# Dormancy Formation and Subsequent Changes of Germination Habits in Rice Seeds


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Earlier transplanting accompanied with hastening of the harvest, which has been prevalent since 1955, often brings about easier germination of intact panicles.

While in the extension of the direct sowing method, quick and stable standing of seedlings was regarded as a key point. This habit was assumed to be closely correlated with faster germination.

These situations imposed upon rice breeders a new task to deliver varieties having desirable germination habits. As the results of works to meet the task, today a comprehensive picture of germination habits may be drawn, though there still remain many problems to be solved.

## Induction of dormancy by temperature during maturation

Seed dormancy in Japanese rice varieties is in general so weak as to sometimes lead to misunderstanding that typical dormancy is absent in domestic varieties.

However, the recognition of the role of environmental factors controlling the formation of dormancy has given us procedures to estimate the varietal difference which is often latent. A typical instance obtained in this way is briefly given below.

Seeds from two varieties contrasting in the degree of dormancy were formed under various temperature conditions where the temperature was shifted from 20°C to 30°C or vice versa at several stages of ripening (Fig. 1). The germination tests with them suggested that high temperatures 10–15 days after flowering induces dormancy.

Varietal difference in the formation of dormancy became clear when the seeds matured at 20°C during 10 days after flowering and at 30°C in the subsequent stages.

On the contrary, the varietal difference of dormancy disappeared when seeds matured

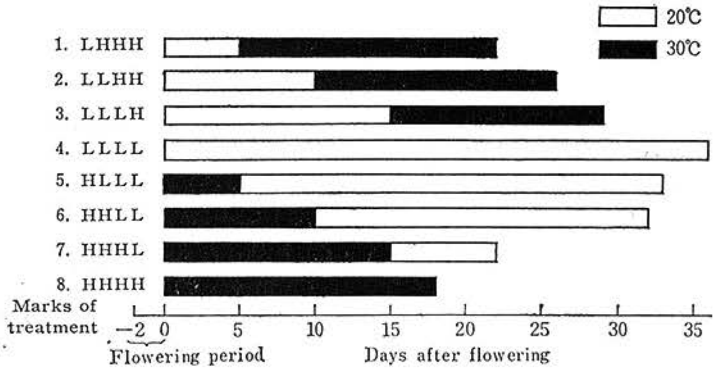



Fig. 1. Experimental conditions to test the effect of temperature during maturation on the induction of dormancy

**Table 1. Effect of temperature during maturation on dormancy**

| No. of Exp. | Temperature regime (Fig. 1) | Ginmasari | | Koshihikari | |
|---|---|---|---|---|---|
| | | Per cent germination (%) | Mean days to germination (days) | Per cent germination (%) | Mean days to germination (days) |
| 1 | L H H H | 12. 6 | 11. 89 | 1. 3 | 13. 5 |
| 2 | L L H H | 68. 6 | 6. 05 | 1. 3 | 19. 5 |
| 3 | L L L H | 80. 0 | 4. 55 | 6. 0 | 12. 1 |
| 4 | L L L L | 70. 0 | 11. 09 | 78. 6 | 12. 6 |
| 5 | H L L L | 78. 0 | 8. 84 | 95. 3 | 8. 4 |
| 6 | H H L L | 89. 3 | 10. 25 | 84. 0 | 10. 5 |
| 7 | H H H L | 57. 3 | 9. 88 | 8. 0 | 13. 0 |
| 8 | H H H H | 40. 6 | 12. 50 | 5. 3 | 14. 9 |

at 20°C throughout the ripening period because of inadequate formation of dormancy (Table 1).

Analogous experimental conditions were applied to 12 exotic and 3 indegenous varieties. In order to induce seed dormancy, the temperature was maintained at 20°C during 5 days after heading and shifted to 30°C in the subsequent period of ripening. As for checking, the temperature was shifted from 30°C to 20°C at the corresponding stages.

