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Effects of soaking and scarification on germination of dry wild rice (*Zizania palustris* L.) seed

Takuma GEMMA, Hideho MIURA and Kazuo FURUSATO*

*(Laboratory of Forage Crops, Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hokkaido 080, Japan and *Hamamatsu Flower Park, Kanzanji-cho, Hamamatsu 431–12, Japan)*

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Summary

In spite of dry storage at about 10% moisture content for more than 180 days after harvesting under room conditions, the seeds of wild rice could be germinated with the combined treatments of soaking in cold water for more than 20 days and seed scarification. It was verified that dehydration of seeds did not cause death of the embryo. Scarification of dry seed was not so effective in increasing germination, but the combined treatment with soaking was considerably effective.

Introduction

Wild rice is classified in *Gramineae* and belongs to the genus *Zizania*. There are four species of the genus: *Z. palustris* L., *Z. aquatica* L., *Z. texana* Hitchcock, and *Z. latifolia* (Griseb.) Turcz. ex Stapf. The first three are native to North America and the last is native to Asia. *Z. palustris* and *Z. aquatica* are annuals, while the others are perennials.

In most reports, wild rice has been identified as *Z. aquatica*. But DORE (1969) classified the wild rice for commercial cultivation as *Z. palustris*, the large seed type, grown in the region of Great Lakes in North America. *Z. aquatica* and *Z. texana* have slender seeds and are not consumed as food.

It has been found that the seed viability is lost by drying for more than 2 or 3 days. If the seed is stored, even for a short time, it should be placed in water to assure germination. Seed viability is reduced when the seeds are dried below 30 percent moisture level (BRUN 1968). Wild rice seeds require to be stored in cold (2°C) water for three to four months for germination (ELLIOTT 1980).

Post-harvest seed dormancy hinders the continued development of a field crop, and the periods of dormancy pose problems to plant breeders desiring multiple generations per year, it also makes the farmers change over to other crops or varieties in established fields. Seed storage fungi are also one of the most troublesome problems in retaining viability even when kept in cold water.

In this study, seeds of four and six months after harvesting which were dried in the laboratory were soaked in cold water for 20

and 40 days and scarified with sand paper to test the germinability.

Materials and Methods

Wild rice (*Z. palustris* varieties palustris and interior), indigenous type in the region of Great Lakes, was grown for two generations in Obihiro and the seeds obtained were used for this study. Seed treatments are summarized in Fig. 1.

(1) Experiment 1.

Germination test was conducted in the laboratory using dehulled seeds dried to about 10% moisture content, to examine the effects of soaking and seed scarification. After soaking for 40 days in cold tap water (4–5°C), scarification was done using #400 silicon carbide sand paper to remove the pericarp (S) and the germination percentage was compared with that of intact caryopses (N).

Seeds after 120 days of dry storage in room conditions were soaked in cold tap water (4–5°C) for 40 days (B). The water was replaced every week with pre-chilled tap water. Germination test was conducted for twenty dehulled seeds which were placed in 9 cm diameter Petri dishes, soaked completely in tap water and kept in darkness at 20°C. The experiment had three replications. Germinated seeds were removed each day until the 20th day. The germination percentage was monitored after 21 days.

(2) Experiment 2.

A similar experiment was carried out as for experiment 1, with changes in the period of seed drying (180 days) and soaking (20 days).

(3) Experiment 3.

Seeds taken from each of eight maternal offsprings grown in paddy field conditions were soaked for 30 days after drying for 240 days. The dehulled seeds without scarification were used in this experiment.

Results and Discussion

As shown in Tables 1 and 2, seeds, stored under room conditions for 160 to 200 days, had a very low germination percentage. However, the germination percentage of seeds soaked in tap water for 20 to 40 days after storage significantly increased by 15 and 27% in BN and DN, respectively.

The combined treatment of soaking with

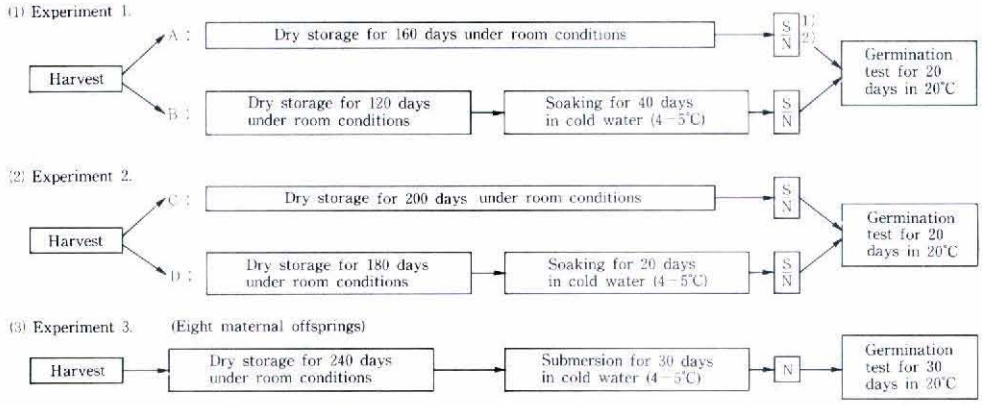

Fig. 1. Seed treatments in each experiment.

