Germination of Two Rice Cultivars and Several Weed Species

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벼와 數種 논雜草의 休眠性과 發芽性

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ABSTRACT

An experiment was carried out at the International Rice Research Institute in 1987 to understand the seed dormancy and germination habit of rice and several weed species.

The germinability of the weed seeds just after harvest was variable depending on the species and ranged from 0 to 72%. Two rice cultivars, IR64(lowland type) and UPLRi-5(upland type) had higher than 95% in germination ability throughout the experimental period due to the fact that the rice seeds came from the harvest of the previous season and dormancy had already been overcome.

The length of the storage period needed to overcome dormancy at room temperature(25±2℃) was about 50 days for *Echinochloa glabrescens* Munro ex Hook. f., more than 60 days for *E.crus-galli* ssp. *hispidula* (Retz.) Honda and 20 days for *Ludwigia octovalvis* (Jacq.) Raven. Seeds of *E.colona* (L.) Link, *Monochoria vaginalis* (Burm. f.) Presl, *Fimbristylis miliacea* (L.) Vahl and *Cyperus difformis* L. appeared to have no dormancy.

Among the nine species *M.vaginalis* had the lowest germination of less than 1% throughout the experimental period. However, its seed germinated easily when planted in soil.

The low germinability of *E. glabrescens*, *E. crus-galli* ssp. *hispidula* and *L. octovalvis* just after harvest could be overcome through pretreatment of seeds either by soaking in nitric acid(0.1N) for 1 day or removal of the hull in the grass species, the nitric acid treatment being superior.

The results imply that germination habit of weed species varied depending on the species through their differential dormancy period or differential germination strategy.

INTRODUCTION

The two fundamental components of fitness or adaptation are survival and reproduction. Germination habit is one of the important characters attributed to enhance adaptability.

Dormancy are generally classified as three types: innate, induced and enforced(Muzik, 1970). Innate dormancy which is genetic is the failure of fresh seed to germinate even under favorable conditions mainly due to impermeable seed coats to water or gases or due to inhibiting chemicals in the fruit or seed coats or within the embryo or endosperm. Seeds which ordinarily would germinate immediately if planted under favorable conditions may be thrown into dormancy by an unfavorable environment so that they will not germinate even when conditions become favorable. This is termed induced or secondary

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dormancy. Seeds, on the other hand, may be prevented from germinating by various environmental factors such as lack of moisture, lack of oxygen, or low temperature. When the external limitation is removed the seeds germinate. This is termed enforced dormancy.

In some weed species like *Echinochloa colona* (L.) Link (Chun, 1982), *Amaranthus graecizans* L. (Martin, 1943) seed dormancy is absent while it is present in a number of other important weed species such as *E. crus-galli* Beauv. var. *oryzicola* Ohwi (Arai and Miyahara, 1960), *Fimbristylis miliacea* (L.) Vahl (Juliano, 1940) and *Alopecurus aequalis* Sobol (Arai and Chisaka, 1961). Also, seeds of some weed species may be capable of germination when collected but may become dormant during storage (Arai and Miyahara, 1960). Kim (1979) reported that seed dormancy of *Monochoria vaginalis* (Burm. f.) Presl is absent while reversed results were reported by Kataoka (1979) and Park (1985).

Dawson (1963) reported that caryopses contained in a spikelet of *E. crus-galli* were dormant at maturity and required an afterripening period to overcome this. Shi-Jean et al (1987) reported a similar result and found that the dormancy was overcome when the spikelets were dry afterripened at 23℃ or subjected to high temperatures, acid scarification, or punctured with a scalpel.

This experiment was conducted in a laboratory at the International Rice Research Institute, LosBanos, Laguna, Philippines using seven lowland weed species and two rice cultivars to clarify the germination habit of these species.

MATERIALS AND METHODS

Seeds of seven weed species (Table 1) were collected from April 15 to 25, 1987 at the IRRI experimental farm. These were air dried for 10 days and then gently rubbed to obtain individual grains or seeds. Seeds of two rice cultivars, IR64 (lowland-type) and UPLRi-5 (upland-type) which were harvested during the previous cropping season were also prepared for use as reference seeds.

