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Germination Characteristics of Some Red Rice Accessions

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ABSTRACT

Nine accessions of red rices collected from different regions were tested for germination characteristics in relation to seed maturity and several storage conditions after harvest. No red rice seeds germinated at five days after anthesis (DAA). Wanjuaengmi (long-grain red rice) seeds at 10DAA germinated up to 30% of total samples, producing only abnormal seedlings, whereas 10D-AA-seeds of normal cultivar showed only 3.3% germinability. Some red rice seeds absorbed more water than cultivated varieties, and showed less decrease in germination rate than cultivated varieties when seeds were exposed at -1, -5 or -10℃ for up to 60 hours after soaking. Red rice accessions maintained more than 95% germination when stored indoor for 120 days. Two short-grain red rices showed about 50% germination when overwintered in the field, while other long-grain red rices and cultivated rices germinated less than 10%. Germination of seeds overwintered in clay loam soil was lower than that in loam soil, and seeds on surface germinated less than those in 1~7cm depth.

Keywords : red rice, germination, overwinter.

Direct seeding in rice cultivation requires lower cost and less labor than transplanting does. However, direct seeding has many of unsolved problems such as uncertain seedling stand, likely to lodge and rank weeds. Particularly, red rice has become the most troublesome weed in direct-seeded rice field recently.

Red rice shows a high possibility to appear annually because of early ripening, shattering habit and dormancy (Dunand, 1988; Abdullah, 1994; Helpert, 1981). It was reported that red rice was distributed through out Korea (Suh et al., 1992), and some physio-ecological characteristics were investigated (Choi et al., 1995; Ree et al., 1983). Some red rice seeds have the germination ability from 4 days after anthesis and start to shatter from 10 days after flowering (Sonnier, 1964; Azim et al., 1994). Red rice seed can maintain dormancy for long time after shattering in the field, and dormancy breaking and improvement was not identified clearly (Cohn and Hughes, 1981; Delouche et al., 1986). Though dormancy breaking progresses gradually in room temperature, dormancy period can be prolonged in field and dormancy periodicity of water-absorbed red rice seeds is related to exposed temperature (Garcia, 1987; Bewley and Black, 1985; Ikehashi, 1972).

This study was conducted to investigate germination characteristics of some red rice seeds from anthesis to the seeding time of the following year.

MATERIALS AND METHODS

Nine accessions of red rices were collected from Honam and Youngnam area in 1995, and planted at Chonbuk National University' farm during 1996~1998. Germination vigour of red rice seeds with time after anthesis was investigated by using Wanjuaengmi (long-grain type) and Juksanaengmi (short-grain type) seeds among red rices used in this experiment. Anthesis date was labeled on glume and seeds were harvested at 5, 10, 20, 30 or 40 days after anthesis. Germination rate and seedling length were checked for 14 days at 20±1℃.

Water absorbing ability of red rice seeds was investigated in 24, 48 or 72 hours after soaking at 15, 10, 5, 1±1℃. Germination after low temperature (-10, -5, -1℃) exposure was examined after soaking for 0, 12, 24, 36, 48 or 60 hours at 20±1℃. Germinability of seeds during winter was surveyed both in ambient temperature and field conditions at 30 days interval from immediately after harvest to the sowing time of the following season. Seeds were buried in 0, 1, 3, 5 or 7cm depths at the loam and clay loam soil to test their germinability during winter.

RESULTS AND DISCUSSION

Some agronomic characteristics of collected red rices used in this study were presented in Table 1. All red rices were different in heading date, effective spike number, culm(panicle) length and 1,000 grains weight. Wanjuaengmi and Buryangaengmi among red rices were classified into long-grain type and

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Table 1. Agronomic characteristics of red rices and cultivated rices used in this study.

