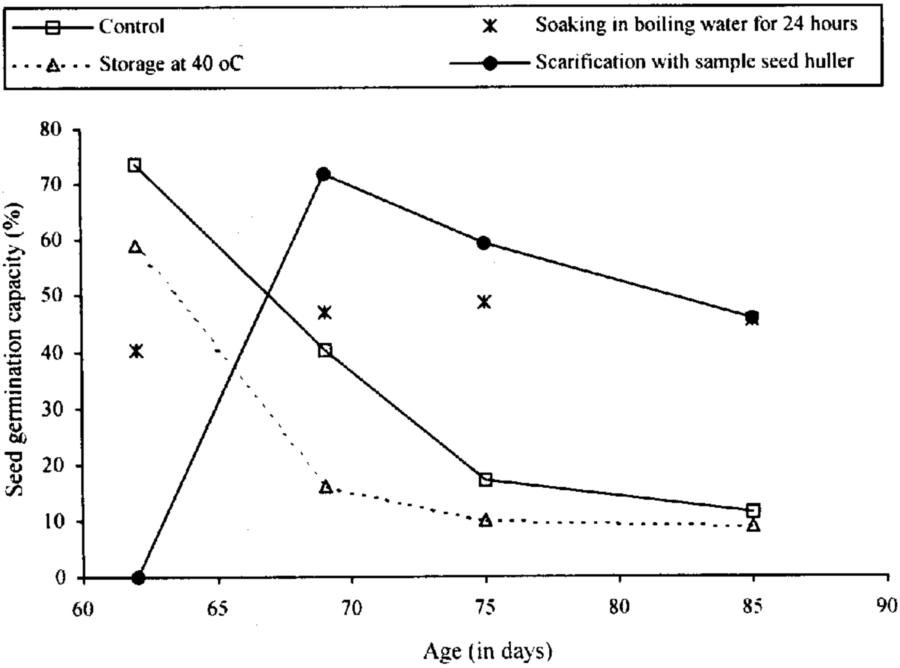

Figure 4. Relation between maturation level and germination capacity of seed treated with various physical means

In this study, all physical means to break dormancy, namely seed soaking in boiling water, seed storage at 40°C and seed scarification, had no effect on seed germination capacity. This was because the effect of dormancy breaking technique varied with various levels of seed maturity (Table 9).

Variation in the effect of treatments at various levels of maturity on the seed germination capacity was due to difference in response from the seed coat of varying levels of maturity, toward a certain treatment (Figure 4). The phenomenon could be described as follows (Figure 4):

1. Soaking in boiling water; many seeds of seed lot no. 1 were damaged and destroyed, due to their seed coat, which were still soft. In such condition, pathogenic fungi developed well and caused the germination capacity of treated seeds to be lower than that of control. For older seed, boiling water was able to soften the seed coat so that germination capacity could exceed that of control, although it did not reach maximum. Maximum results from seed soaking in boiling water could be achieved by adjusting the volume and temperature of water, and the soaking duration (Goor and Barney, 1968, and Woody Plant Seed Manual, 1948). Probably, the maximum germination capacity of seed lot no. 2, 3, and 4 could be achieved by longer soaking duration, or by

the use of higher water temperature, greater volume of water, or combination of those treatments. To get information of this phenomenon, further studies need to be conducted.

Table 9. Germination capacity of *L. leucocephala* seeds from various levels of pod maturity (A) by physical treatments (T) (in arcsin √%)

Treatment	Replication				Sum
	1	2	3	4	
a_1t_0	77.08	72.54	75.82	68.87	294.31
a_2t_0	48.45	38.06	34.47	39.82	160.80
a_3t_0	14.18	15.34	18.44	20.27	68.23
a_4t_0	12.92	9.98	9.98	12.92	45.80
a_1t_1	39.82	35.06	33.21	52.53	160.62
a_2t_1	47.87	45.57	49.60	45.00	188.04
a_3t_1	50.18	49.02	50.18	45.57	194.95
a_4t_1	42.71	45.00	50.18	44.45	182.34
a_1t_2	59.34	57.42	59.34	59.34	235.44
a_2t_2	15.34	8.13	20.27	20.27	64.01
a_3t_2	8.13	8.13	11.54	11.54	39.34
a_4t_2	12.92	8.13	5.74	8.13	34.92
a_1t_3	0.00	0.00	0.00	0.00	0.00
a_2t_3	77.08	67.21	68.87	74.66	287.82
a_3t_3	64.16	53.73	63.44	56.17	237.50
a_4t_3	45.00	42.71	49.02	46.72	183.45

2. Treatment by exposing the seeds to temperature of 40°C; germination capacity of seeds from all levels of maturity was lower than those of control if the former was previously exposed to temperature of 40°C. This was probably due to decreasing moisture content, so that the seeds were not ready to germinate or the protein begun to be destroyed at this temperature. Injury on seed could become a site or center of infection of pathogenic fungi.
3. Treatment with scarification; seed lot no. 1, became destroyed if scarified, because the seeds were still succulent and having soft seed coat. For seed lot no. 2, 3, and 4, scarification treatment produced the highest germination capacity as compared with other treatments. Adjustment of distance between concave plane and the cylinder, and the three times passing through of seeds, seemed to be not optimum enough for scarifying seeds of *L. leucocephala*. Researches on the appropriate distance of concave plane and the cylinder, and the number of passing through for various levels of seed maturity, should be conducted to obtain an optimum germination capacity.