For all germination tests, there were three replications of 50 seeds each. The seeds were placed on water-moistened 5.5cm-diameter filter paper in 5.5cm petri dishes and maintained at 25±2℃ under fluorescent light. Additional water was added when required. Protrusion of the radicle or coleoptile from the seed was the criterion for germination. Germination counts were taken every day for 3 weeks.

To understand the innate dormancy of each species, seed germination tests were run at 10-day-intervals from May 5 to July 5. Another germination test was run on November 22 to determine if there was any induced dormancy in any of the species.

The effect of seed pre-treatment was also

Table 1. Plant species used in the experiments

Species	Family	Photosynthetic pathway	Group	Habitat
Rice				
'IR 64	Poaceae	C_3	Grass	Lowland
'UPLRi-5	Poaceae	C_3	Grass	Upland
Weeds				
'*Echinochloa glabrescens*	Poaceae	C_4	Grass	Lowland
'*Echinochloa crus-galli* ssp. *hispidula*	Poaceae	C_4	Grass	Lowland
'*Echinochloa colona*	Poaceae	C_4	Grass	Upland
'*Monochoria vaginalis*	Pontederiaceae	C_3	Broadleaf (Monocot)	Lowland
Ludwigia octovalvis	Onagraceae	C_3	Broadleaf (Dicot)	Lowland
'*Fimbristylis miliacea*	Cyperaceae	C_4	Sedge	Lowland
'*Cyperus difformis*	Cyperaceae	C_3	Sedge	Lowland

evaluated by soaking the seeds for 1 day in 0.1N nitric acid solution or water and by removing the seed hull of rice and the *Echinochloa* species. Seeds soaked in nitric acid were rinsed with water before the germination test. The effect of the duration of soaking in nitric acid solution and water was included in the germination tests from May 26. For this seeds were soaked in nitric acid solution or water for 1 to 7 days.

RESULTS AND DISCUSSION

One of the major problems in getting plants to grow when and where desired is a differential dormancy strategy in each of the species. In this experiment the germinability of the weed seeds just after harvest was variable depending on the species and ranged from 0 to 72% (Table 2). The two rice cultivars, IR64 and UPLRi-5, had extremely high germination ability (>95%) throughout the experimental period. This was probably due to the fact that the rice seeds came from the harvest of the previous season and dormancy had already been broken.

Echinochloa colona, *F. miliacea*, *C. difformis* and *L. octovalvis* showed relatively high germinability (about 70% immediately after harvest). The results for *F. miliacea* differ from those of Juliano (1940) who reported no germination of this species soon after harvest. Among the *Echinochloa* species *E. crus-galli* ssp. *hispidula* exhibited the lowest germination having less than 15% germination for 2 months after harvest while *E. glabrescens* was intermediate having 20-40% germination for 1 month after harvest. *Echinochloa colona* had almost 70% germination at all planting dates.

The length of the storage period needed to overcome dormancy at room temperature (25±2℃) was about 50 days for *E. glabrescens* and more than 2 months for *E. crus-galli* ssp. *hispidula*. The seeds of *E. colona* appeared to have no dormancy which agrees with the results of Chun (1982). The germination of *F. miliacea* and *C. difformis* did not differ for 2 months from May 5 to July 5. However, their germination was drastically decreased in the November planting. Seed treatment of these species such as seed soaking in 0.1 N nitric acid solution and water soaking did not enhance germination. Thus it appears as though they lost their viability rather than induced

Table 2. Germination percentage of rice cultivars and weed species as affected by time after harvest

Date	Germination Percentage								
	IR64	UPLRi-5	*Echinochloa glabrescens*	*Echinochloa crus-galli* ssp. *hispidula*	*Echinochloa colona*	*Ludwigia octovalvis*	*Monochoria vaginalis*	*Fimbristylis miliacea*	*Cyperus difformis*
May 5	95a	96a	20e	2c	67a	52c	0.0 (55)a	65a	72a
May15	97a	98a	26de	4c	72a	62b	0.1 (50)a	70a	71a
May25	98a	98a	35cd	6c	74a	70a	0.1 (49)a	67a	71a
June 5	98a	97a	43bc	13b	66a	65ab	0.6 (53)a	64a	72a
June15	97a	97a	48b	17b	73a	70a	0.3 (54)a	67a	68a
June25	98a	98a	63ab	14b	72a	65ab	0.3 (47)a	67a	66a
July 5	98a	98a	66a	12b	74a	66ab	0.9 (51)a	72a	74a
Nov22	99a	95a	71a	42a	76a	64ab	0.0 (47)a	4b	3a

Average of three replications.
In a column, means having a common letter are not significantly different at the 5% level by DMRT.
( ) : Results from of soil germination test.

dormancy setting in.