No	Varieties	Heading date	Effective spike No./stock	Culm length (cm)	Panicle length (cm)	Spikelets /panicle	1,000 grains weight(g)	Length/ width ratio of grain	Awn length (cm)	Shattering habit
I	Wanjuaengmi	Aug 20	32	99	21.7	84.5	21.7	2.21	0	easy
II	Buryangaengmi	Aug 21	30	99	22.5	78.5	20.3	2.38	0	easy
III	Juksanaengmi	Aug 29	23	96	20.8	94.9	21.5	1.93	0.9	hard
IV	Hosiaengmi	Aug 14	25	96	18.1	90.3	18.4	1.72	0	easy
V	Youngdongaengmi	Aug 14	23	99	23.4	99.6	19.4	2.04	2.7	medium
VI	Onyangaengmi	Aug 15	24	95	20.3	97.0	21.4	1.80	0	medium
VII	Youngsiaengmi	Aug 13	26	81	18.1	90.4	18.5	1.71	0.7	easy
VIII	Uljuaengmi	Aug 21	25	85	19.6	86.5	18.8	1.82	0	medium
IX	Susungaengmi	Aug 15	24	82	20.8	94.1	19.1	1.99	2.5	medium
X	Dongjinbyeo[1)]	Aug 18	24	82	18.2	82.2	22.9	1.72	0	hard
XI	Gancheokbyeo[1)]	Aug 16	22	79	17.8	81.0	22.4	1.78	0	hard

[1)] Cultivated variety

others belonged to short-grain type. Also, some red rices had awns, and extent of shattering habit differed from each other.

As shown in Table 2, Wanjuaengmi, Juksanaengmi and Dongjinbyeo seeds did not germinate when they were harvested at 5 days after anthesis (DAA). When they were harvested at 10 DAA, germination rate of Wanjuaengmi and Juksanaengmi were 30.7% and 10.7%, respectively, while Dongjinbyeo was 3.3%. However, seedlings of Wanjuaengmi harvested at 10 DAA were abnormal in compare with those of 40 DAA. At 20 DAA, there was no difference in germination rate between Juksanaengmi and Dongjinbyeo. Germination of Wanjuaengmi was markedly higher than that of Juksanaengmi in 10 DAA, but the two red rices had little or no difference in 20, 30 and 40 DAA.

Some red rice seeds have been reported to have germination ability from 4 days after anthesis and start to shatter from 10 days after flowering (Dunand, 1988; Azim et al., 1994). Wanjuaengmi and Juksanaengmi seeds acquired germination ability from about 10 DAA, but it was considered that longer time after anthesis was required to produce normal plant.

Water absorption of red rices were tested as shown in Table 3. Juksanaengmi, Hosiaengmi, Onyangaengmi and Youngsiaengmi absorbed less water than Dongjinbyeo or Gancheokbyeo, but Uljuaengmi and Susungaengmi absorbed more water than Dongjinbyeo or Gancheokbyeo at 1, 5, 10 or 15℃. This result somewhat differs from that of Sumio(1965) who reported that red rice seed had high overwintering capability because of low permeability of water into seed.

Table 4 shows the germination rate of red rice seeds after soaking followed by low temperature exposure. Red rices and Dongjinbyeo seeds exposed for 72 hours at -1℃ had no difference in germination regardless of soaking time. When seeds were exposed for 72 hours at -5℃, germination of long-grain red rices (Wanjuaengmi, Buryangaengmi) decreased greatly as soaking time became longer, and others tended to decrease generally. When seeds were exposed at -10℃, germination of seeds soaked for 24 hours decreased markedly, and when soaked more than 48 hours no seeds germinated except Hosia-

Table 2. Germination vigour of red rice and cultivated rice seeds with the progress of ripening after anthesis.

