Seed Longevity of Miscanthus Species [1]

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Abstract

The objectives of this experiment were to determine the relationship between seed longevity and storing period for *Miscanthus* spp. Seeds of *M. floridulus* were harvested from Taitung county and mountainous areas at 1600 m in elevation in Nantou county and those of *M. transmorrisonensis* from mountainous areas at 2600 m in elevation in Nantou county, respectively. Before germination test, the seeds were stored in ambient condition and in a refrigerator at 4℃ for 0, 3, 6, 12, 18 and 24 months, respectively. Germination tests were conducted in an incubator at 25℃. The germination ability of the seeds stored in ambient condition for 6 months was reduced drastically. No germination was observed after storing in ambient condition for periods of 12 months or more. The germination ability of those seeds stored in a refrigerator for up to 24 months was not affected. Seeds of *M. transmorrisonensis* showed the highest germination ability stored in a refrigerator for 24 months. No effect was observed on germination ability of the seeds after aging in a dry state at 40℃ for 96 hours. However, significant decrease in germination ability was observed after aging in a moistened state at 40℃ for 24 hours, and germination was almost stopped after aging under this condition for 48 hours. Seeds of *M. transmorrisonensis* were more tolerant to aging treatment than those of *M. floridulus*. It was concluded that *Miscanthus* seeds might lose their germination ability 6 months after being dispersed by the wind under natural conditions.

Key words: *Miscathus*, Germination, Aging, Seed longevity.

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Introduction

Miscanthus spp., a native grass, is distributed widely in Taiwan, from lower land areas up to mountainous areas at 3000 m in elevation. *Miscanthus* commonly blooms between September and November, although some flower during late spring and early summer. The matured seeds are easily dispersed by wind and grow vigorously in the soil. Hsu (1985) reported that germination percentages of the unchilled seeds of *Miscanthus* were above 86% when they were germinated at temperatures between 10 and 35℃. Chilling did not improve seed germination, however, it did enhance the rate of germination. The lowest temperature tolerated for germination of unchilled seeds was 8.3℃. Hsu (1986) showed that seeds harvested from different locations had the same germination percentages when they were incubated at 15, 25 and 35℃, respectively. This confirmed further the results reported by Hsu (1985). Hsu (1986) also reported that germination percentages of *Miscanthus* in light was higher than that under condition of darkness.

Hsu (1988) indicated that the range of tolerance to water potential for seed germination of *Miscanthus* was between blue stem (*Andropogon* spp.) and sorghum (*Sorghum bicolor*). Hsu (1989) pointed out that seed germination of *M. floridulus* was inhibited by infrared, ultra violet and blue light, and concluded that the germination of *Miscanthus* seeds was of the short-day type which required only 5 minutes of light exposure to enhance their germination ability. Hsu (1990) reported that percentages and rates of germination of *Miscanthus* were reduced when the concentrations of NaCl solution were increased, suggesting that seeds harvested from lower land areas were more salt-tolerant. The maximum concentration of salt tolerance to seed germination for *M. floridulus* was 23,775 ppm, while that for *M. transmorrisonensis* was 18,865 ppm. Hsu and Chou (1992) showed that the germination ability of *Miscanthus* was decreased with increasing concentrations of heavy metals and followed a decreasing order of inhibition : Cd > Cu > Hg > Pb. *Miscanthus* seeds had high ability adapting to different environments. There is little information about seed longevity and germination ability of *Miscamthus* under natural condition.The objectives of this study were to determine the germination ability of *Miscanthus* seeds under different storing conditions and periods and to learn more about the seed longevity of *Miscanthus*.

Materials and Methods

Seed preparation

The seeds were harvested from *Miscanthus floridulus* in Taitung county and in mountainous areas at 1600 m in elevation in Nantou county and from *M. transmorrisonensis* in mountainous areas at 2600 m in elevation in Nantou county, respectively. Seeds were stored both in an ambient condition and in a refrigerator at 4℃ for 0, 3, 6, 12, 18 and 24 months, respectively, and were taken out from the caryopsis by hand before germination test.