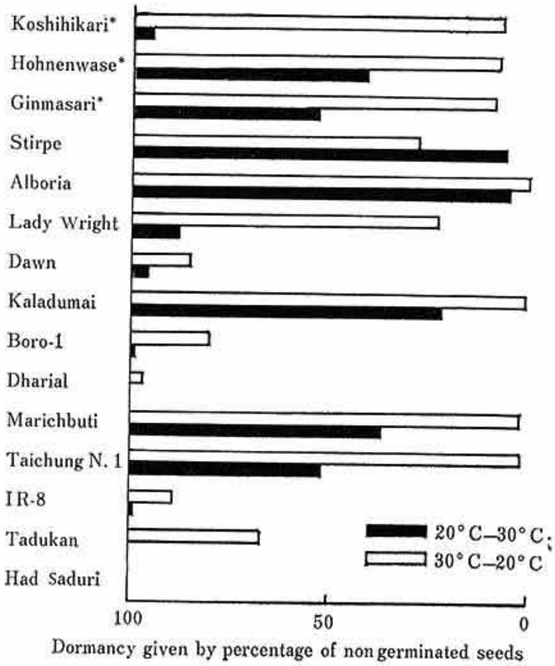



Fig. 2. Effect of temperature during maturation on dormancy
(* stands for indegenous varieties)

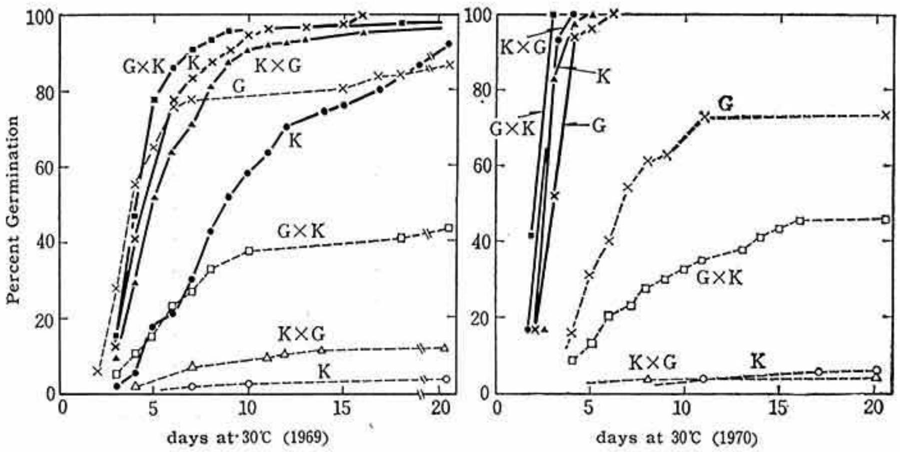
As the results, various types of response of the dormancy formation to temperature conditions were observed among foreign varieties (Fig. 2). For example, two varieties from South Europe (Stirpe and Alboria) showed almost uniform response to different temperatures, suggesting absence of ability to form dormancy. However, there is a common tendency to form stronger dormancy at the higher temperature during the latter period of ripening.

Besides these tests in growth cabinets, the role of temperature conditions during maturation was confirmed to be remarkable also in practical cultivation. The varietal difference as to dormancy becomes apparent in earlier transplanting cultivation in which ripening takes place from the end of August to early September.

Dormancy becomes slight even in varieties having considerable genetic base towards dormancy when they are grown under later transplanting where ripening advances from the end of September to October.

## Temperature-induced dormancy and seed structure

The removal of the lemma from the seeds with marked dormancy caused them to germinate instantly. Further investigations were designed to analyze the relative role of covering layers and embryo in the dormancy.




——: Seeds formed at 20°C throughout ripening stage
- - -: Seeds formed at 20°C during early stage of ripening and at 30°C from middle to late period of ripening
K: Koshihikari
G: Ginmasari

Fig. 3. Effect of reciprocal cross on germination of seeds formed under different temperature regimes during ripening stage

Since rice seeds are composed of covering layers originated from the mother plant and of embryo formed as the result of fertilization, the estimation of role of each part will give us direct indications on the breeding methods.

The seeds from two varieties contrasting in dormancy formation and from their reciprocal crosses were matured under favorable and unfavorable conditions for dormancy formation.

As the results of germination tests, the difference of dormancy among seed sources was found to be negligible when the seeds were matured at 20°C throughout the ripening period. While, when seeds were formed at 20°C in early stage and at 30°C in subsequent stage of ripening, apparent difference of dormancy was observed among seed sources (Fig. 3).

From these facts, both covering layers and the embryo seemed to be responsible for dormancy formation, though their relative roles on dormancy are estimated only under some specific conditions.

