

Effect of Humidification and Hardening Treatment on Seed Germination of Rice

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ABSTRACT

To find out the effects of humidification and hardening of rice (*Oryza sativa* L. cv. Ilpumbyeo) seeds on the germination, both normal and artificially aged seeds with 60% germination rate were humidified at 40, 60, and 80% RHs and 25°C for five weeks or hydrated for 6, 12, 18, and 24 hours at 25°C from one to five cycles for hardening. Relative humidity and duration of humidification did not affect the germination rate of normal seeds, while reduced the time to get 50% germination rate (T_{50}) by 1.0~1.6 days compared to that of normal seeds at 25°C. Aged seeds humidified at 40 and 60% RHs did not affect the germination rate and T_{50} regardless of relative humidity and duration of treatment, while at 80% RH, the germination rate decreased and T_{50} increased significantly with the duration of humidification. Hardening of normal seeds reduced T_{50} by 0.7~1.1 days without changes in the germination rate. However, the germination rate and T_{50} of aged seeds soaked in water for 6, 12, and 18 hours were similar regardless of soaking/drying cycles, while hardening of artificially aged seeds with 1~4 cycles in 24 hours soaking increased the germination rate by 11~16% and reduced T_{50} by 1.4~2.0 days.

Key words : humidification, hardening, rice, seed, germination rate, T_{50} .

Recently dry field direct seeding of rice has been extensively studied to reduce production cost by removing the expenses for raising and transplanting of seedlings. However, poor seedling establishment in direct seeding is one of the serious problems especially for early planting when temperatures are suboptimal.

Preplant seed treatments such as hardening, humidification, osmoconditioning, and matricconditioning are practiced to reduce the germination time, synchronize germination, and improve germination rate and seedling stand (Khan, 1992).

Humidification is the control of seed hydration by the exposure of seeds to water vapor in indirect contact with water (Khan, 1992). Seed activation and germination can be achieved in vapor phase over a range of water potentials (Owen, 1952) and the treated seeds germinated rapidly (Heydecker & Coolbear, 1977). However, this treatment has the danger of seed deterioration during the prolonged period of seed humidification (Hegarty, 1978).

Hardening, also called wetting/drying or hydration/dehydration, is done by repeated soaking and drying of

seeds in water at 15~25°C (Pen aloza & Eira, 1993). The beneficial effects of seed hardening are primarily due to pre-enlargement of the embryo (Austin et al., 1969), biochemical changes like enzyme activation (Villiers & Edgcombe, 1975), and improvement of germination rate particularly in old seeds (Gray & Steckel, 1977).

Practically, humidification and hardening treatments are applied in the seeds of tomato (Pen aloza & Eira, 1993), jute (Chowdhury & Choudhuri, 1987), eggplant (Rudrapal & Nakamura, 1988), radish (Rudrapal & Nakamura, 1988), and peas (Sivritepe & Dourado, 1994), but information is limited for rice seed (Basu & Pal, 1980). Therefore, humidification and hardening effects of rice seeds were studied to improve germination when planted under the suboptimal germination conditions in the field.

MATERIALS AND METHODS

Seed materials

Seeds of the rice variety Ilpumbyeo, grown at the Research Farm of the Kyongbuk Provincial Rural Development Administration in Taegu, Korea in 1995 were used for this experiment in 1996. In order to make poor quality seeds (approximately 60% germination rate), normal seeds were artificially aged at 80% RH and 40°C for 10 days. The 80% RH was maintained by a glycerol-water solution which has a specific gravity of 1.135 in a closed chamber (Forney & Brandl, 1992).

Humidification

Normal and aged seeds were humidified at 40, 60, and 80% RH and at 25°C for 1, 2, 3, 4, and 5 weeks. The specific gravity of glycerol solutions to maintain 40, 60, and 80% RH was 1.225, 1.189, and 1.135, respectively (Forney & Brandl, 1992). The humidified seeds were dried at room temperature and stored in a freezer at -12°C prior to use.

Hardening

One hundred and fifty grams of normal and aged seeds were soaked in 500ml water for 6, 12, 18, and 24 hours at

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25°C and dried at room temperature for 2 days. This soaking and drying of seeds were repeated from one to five cycles.