Varieties	Days after anthesis									
	5		10		20		30		40	
	GP[1)]	SL[2)]	GP	SL	GP	SL	GP	SL	GP	SL
Wanjuaengmi	0	0	30.7a[3)]	1.2a	55.0a	2.4a	86.3ab	7.7a	99.3a	8.8a
Juksanaengmi	0	0	10.7b	1.1a	51.0b	2.2a	82.7b	6.0c	99.3a	7.0b
Dongjinbyeo	0	0	3.3c	1.0a	50.7b	1.5b	90.3a	6.7b	98.7a	6.8b

[1)] GP : Germination percentage(%) for 14 days after water-soaking at 20±1℃
[2)] SL : Shoot length(cm)
[3)] Means followed by the same letter in a column are not significantly different at 5% level by DMRT.

Table 3. Water absorption of red rice and cultivated rice seeds under different soaking temperature and time.

Varieties	1°C			5°C			10°C			15°C		
	Soaking time(hours)											
	24	48	72	24	48	72	24	48	72	24	48	72
Ⅰ	±[3]	±	±	±	±	±	−	±	±	±	±	±
Ⅱ	−[2]	−	−	±	±	±	±	±	−	±	±	±
Ⅲ	−	−	−	−	−	−	−	−	−	−	−	−
Ⅳ	−	−	−	−	−	−	−	−	−	−	−	−
Ⅴ	±	±	±	−	±	+	±	+	±	−	±	±
Ⅵ	±	−	±	−	−	−	−	−	−	−	−	−
Ⅶ	±	−	−	−	−	−	−	−	−	−	−	−
Ⅷ	+[1]	+	+	+	+	±	+	+	±	+	+	±
Ⅸ	±	+	+	+	+	+	+	+	±	+	+	±
Ⅹ	12.3[4]	17.8	21.8	15.1	21.6	26.8	17.6	24.8	30.1	20.5	26.8	32.1
ⅩⅠ	16.0	20.6	26.4	17.5	24.2	29.5	19.1	26.7	32.1	22.2	30.4	35.4

Ⅰ : Wanjuaengmi, Ⅱ : Buryangaengmi, Ⅲ : Juksanaengmi, Ⅳ : Hosiaengmi, Ⅴ : Youngdongaengmi, Ⅵ : Onyangaengmi, Ⅶ : Youngsiaengmi, Ⅷ : Uljuaengmi, Ⅸ : Susungaengmi, Ⅹ : Dongjinbyeo, ⅩⅠ: Gancheokbyeo
1) + : Absorbed water amount more than Dongjinbyeo or Gancheokbyeo
2) − : Absorbed water amount less than Dongjinbyeo or Gancheokbyeo
3) ± : Absorbed water amount between Dongjinbyeo and Gancheokbyeo
4) % : Absorbed water amount

Table 4. Germination rate of red rice and cultivated rice seeds after soaking followed by low temperature exposure.