On the other hand, the germination ability of *L. octovalvis* was not significantly different from May 25 to November 22. Of the nine species, *M. vaginalis* had the least germinability having less than 1% throughout the period. However, *M. vaginalis* seeds germinated easily when the seeds were planted into soil regardless of the planting time. They had about 50%. The reason for this could possibly be explained by the fact that seed germination of *M. vaginalis* was enhanced under reduction condition (submerged situation). Park (1985) reported that germination rate and percentage of germination under 4cm water depth exhibited 59% and 54%, respectively while these for saturation condition recorded 31% and 29%, respectively. The percentage germination of *M. vaginalis* in soil was somewhat lower than that reported by Kim and Moody(1980).

The low germinability of *E.glabrescens*, *E.crus-galli* ssp.*hispidula* and *L.octovalvis* just after harvest could be overcome by either soaking the seeds in nitric acid(0.1N) for 1 day(Table 3) or by removal of the hull(Fig. 1). Nitric acid treatment was superior to removed of the hull. The germinability of *E.glabrescens* could be increased to 70% by soaking in nitric acid while that of *L. octovalvis* and *E. crus-galli* ssp. *hispidula* could be increased to 77 and 50%, respectively. This result imply that above the weed species have somewhat innate dormancy

Table 3. Effect of soaking in nitric acid solution on seed germination

Species	Germination percentage	
	H_2O Soaking	HNO_3 Soaking
Rice		
'IR64	99a	98a
'UPLRi-5	97a	97a
Weeds		
Echinochloa glabrescens	54b	71a
Echinochloa crus-galli ssp. *hispidula*	11b	49a
Echinochloa colona	69a	71a
Monochoria vaginalis	0.2a	0a
Ludwigia octovalvis	43b	77a
Fimbristylis miliacea	72a	73a
Cyperus difformis	68a	74a

Average of three replications.
In a row, means having a common letter are not significantly different at 5% level by DMRT.
Soaking in 0.1N HNO_3 for 24 hours.

mainly due to inhibiting chemicals.

Soaking in nitric acid faster not only the precentage germination but also increased the germination rate for *E.glabrescens*, *E.crus-galli* ssp.*hispidula* and *L.octovalvis*(Fig 1). Germination of *L.octovalvis* was faster by 7 days by seed soaking in nitric acid while this effect was about 2-3 days for *E.glabrescens* and *E.crus-galli* ssp. *hispidula*. The effect of nitric acid soaking, however, varied depending on the length of the soaking period and the species(Table 4). The two rice cultivars, *E.colona* and *F.miliacea* were the most sensitive species to nitric acid soaking. No germination was recorded when there was 2 days

Table 4-1. Effect of length of soaking in water and nitric acid solutions on seed germination of rice and *Echinochloa* species

Soaking period (days)	Germination percentage									
	IR 64		UPLRi-5		*Echinochloa glabrescens*		*Echinochloa crus-galli* ssp. *hispidula*		*Echinochloa colona*	
	HNO_3	H_2O	HNO_3	H_2O	HNO_3	H_2O	HNO	H_2O	HNO_3	H_2O
1	99a(a)	68b(b)	99a(a)	83b(b)	65a(a)	30b(b)	32a (a)	6c (b)	66a(a)	65a(a)
2	30b(b)	98a(a)	19b(b)	99a(a)	60a(a)	53a(b)	26ab(a)	10bc(b)	66a(a)	68a(a)
3	0c(b)	99a(a)	0c(b)	100a(a)	40b(b)	57a(a)	25ab(a)	18ab(b)	0b(b)	65a(a)
4	0c(b)	99a(a)	0c(b)	99a(a)	42b(b)	50a(a)	25ab(a)	15ab(b)	0b(b)	61a(a)
5	0c(b)	99a(a)	0c(b)	99a(a)	39b(b)	54a(a)	19b (a)	14ab(a)	0b(b)	58a(a)
6	0c(b)	97a(a)	0c(b)	97a(a)	47b(b)	50a(a)	9c (b)	20a (a)	0b(b)	64a(a)
7	0c(b)	97a(a)	0c(b)	97a(a)	33b(b)	51a(a)	11c (a)	16ab(a)	0b(b)	64a(a)

Average of three replications.
In a column or row(parenthesis), means having a common letter are not significantly different at 5% level by DMRT.

