Germination Habits in Rice Breeding

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The extension of early cultivation or early transplanting since 1955 has marked an, epoch in the history of rice production. However, the acceleration of harvest, thus introduced, has brought about an unfavorable effect on the plant that often causes germination of intact panicle. Previously keen attention had not been paid to the germination problem before harvest in rice breeding. In the past ten years research on germination has been one of the urgent tasks. And herewith are summarized some result of the preliminary experiments on this subject.

Effect of temperature during maturation on germination of rice seeds

Though the degree of dormancy or delayed germination is confirmed to be of a genetical nature, there are many evidences to show the environmental variation of hereditary germination habits. For example, short days have been pointed out as a factor responsible for such deviation. After some preliminary tests, the author became aware of the effect of temperature during maturation on germination habits and carried out an experiment.

As the result, considerable dormancy or delayed germination was found to be induced when rice seeds matured at a relatively low temperature in the early stage of maturation and at a high temperature (about 30°C or more) in the latter half of that period (Fig. 1). In contrast to this fact, the germination speed was accelerated by the high temperature 5 or 10 days after heading. This tendency was observed equally in three varieties differentiating each other in germination habit, thus, suggesting a latent ability in non-dormant varieties to form dormancy to some extent.

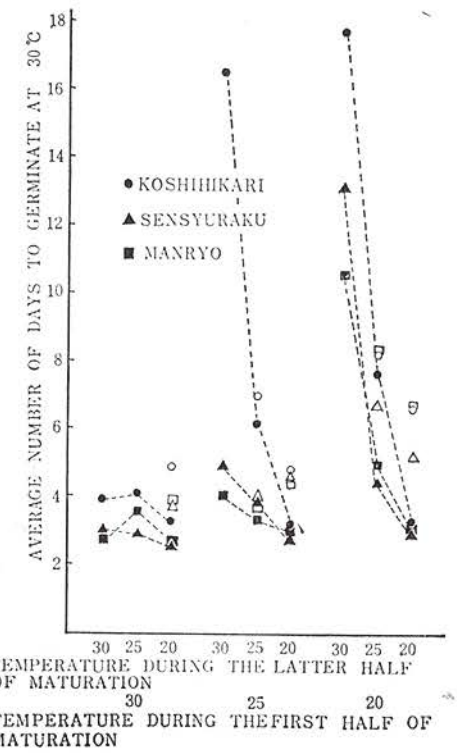

Fig. 1. The effect of temperature during maturation on the germination speed.
Note: White marks express the value of immature seeds.

Response of germination habits to storage

Our experience has shown that a variety-

Table 1. The Varietal difference in the germination behaviour after the storage for various periods in open air at room temperature (This test was continued from Feb. 14 in 1963 at 17.5°C)

Varieties	Incrination to germinate before harvest	Years of harvest	Number of days at germinator 2 3 4 5 6 7 8 9 10 11 12 percent germination corresponding to the number of days	Number of days until 50% germination
				Days
Koshihikari	weak	1960	2 14 36 53 68 76 79 83	7.81
		1961	4 64 88 95 97 97 97 97 98	2.76
		1962	1 25 63 89 98 99 100	4.67
Kanto No. 55	weak	1961	15 79 94 97 100	3.55
		1962	10 16 59 81 89 92 96	4.53
Honen-wase	medium	1961	6 20 54 72 78 82 88 92 93	3.89
		1962	17 84 100	4.49
Yachikogane	medium	1961	1 49 60 74 81 84 87 88 89 90	3.13
		1962	14 76 100	3.37
Manryo	strong	1960	All seeds were found to be dead	—
		1961	2 15 44 57 64 68 71 76 77 78 79	4.47
		1962	3 17 65 91 97 99 100	3.70
Tarehonami	strong	1961	12 34 42 51 57 62 67 69 72 73	5.88
		1962	3 31 95 100	3.29

giving dormant seed is usually retardant in sprouting on nursery bed at lower temperature so that it seemed difficult to breed new varieties with the faster sprouting in cool condition as well as the adequate dormancy free from germination before harvest. However, according to the author's observation, the seeds apt to germinate before harvest attained its maximum germination speed after several months' storage (in usual sowing season), and began to loose their viability during the first summer after harvest. Meanwhile the seeds more or less dormant in their maturing period still showed delayed germination after several months' storage, gave maximum germination energy following a year's storage and retained remarkable viability after two years' storage (Table 1).