Germination test was conducted according to the Association of Official Seed Analysts (1981). A piece of sponge was saturated with 0.1% Benalate, methyl-1-(butylcarbamoyl)-2-benzimidazole carbamate, to prevent bacterial growth. Then a filter paper was layed on the sponge. Twenty seeds for each treatment were distributed fairly uniformly on filter paper in Petri dishes. The Petri dishes were set in incubator with a constant temperature of 25℃, and light and dark periods were set for 12 hours each. Germination was recorded when the radical reached 2 mm. The seeds were counted and removed twice per day during the first week, once per day during the second week, and then once every two days until the end of the test period. The test was terminated when there was no further germination after three consecutive days. The final germination percentage and rate of germination were determined. Germination rate index (GRI) was used to evaluate germination ability.

The GRI was obtained by summarizing germination percentages at each counting divided by the days after placing seeds in the incubator (Hsu *et al.*, 1985). The germination percentage was arcsine-transformed prior to statistical analysis (Snedecor and Cochran, 1980). A completely randomized design (CRD) was used with 5 replications.

Aging treatment

Aging is defined as the germination ability of the seeds decreased when the storing period is increased. Generally, the aging rate of the seed is increased under the conditions of high temperature and moistened state. The above-mentioned seeds were aged at 40℃ under both dry and moistened states for 0, 24, 48, 72 and 96 hours, respectively. Then germination test was conducted on these seeds following the procedures mentioned above.

Table 1. Effects of storing conditions and periods on seed germination of *Miscanthus floridulus* and *M. transmorrisonensis*

Storing condition	Storing period	*M. floridulus* (Taitung)		*M. floridulus* (Nantou)		*M. transmorrisonensis*	
		Germination percentage	Germination rate index	Germination percentage	Germination rate index	Germination percentage	Germination rate index
	month	%	% day^{-1}	%	% day^{-1}	%	% day^{-1}
Ambient condition	0	100^{a}	5.54^{a}	100^{a}	3.17^{b}	93^{a}	2.57^{b}
	3	95^{b}	5.18^{b}	98^{a}	3.81^{a}	95^{a}	3.35^{a}
	6	61^{c}	2.79^{c}	74^{b}	2.30^{c}	60^{b}	1.62^{c}
	12	0^{d}	0^{d}	0^{c}	0^{d}	0^{c}	0^{c}
	18	0^{d}	0^{d}	0^{c}	0^{d}	0^{c}	0^{c}
	24	0^{d}	0^{d}	0^{c}	0^{d}	0^{c}	0^{c}
	Mean	42.7^{B}	2.25^{B}	45.3^{B}	1.55^{B}	41.3^{B}	1.26^{B}
4℃	0	100^{a}	5.54^{b}	100^{a}	3.17^{c}	93^{ab}	2.57^{c}
	3	97^{ab}	5.03^{c}	94^{b}	3.41^{c}	93^{ab}	3.03^{b}
	6	100^{a}	6.03^{a}	95^{ab}	3.09^{c}	89^{b}	2.94^{bc}
	12	99^{a}	4.91^{c}	99^{ab}	5.19^{a}	89^{b}	3.29^{b}
	18	100^{a}	5.90^{ab}	98^{ab}	4.49^{b}	95^{ab}	3.26^{b}
	24	95^{b}	4.98^{c}	97^{ab}	4.12^{b}	100^{a}	4.41^{a}
	Mean	98.3^{A}	5.40^{A}	97.2^{A}	3.91^{A}	93.2^{A}	3.25^{A}

$^{a, b, c, d}$: Means with the same letter within the same storing condition in the same column are not significantly different at 5% level.

$^{A, B}$: Means with the same letter in the same column are not significantly different at 5% level.