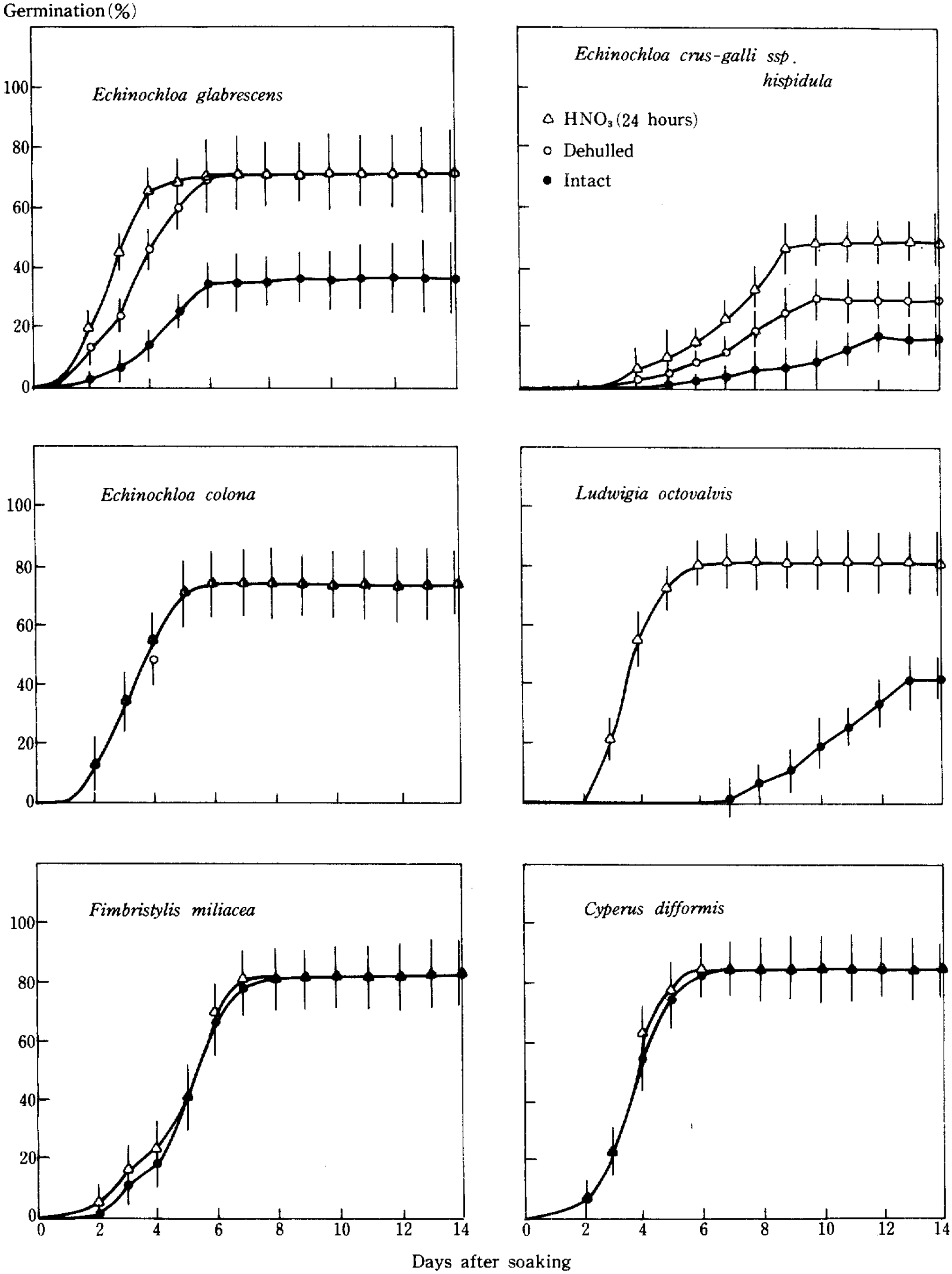

Fig. 1. Effect of seed treatment on germinability of several weed species (Average of three replications). Vertical bars represent the standard error of the mean.