## Successive changes of germination habits during storage

Harvested seeds, being in various states depending upon ripening conditions as shown above, are assumed to incessantly respond to storage conditions and to change continuously their germination habits until the loss of viability.

Practically important traits, such as the duration of the dormant state, germination velocity at low temperature and longevity of seeds are supposed to be affected by storage conditions so that the understanding of outline of the changes of germination habits in the course of storage should be necessary for appropriate design of tests or for integration of data obtained.

In this connection, discrimination of phases was found to be possible after a series of successive germination tests during storage. And the effect of environmental factors could be estimated as an agent responsible for retardation or acceleration of the succession of phases.

Actual examples are illustrated in Fig. 4.

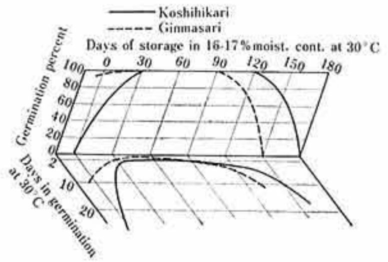



Fig. 4. Successive changes of germination habits

Dormant phase: identified by insufficient per cent germination with sporadic sprouting.

Delayed germination phase: identified by practically 100 per cent germination, but full germination is not attained within 2 days.

Fastest germination phase: identified by full germination within 2 days.

Declining phase: identified by 100 per cent but significantly retarded germination.

Viability losing phase: identified by significant decrease of germination percentage accompanied by irregular sprouting, e.g. lack of root, etc.

Succession of stages shown above is affected chiefly by temperature and by moisture content of seeds, but also largely determined by initial strength of dormancy. The less dormant seeds were, the faster the succession advanced in the course of storage.

Meanwhile, the dormant state of rice seeds can be maintained to some extent by two ways, i.e. by storage of seeds in a refrigerator, and by soaking in water at a room temperature. These facts provide the base for improvements of testing methods on dormancy.

Furthermore, germination speed at lower temperature was also confirmed to be remarkably affected by the stage of seeds in storage. Accordingly, the exact comparison of varietal difference on this trait should be conducted after synchronization of phases of material under examination.

Particular interest will be drawn also to the differentiation among varieties as for the succession of phases.

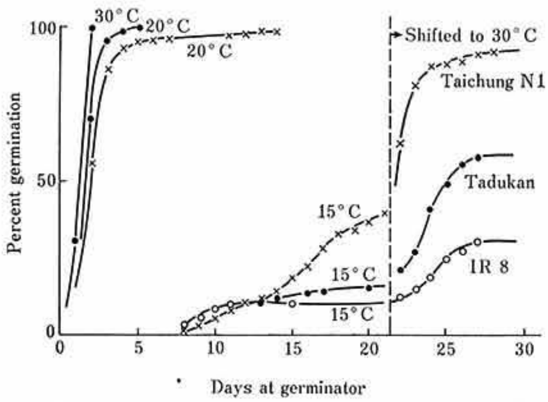



Fig. 5. Secondary dormancy induced at lower temperature

Seeds from some foreign varieties after the dormant phase showed the fastest and the most uniform germination at 20°C and 30°C, suggesting the lack of the delayed germination phase. However, these seeds gave extremely delayed germination at 15°C, and they did not attain 100 per cent germination, even if they were later shifted to 30°C (Fig. 5). Some foreign varieties thus seemed to have delayed germination phase only at lower temperature, and this phase is apparently connected with the ability to form secondary dormancy. Incidentally the seeds from these varieties after their 'modified delayed germination phase' were proved to sprout quicker than the seeds of domestic varieties at lower temperature.

## Conclusion

The complicated actions of environmental factors affecting germination of rice seeds may be summarized as follows:

Firstly, the level of dormancy which conditions further the succession of germination habits during storage is determined by temperatures in the ripening period.

Secondly, the change of germination habits or, in other words the aging of seeds pass through several phases under incessant influence of moisture content of seeds and storage temperature.

Thirdly, saturation of seeds with water, combined with a specific inner state of seeds, seems to depress germination. In domestic varieties, soaking seeds in water is efficient to conservation of dormant state to some extent. In some foreign varieties, it seems to induce secondary dormancy at lower temperature. From an evolutionary point of view, this habit might have an advantage in maintenance of longevity under swampy condition.

The recognition of these complex actions indicates difficulties in genetical analysis of germination habits, though, it may be the necessary step for further studies.

## References

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