Germination test

Germination was observed daily at 25°C, according to the AOSA method (AOSA, 1990). The time to get 50% germination rate (T_{50}) was calculated according to the formula (Coolbear et al., 1984):

$$T_{50} = t_i + \frac{(N+1)/2 + n_i}{(n_j - n_i)} \cdot (t_j - t_i)$$

where N is the final number of germination and n_i , n_j cumulative numbers of seeds germinated by adjacent counts at times t_i and t_j when $n_i < (N + 1)/2 < n_j$.

RESULTS AND DISCUSSION

Humidification

Germination rate and T_{50} of normal and aged seeds humidified at different RHs and durations are shown in Fig. 1. Germination rate of normal seeds humidified at 40, 60, and 80% RHs were similar to untreated seeds regardless the duration of humidification. In contrast, the germination rate of artificially aged seeds humidified at 40 and 60% RHs was similar to untreated seeds. However, humidification at 80% RH for less than two weeks did not affect the germination rate, while the germination rate of aged seeds humidified for more than three weeks decreased as the duration of humidification increased.

T_{50} of normal seeds humidified at 40, 60, and 80% RHs was lower (faster germination) compared with untreated seeds by 1.0~1.6 days. However, T_{50} of aged seeds humidified at 40 and 60% RH was similar regardless duration of humidification, while humidification at 80% RH increased T_{50} significantly (delayed germination) as duration of humidification increased.

Absorbed equilibrium moisture content of rice seeds at relative humidity of 40, 60, 80% at 25°C is approximately 10.0, 12.8, and 16.0%, respectively (Justice & Bass, 1978). Therefore, moisture content of seeds humidified at 40 and 60% RH would be less than 12.8% and would not affect the viability of both normal and aged seeds. However, the moisture content of seeds humidified at 80% RH would be 16.0% and high enough to accelerate the aging process (Hegarty, 1978); germination rate decreased and T_{50} increased (delayed germination) as duration of humidification increased. At the same moisture content normal seeds did not deteriorate seeds in five weeks at 80% RH.

Hardening

Germination rate and T_{50} of normal and artificially aged rice seeds soaked in water for different durations and soaking/drying cycles are shown in Fig. 2. Both soaking duration and the number of times of soaking/drying did not affect the germination rate of normal seeds. The germination rate of artificially aged seeds

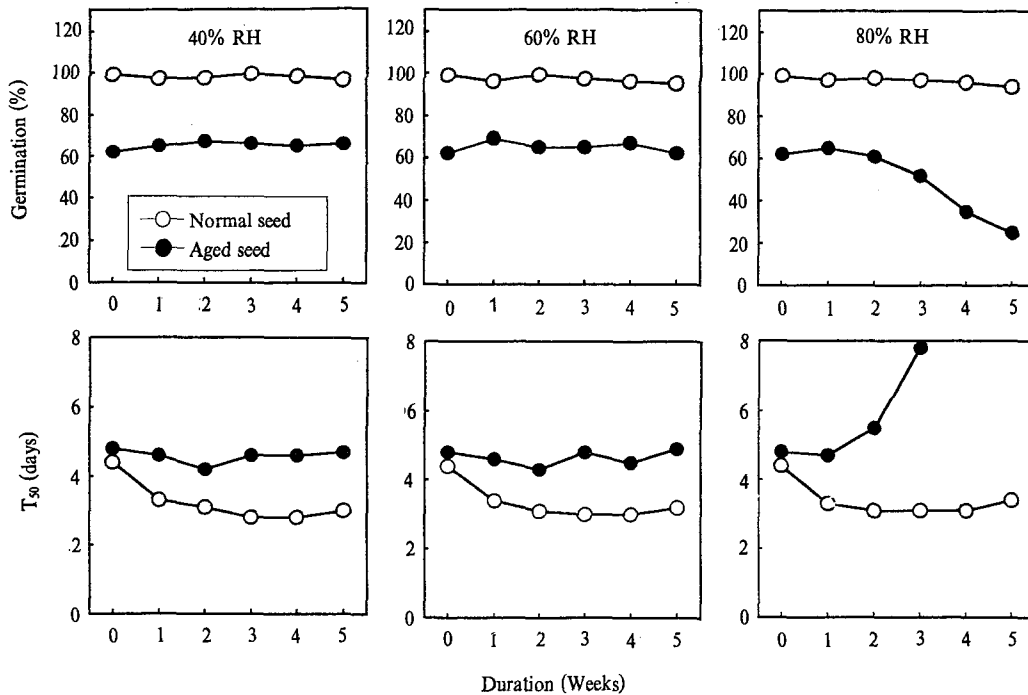


Fig. 1. Germination rate and T_{50} of normal and artificially aged rice seeds humidified at different duration and RHs.