soaking for *F. miliacea* and 3 days soaking for *E. colona* and the rice cultivars. *Echinochloa glabrescens*, *L. octovalvis* and *C. difformis* were the most tolerant to nitric acid soaking while *E. crus-galli* ssp. *hispidula* was intermediate in reaction. This result imply that there were apparent species

Table 4-2. Effect of length of soaking in water and nitric acid solutions on seed germination of *Monochoria vaginalis*, *Ludwigia octovalvis*, *Fimbristylis miliacea* and *Cyperus difformis*.

Soaking period (days)	Germination percentage							
	Monochoria	*vaginalis*	*Ludwigia*	*octovalvis*	*Fimbristylis*	*miliacea*	*Cyperus*	*difformis*
	HNO_3	H_2O	HNO_3	H_2O	HNO_3	H_2O	HNO_3	H_2O
1	0a(a)	0a(a)	61a(a)	62a(a)	60a(a)	63a(a)	67a(a)	65a(a)
2	0a(a)	0.2a(a)	75a(a)	59a(a)	0b(b)	62a(a)	72a(a)	61a(a)
3	0.1a(a)	0.2a(a)	68a(a)	40b(b)	0b(b)	33b(a)	61a(a)	63a(a)
4	0a(a)	0.1a(a)	70a(a)	27c(b)	0b(b)	22c(a)	64a(a)	54a(a)
5	0a(a)	0.1a(a)	72a(a)	16d(b)	0b(b)	8d(a)	62a(a)	57a(a)
6	0a(a)	0.2a(a)	74a(a)	15d(b)	0b(b)	7d(a)	63a(a)	63a(a)
7	0a(a)	0.2a(a)	72a(a)	15d(b)	0b(b)	7a(a)	53a(a)	55a(a)

Average of three replications.
In a column or row(parenthesis), means having a common letter are not significantly different at the 5% level by DMRT.

difference in tolerance to nitric acid during seed germination.

This experiment, in summary, could be concluded that germination habit which attribute to adaptation strategy is varied significantly depending on the species. In other word, each species has its own peculiar seed germination habit as adaptation strategy through differential dormancy regime or differential germination regime.

摘 要

1987年 國際米作硏究所(IRRI)에서 벼2品種(水稻IR64, 陸稻UPLRi-5)과 논雜草 7種에 對한 休眠性과 發芽性을 調査하였다.

・供試된 두品種의 벼는 前作期에 收穫된 種子를 使用한 關係로 95%以上의 높은 發芽率을 보였으며, 雜草의 收穫直後 發芽率은 0~72%範圍를 보였다. 自然 後熟에의한(25℃) 休眠打破期間은 *Echinochloa glabrescens*(강피 일종)은 50日程度, *E.crus-galli* ssp. *hispidula*(물피일종)은 60日以上, 여뀌바늘은 20日程度였고, *E.colona*(돌피일종), 물달개비, 바람하늘직이 및 알방동산이는 休眠이 없었다.

・供試된 雜草中에서 물달개비의 경우 샤레 發芽試驗에서는 全試驗 期間동안 1%以下의 發芽率로 가장 낮은 수치를 보였으나 土壤中發芽試驗에서는 거의 50%수준의 發芽率을 보였다.

・*E.colona*(돌피일종)를 除外한 피종류와 여뀌바늘의 收穫直後의 낮은 發芽性은 0.1N 窒酸溶液 1日浸種處理 또는 種子껍질 除去 處理에 의해 發芽가 促進되나 窒酸處理의 効果가 높았다. 窒酸에 對한 種子反應도 草種에 따라 큰 差異를 보였는데 바람하늘직이는 1일, 벼와 *E.colona*는 2일 以上의 處理에서는 發芽力을 喪失한데 反해 *E. glabrescens*, *E. crus-galli* ssp. *hispidula*, 여뀌바늘 및 알방동산이는 7日間의 浸種에도 發芽力을 維持하였다.

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