Results and Discussion

Effects of storing condition and period on seed germination of *Miscanthus*

The germination percentages of *M. floridulus* from Taitung county and *M. transmorrisonensis* from Nantou county were not affected by their storage in ambient conditions 3 months after storing. Germination percentages, however, were significantly decreased after 6 months storage. No germination was observed for these 3 entries after 12, 18 and 24 months storage, respectively (Table 1). Germination rate indices were the highest for *M. floridulus* (Nantou) and *M. transmorrisonensis* 3 months after storing, but not for *M. floridulus* from Taitung. The GRIs were significantly decreased 6 months after storing (Table 1). Germination percentages of these 3 entries were not affected by storing period when the seeds were stored at 4℃ in a refrigerator for 24 months. The GRIs were also not greatly affected by storing period

when the seeds were stored at 4℃. Some GRIs were increased after storing at 4℃ for more than 12 months. *M. transmorrisonensis* had the highest germination percentage and GRIs after storing at 4℃ for 24 months.

The results showed that both germination percentage and GRI of these 3 entries stored at 4℃ were higher than those stored under ambient conditions. The seeds of *Miscanthus* spp. lost their germination ability 6 months after storing in an ambient condition.

Effects of aging treatment on seed germination of *Miscanthus*

Both germination percentage and GRI of *M. floridulus* from Taitung and Nantou counties and *M. transmorrisonensis* from Nantou county at 2000 m in elevation stored at 4℃ for different periods were little affected by aging treatments in a dry state at 40 ℃ for 0 – 96 hours (Table 2). However, germination percentages and GRI were significantly decreased when the seeds were aged at 40℃ with moistened state (Table 3).

Table 2. Effects of the aging treatment in a dry state on seed germination of *Miscanthus floridulus and M. transmorrisonensis* after storing at 4℃ for different periods

Storing	Aging	*M. floridulus* (Taitung)		*M. floridulus* (Nantou)		*M. transmorrisonensis*	
period	treatment	Germination percentage	Germination rate index	Germination percentage	Germination rate index	Germination percentage	Germination rate index
month	hour	%	% day^{-1}	%	% day^{-1}	%	% day^{-1}
3	0	97^{a}	5.03^{a}	94^{ab}	3.14^{a}	93^{a}	3.03^{a}
	24	94^{a}	4.74^{a}	95^{a}	2.94^{b}	89^{a}	2.40^{b}
	48	94^{a}	4.98^{a}	92^{ab}	2.96^{ab}	88^{a}	2.45^{b}
	72	92^{a}	5.19^{a}	85^{b}	2.69^{b}	92^{a}	2.59^{b}
	96	97^{a}	5.06^{a}	97^{a}	3.08^{ab}	93^{a}	2.91^{a}
12	0	99^{a}	4.91^{a}	99^{a}	5.15^{a}	89^{a}	3.29^{a}
	24	98^{a}	4.94^{a}	98^{a}	3.90^{b}	90^{a}	3.11^{a}
	48	100^{a}	5.14^{a}	88^{bc}	3.62^{bc}	88^{a}	3.04^{a}
	72	96^{a}	4.94^{a}	84^{c}	3.48^{c}	91^{a}	3.03^{a}
	96	96^{a}	4.75^{a}	93^{b}	3.83^{bc}	89^{a}	3.00^{a}
24	0	95^{a}	4.98^{a}	97^{a}	4.12^{a}	100^{a}	4.41^{a}
	24	96^{a}	5.16^{a}	93^{a}	3.20^{b}	95^{b}	3.26^{b}
	48	95^{a}	5.03^{a}	93^{a}	3.21^{b}	91^{b}	3.27^{b}
	72	95^{a}	5.28^{a}	96^{a}	3.31^{b}	84^{c}	2.95^{b}
	96	88^{a}	4.91^{a}	95^{a}	3.20^{b}	94^{b}	3.23^{b}

$^{a, b}$: Means with the same letter within the same storing period in the same column are not significantly different at 5% level.