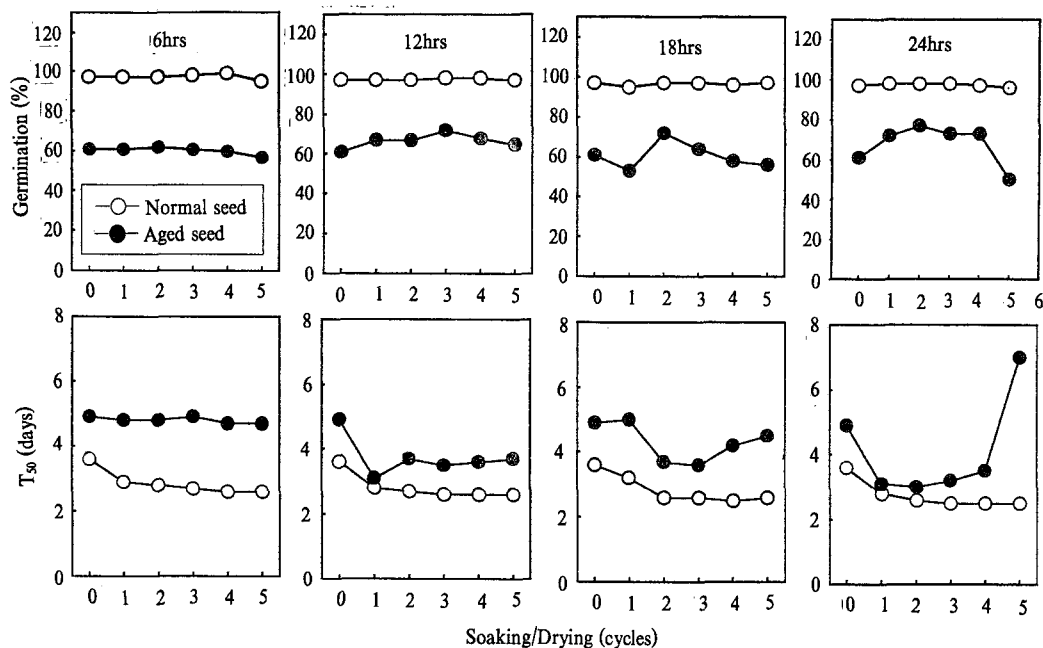


Fig. 2. Germination rate and T_{50} of normal and artificially aged rice seeds soaked in water for duration and soaking / drying cycles.

soaked in water for 6 and 12 hours from 0 to 5 cycles was similar, while hardening treatment for 18 hours two cycles and for 24 hours from one to 4 cycles increased germination rate by 3~16%.

T_{50} of normal seeds soaked in water from one to 5 cycles was lower by a day (faster germination) compared with nonsoaked normal seeds at all soaking periods. However, effects of soaking duration and soaking/drying cycles on T_{50} of aged seeds were quite different from normal seeds. For aged seeds the soaking/drying cycles did not affect T_{50} in 6 hours soaking duration, while in 12, 18, 24 hours soaking the soaking/drying cycles tended to reduce T_{50} a little although T_{50} of the 5 soaking/drying cycles in 24 hours soaking duration increased rapidly.

Hardening of normal seeds did not increase germination rate compared to the germination rate of untreated normal seeds while was high (97%). However, earlier germination of water soaked seeds were probably due to the pre-enlargement of embryo (Austin, et al., 1969) and biochemical changes (Villiers & Edgcumbe, 1975). However, beneficial effects of hardening in aged seeds were obtained only with 1~4 cycles of soaking/drying in 24 hours soaking and similar results were reported by others (Gray & Steckel, 1977). Too much hardening treatment, 5 cycles of soaking/drying in 24 hours soaking duration, seemed to deteriorate seeds.

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