Pathogenic Fungi Associated with the Seeds

Pathogenic fungi, which attacked seed of *L. leucocephala* from various levels of seed maturity, are depicted in Table 10.

Table 10. Pathogenic fungi associated with the seeds of *L. leucocephala*

Maturity Level (number)	Moisture Content (%)	Percentage		Pathogenic Fungi
		Germination	Attacked	
1	50.30	93	2.50	*Aspergillus* sp., *Penicillium* sp., *Colletotrichum* sp., *Spesies* x
2	15.83	48.25	20.00	*Aspergillus* sp., *Colletotrichum* sp., *Pythium* sp.
3	9.70	5.00	3.00	*Aspergillus* sp., *Pythium* sp.
4	7.85	5.00	1.00	*Aspergillus* sp., *Pythium* sp.

Remark : Species x = unidentified

Species of fungi was found mostly on youngest seed, and was less on older seeds. This had something to do with seed moisture content. The older the seed, the lower was its moisture content. Higher moisture content of seed is more suitable for development of various fungi. This phenomenon was indicated by the least number of pathogenic fungi on seed lot no. 3 and 4. It turned out that moisture content of seed lot no. 3 and 4 had been too low and were not suitable anymore for growth of pathogenic fungi. Seed lot no. 3 and 4 underwent dormancy; their seed coat was hard so that fungi could not develop. The decreasing number of fungi species for older seeds was due to the phenomenon that each fungi species processed a somewhat specified range of tolerance toward seed moisture content which was suitable for their development (Christensen, 1972).

The presence of fungi in seeds, right after extraction, was supposed to be derived from contamination before seed extraction was conducted. This appeared more clearly at pods, which became rotten due to attack by fungi when they were still at trees.

Aspergillus sp. was a species, which commonly attacked seeds. Their range of tolerance toward seed moisture content was very wide. This species was known to be able to develop in soybean seeds with moisture content of 90 % (Sukmaraganda, 1976). This species occurred on seed surface as resting spores, or under the pericarp layer as dormant mycelium. This species could deteriorate seed quality (Christensen and Kaufmann, 1968).

The decreasing germination capacity of seeds was due to seeds physiological activity, as well as to pathogenic fungi, which damage the seeds. Fungi affect seed directly by taking out energy and indirectly by producing toxic substances for the seeds through metabolic process. Beside that, fungi also produced more water, which made the seeds more conducive for further fungi development.

CONCLUSSION AND RECOMMENDATION

Seed Dormancy Breaking Methods

Method of dormancy breaking affected very much the seed germination capacity. In applying the various methods, levels of seed maturity were influenced on seed germination capacity.

Chemical Method

Seed soaking in sulfuric acid increased the germination capacity. The higher the sulfuric acid concentration, the higher was the seed germination capacity. Application of sulfuric acid 65-75% was the most effective for seed lot no. 3, but was less effective for seed lot no. 4 due to already hardened seed coat, and was not effective for seed lot no. 1 and no. 2 due to seed damage by sulfuric acid which even was able to kill seed lot no. 1.

Soaking duration of seed in sulfuric acid affected very much the seed germination capacity. The longer the soaking duration, the greater was the germination capacity.

It was recommended that the seeds were soaked in sulfuric acid for 65 minutes before sowing. Concentration of sulfuric acid for seed lot no. 3 should be 75%. The corresponding figure for seed lot no. 4 could still be higher than 75%, whereas those for seed lot no. 2 and no. 1 could be lower than 65%.

Physical Method

Effects of various physical treatments for breaking seed dormancy, on the seed germination capacity were not different among those of various levels of seed maturity. However, the effect of treatment varied within each level of seed maturity.

Soaking seed in boiled for 24 hours could decrease germination capacity of seed lot no. 1, but this treatment could increase in highly significant amount the germination capacity of older seeds.

Seed storage at 40°C decreased seed germination capacity for each level of seed maturity, although the effect of storage was not significant for seed lot no. 3 and 4. Seed scarification using sample seed huller with three times of passing through increased seed germination capacity, as compared to other physical treatments, except for seed lot no. 4 which did not show significant difference with the results of soaking for 24 hours in boiled water. Scarification could make seed lot no. 1 failed to germinate, due to damage of all of the seeds.

It could be recommended that if the seeds were not grouped according to their level of maturity before sowing, the seeds to be treated seed lot no. 2, no. 3, and no. 4, should be scarified before sowing or could be soaked in boiled water for 24 hours before sowing. Seed lot no. 1 need not be treated before sowing.

Pathogenic Fungi Associated with the Seeds

It was various pathogenic fungi could attack the seeds of *L. leucocephala*. Infestation by fungi could occur while the seeds or pods were still on the trees or after harvesting time.

Level of maturity and seeds moisture content, affected strongly the number of pathogenic fungi species on seeds. The higher the level of seed maturity, the lower would be the number of fungi species and attacked by pathogenic fungi.

Aspergillus sp. occurred on all seeds attacked by fungi. The use of seed lot no. 1 or no. 2 is more beneficial than of seed lot no. 3 and no. 4, due to better germination capacity.

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