Table 3. Effects of aging treatment in a moistened state on seed germination of *Miscanthus floridulus and M. transmorrisonensis*

Entry	Aging treatment	Germination percentage	Germination rate index
M. floridulus (Taitung)	hour	%	% day^{-1}
	0	92^{a}	2.56^{a}
	24	20^{b}	0.45^{b}
	48	4^{c}	0.06^{c}
	72	0^{c}	0^{c}
	96	0^{c}	0^{c}
M. floridulus (Nantou)	0	98^{a}	1.63^{a}
	24	18^{b}	0.39^{b}
	48	2^{c}	0.03^{c}
	72	2^{c}	0.03^{c}
	96	0^{c}	0^{c}
M. transmorrisonensis	0	92^{a}	1.38^{a}
	24	64^{b}	1.03^{b}
	48	18^{c}	0.23^{c}
	72	16^{c}	0.21^{c}
	96	6^{c}	0.07^{c}

$^{a, b, c}$: Means with the same letter within the same entry in the same column are not significantly different at 5% level.

Both germination percentages and GRI for the seeds of *M. floridulus* from both Taitung and Nantou counties were remarkably decreased after aging for 24 hours. It was almost no germination for these two entries after aging for 48 hours. *M. transmorrisonensis* was more tolerant to aging treatment in a moistened state than *M. floridulus*. The former still had the abilty to germinate after aging in a moistened state for 96 hours.

The results indicated that the germination ability of *Miscanthus* seeds were significantly decreased 6 months after storing under ambient condition. However, the germination ability was not affected when the seeds were stored at 4℃ for up to 24 months. Oliveira and Mastrocola (1987) reported that the germination ability of some tropical forage species was not significantly affected after the seeds were stored at 22 ℃ for 11 to 12 months. Delouche and Baskin (1983) indicated that the aging treatment

could be used to estimate the storing potential of seeds. The results showed that no effect was observed when the seeds were aged in a dry state at 40℃ for 96 hours. However, significant effect was observed after the seeds were aged in a moistened state at 40℃ for 24 hours. Hsu (1990) reported that germination ability and salt tolerance of *Miscanthus* seeds were decreased after aging at 35℃ and relative humidity of 90% for 1 to 4 weeks.

Based on the results obtained, the germination ability of *Miscanthus* seeds was significantly decreased after storing in an ambient condition for 6 months. No germination was observed 12 months after storing in the ambient condition. In nature, the seeds of *Miscanthus* spp. are dispersed by wind during the matured stage in winter. The seeds might have a chance to germinate and grow under conditions of rain and warmer temperature in the next spring. If the seeds did not have chance to germinate in the next spring, the seeds might lose their germination ability. When the seeds germinate in spring and grow through the summer, the plants will have a better chance to survive through the dry and cold winter and maintain their dominant distribution in the natural ecosystem.

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芒草種子壽命之研究(1)

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摘　要

本試驗目的乃在探討芒草(*Miscanthus* spp.) 種子壽命與貯存期限之關係，將採自台東及南投海拔1,600公尺之五節芒(*M. floridulus*)與採自海拔2,600公尺之高出芒(*M. transmorrisonensis*) 種子分別貯存於室溫及冷藏櫃(4℃及相對濕度50%)0、3、6、12、18及24個月後，置於發箱25℃中發芽，結果得悉貯存在室溫下的種子，其發芽力於貯存6個月後即急速減少，貯存12個月以上種子即無法發芽，而貯存在冷藏櫃中者，其發芽力則未受貯存期限的影響，高山芒反而於冷藏櫃貯存24個月後，仍保有最高的發芽力。芒草種子在乾燥情況下於40℃經過衰化處理96小時後，對其種子發芽力沒有很大的影響。但在潤溼情況及40℃下，經過衰化處理24小時後，其種子發芽力即顯著的降低，在衰化處理48小時後，其發芽力幾乎停止；高山芒比五節芒種子較能忍受衰化處理。依此推斷芒草種子於冬天成熟後被風吹落於土中，若未能於第二年的春天發芽生長，於6個月後，將會失去其發芽能力。

關鍵詞：芒草、發芽、衰化、種子壽命。

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