1) S: Scarification was done using #400 silicon carbide sand paper to remove the pericarp above the embryo.

2) N: Non-scarification as the control.

Table 1. Germination percentage in each combination of treatments

	Experiment 1		Experiment 2	
	A	B	C	D
N[1)]	2.5	15.0	5.0	27.5
S[2)]	2.5	42.9	7.5	42.5

Note) A, B, C and D are treatments of seed storage and soaking. (see Fig. 1).
1) N: Non-scarification treatment.
2) S: Scarification treatment with sand paper.

Table 2. Analysis of variance for germination percentage in experiments 1 and 2

Source of variations	Experiment 1		Experiment 2	
	d.f.	M.S.	d.f.	M.S.
Soaking	1	2497.5**	1	1114.2*
Scarification	1	358.2*	1	123.6
Interaction	1	358.0*	1	3.9
Error	12	46.6	4	59.1

Note) Germination percentage was transformed into an angle scale prior to analysis.
*, **: Significant at the 5% and 1% levels, respectively.

scarification was the most effective way to increase the germination percentage up to 42% in BS and DS. The effect of scarification itself was significant only in experiment 1.

Wild rice appears to have multiple mechanisms of seed dormancy. The seed pericarp exhibits mechanical resistance and impermeability (SIMPSON 1966). CARDWELL *et al.* (1978) reported that water soluble inhibitors appeared to be present in hull and pericarp. Gibberellic acid concentration is low in freshly harvested seed. A high concentration of abscisic acid in the embryo and pericarp may be one cause of dormancy (ALBRECHT *et al.* 1979).

Treating seeds with ultrasonic vibrations at 70 kc/s for 10 min. resulted in 70% germination (HALSTEAD and VICARIO 1969). Scraping off the pericarp above the embryo permitted germination of freshly harvested seed (WOODS and GUTEK 1974). However, scraping is time-consuming. OELKE and ALBRECHT (1978) successfully utilized the rock polisher to scarify the seeds with minimum amount of injury. Chemical seed teatments using gibberellic acid and 6-benzyl adenine were also effective in increasing germination and subsequent seedling vigor (OELKE and ALBRECHT 1980).

While there are several ways of increasing germination, as mentioned above, it had been emphasized that the seeds must be kept in cold water to maintain the viability. But there are few investigations on the germination of dry wild rice seed.

According to SIMPSON (1966), the embryos remain viable in caryopses dried for 2 or 3 weeks, but when the period is longer, it leads to a drastic reduction in viability. This is probably caused by a breakdown in the normally impermeable seed coat, which allows the embryo to dehydrate to the level of equi-

Table 3. Germination percentage of seeds in each maternal offspring

	Maternal offsprings							
	1	2	3	4	5	6	7	8
No. of seeds	66	95	90	81	47	55	65	74
No. of seeds germinated	6	39	30	15	8	12	17	49
Germination percentage (%)	9.1	41.0	33.3	18.5	17.0	21.8	26.2	66.2

librium with the external environments.

In the present study, however, it was found that the seeds dried for more than 180 days under room conditions after harvesting could germinate with the treatment of soaking in cold water for more than 20 days. Thus the dehydration of seeds does not cause death of the embryo. The conclusion was supported by the results of the test in eight maternal offsprings, while a great variation from 9.1% to 66.2% was recognized (Table 3).

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アメリカマコモ（*Zizania palustris* L.）種子の発芽に及ぼす浸漬処理ならびに種皮処理の効果

源馬琢磨・三浦秀穂
（帯広畜産大学飼料作物学研究室）

古里和夫
（浜松市フラワーパーク公社）

摘　　要

一般にアメリカマコモ（ワイルドライス）種子は，採種後直ちに冷水貯蔵しないと胚の生存力が低下し，発芽能力を消失するとされている。本試験では，採種後乾燥状態で室内貯蔵した種子（水分10%以下）を供試し，冷水浸漬処理ならびに種皮処理を施したときの発芽率を検討した。

採種後4～6カ月間乾燥貯蔵した種子は，ほとんど発芽しなかったが，20～40日間冷水浸漬処理することによって15.0～27.5%発芽した。サンドペーパーを用いて胚上部の果皮を除去する方法で種皮処理を行ったところ，発芽率の向上は認められなかったが，冷水浸漬処理後種皮処理を行うことによって40%以上の種子が発芽した。したがって，乾燥貯蔵した種子の低い発芽率は，胚の生存力の低下によるよりもむしろ休眠性，果皮の不透水性によると推察された。

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