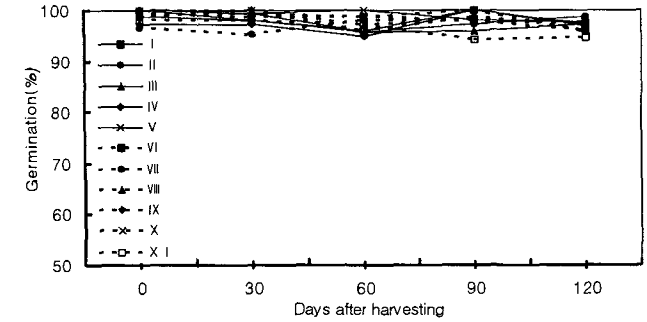
Varieties	Soaking time(hours)														
	12	24	36	48	60	12	24	36	48	60	12	24	36	48	60
	Exposured temperature														
	-1°C					-5°C					-10°C				
Ⅰ	100a[1]	99.3a	91.0b	90.0b	90.0ab	98.7a	91.0b	25.3g	8.0g	0g	62.0c	15.0h	0d	0c	0b
Ⅱ	99.3a	99.3a	97.3a	97.3a	97.3a	96.0a	91.7b	52.7e	8.7g	0g	82.7b	21.3g	20.0c	0c	0b
Ⅲ	100a	99.3a	98.0a	98.0a	83.7b	99.3a	98.7a	82.0b	61.0c	17.3e	91.3ab	36.0f	0d	0c	0b
Ⅳ	99.3a	98.0a	97.3a	97.3a	85.0b	97.0a	92.0b	91.7a	79.3a	65.0a	96.7a	92.0a	63.3a	41.3a	18.3a
Ⅴ	99.3a	99.3a	97.3a	97.0a	97.0a	97.3a	90.0b	85.0ab	61.3c	16.7e	96.7a	46.0e	25.7c	0c	0b
Ⅵ	98.7a	98.7a	98.0a	97.3a	96.7a	96.0a	92.0b	81.3b	70.7b	47.3c	91.7ab	55.3d	26.0c	8.0bc	4.0b
Ⅶ	99.7a	99.3a	99.3a	98.7a	98.0a	90.7ab	84.7c	81.0b	78.7a	56.0b	90.7ab	80.7b	46.7b	18.0b	11.0ab
Ⅷ	99.3a	98.7a	98.0a	98.0a	95.2a	99.3a	84.0c	66.0d	52.7d	7.3f	84.0b	20.7g	9.3cd	0c	0b
Ⅸ	99.3a	99.3a	99.3a	98.7a	98.7a	98.0a	90.7b	90.0a	51.7d	28.0d	91.7ab	65.7c	15.3cd	0c	0b
Ⅹ	99.7a	100a	98.7a	98.3a	95.7a	97.3a	90.7b	73.3c	34.0e	6.7f	82.3b	32.7f	0.7d	0c	0b
ⅩⅠ	92.0b	90.0b	84.0c	79.3c	70.7c	86.7b	77.3d	44.0f	23.3f	7.3f	33.3d	16.3h	0d	0c	0b

Ⅰ : Wanjuaengmi, Ⅱ : Buryangaengmi, Ⅲ : Juksanaengmi, Ⅳ : Hosiaengmi, Ⅴ : Youngdongaengmi, Ⅵ : Onyangaengmi, Ⅶ : Youngsiaengmi, Ⅷ : Uljuaengmi, Ⅸ : Susungaengmi, Ⅹ : Dongjinbyeo, ⅩⅠ : Gancheokbyeo
1) Means followed by the same letter in a column are not significantly different at 5% level by DMRT.

engmi, Onyangaengmi and Youngsiaengmi. Therefore, it was considered that water content of red rice seeds during winter played an important role to maintain seed vigour. Some red rice seeds seemed to have higher possibility of survival during winter than cultivated rice seeds because of low susceptibility to low temperature.

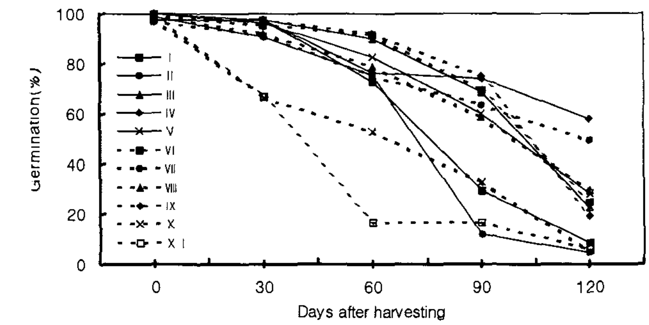
As shown in Fig. 1, all red rice seeds overwintered in room temperature showed more than 95%, keeping same germinability, until just before the sowing time of the following year. Therefore, reproduction of red rice is definitely magnified when harvested, stored and sowed with cultivated rice.

Fig. 2 illustrates the germination of red rice seeds overwintered in field. Red rice and cultivated rice seeds showed more than 95% germination at immed-



I : Wanjuaengmi, II : Buryangaengmi, III : Juksanaengmi, IV : Hosiaengmi, V : Youngdongaengmi, VI : Onyangaengmi, VII : Youngsiaengmi, VIII : Uljuaengmi, IX : Susungaengmi, X Dongjinbyeo, XI : Gancheokbyeo

Fig 1. Germination of red rice and cultivated rice seeds overwintered in room temperature.

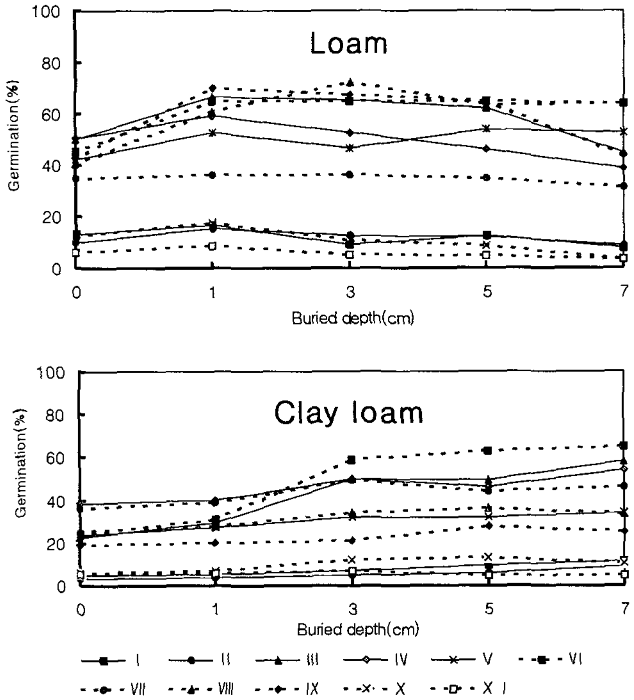


I : Wanjuaengmi, II : Buryangaengmi, III : Juksanaengmi, IV : Hosiaengmi, V : Youngdongaengmi, VI : Onyangaengmi, VII : Youngsiaengmi, VIII : Uljuaengmi, IX : Susungaengmi, X Dongjinbyeo, XI : Gancheokbyeo

Fig. 2. Germination of red rice and cultivated rice seeds overwintered in field surface.

ately after harvest. At 30 days after harvest, germination of red rice seeds was decreased by 5% compared with that of harvest time, but that of cultivated rices decreased by more than 30%. At 120 days after harvest, short-grain red rices maintained more than 20% germination except Susungaengmi, while Hosiaengmi and Youngsiaengmi maintained more than 50%. However, germination of Wanjuaengmi, Buryangaengmi and two cultivars showed less than 10%. Consequently, it was considered that Wanjuaengmi or Buryangaengmi had little possibility to reproduce in the following year when they were overwintered on the surface of paddy field.

Fig. 3 describes the germination rate of red rice seeds after winter according to soil textures and buried depths. In loam soil, germination of red rice seeds overwintered on surface was lower than that buried in 1~7cm depth. In clay loam soil, germinations of red rice seeds overwintered on surface and in 1cm depth soil were lower than those in 3, 5, 7cm depths, but there were no difference among 3, 5, 7cm depths. In both loam and clay loam soil, cultivated rice seeds germinated lower than red rice seeds except Wanjuaengmi and Buryangaengmi. Germination of red rice seeds overwintered in clay loam soil was lower than that in loam soil, and this result might be caused by the water content of seeds overwintered in clay loam soil being more than that in loam soil.



I : Wanjuaengmi, II : Buryangaengmi, III : Juksanaengmi, IV : Hosiaengmi, V : Youngdongaengmi, VI : Onyangaengmi, VII : Youngsiaengmi, VIII : Uljuaengmi, IX : Susungaengmi, X : Dongjinbyeo, XI : Gancheokbyeo

Fig. 3. Germination rate of red rice and cultivated rice seeds after winter under different soil textures and buried depths.

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