In addition, it has been proved that successive changes of germination energy were realized within about 50 days' storage under high moisture condition at 30°C. Since germination speed was found to be variable in the course of storage as shown above, there is no 'definite order' in germination speed among varieties as has been believed to exist.

This fact leads us to conclude that emphasis should be placed upon dormancy rather than on rapid germination in cool condition because germination speed in such condition is able to be hastened by an appropriate storage or heat treatment which breaks dormancy.

Labor-saving method to check dormancy

When we have to deal with so many lines differing with each other in maturing time,

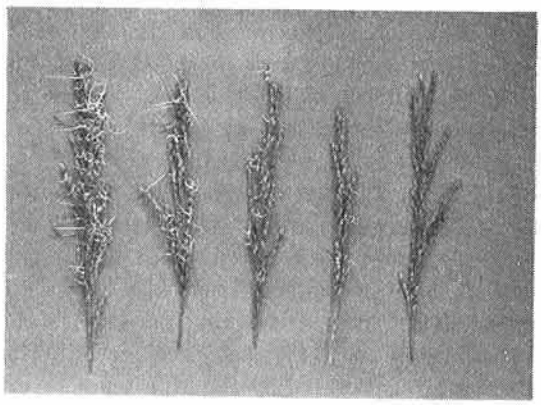

Fig. 2. Dormancy test after storage in refrigerator.

the germination tests to check dormancy become considerably laborious. Therefore a labor-saving mean to check dormancy is desirable for breeding purpose. To meet this demand, an application of the principle that breaking of dormancy is extremely retarded at a low temperature was examined. As the result, checking of germination of panicles stored for several months in a refrigerator (5~7°C) has been ascertained to be enough to determine the approximate degree of dormancy (Fig. 2).

Under this method, matured panicles are collected in the field with those of check varieties in their perfect maturity and stored in a refrigerator, and after the maturation of all sample lines, germination test is carried out at once, instead of several germination tests for each maturing time.

Experiments on hereditary nature of germination speed

Japanese rice varieties in general are not sufficient in the degree of dormancy. It might have probably been caused by the historical endeavor toward rapid germination under cool condition. And relatively cool storage condition of rice seeds might have been effective to keep viability without a protective role of dormancy. However, as the result of the appreciation of selective value of dormancy, some information on its hereditary nature becomes necessary.

The results of experiment undertaken by the author with four hybrid population to obtain some elementary knowledge are summarized as follows: There are at least two factors controlling germination speed, i.e. one in covering layers (glumes, seed coat or pericarp) derived from the mother plant and another in the embryo. And the expression of the segregation in the latter trait is almost completely suppressed by the former, as was found in the case of F_2 seed population where variances of germination speeds are nearly equal to that in parents (Fig. 3).

But the slight effect of selection on germination speed in F_2 seed population suggested the presence among the embryos of the segregation of factor related to germination speed, especially in the cross a parent of which is remarkably dormant.

On the other hand, the factor in covering

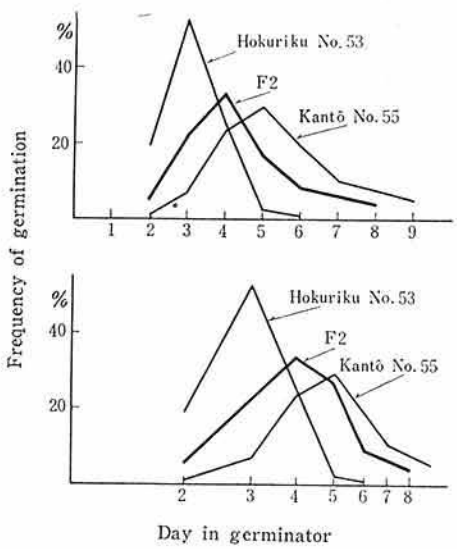

Fig. 3. Frequency of germination speed in F_2 population and its parents.
Note: The values of variance of germination speed are shown to be proportional to the degree of mean, if number of days in germinator is not converted into logarithmic scale.

Table 2. Frequency distribution of germination speed among groups of F_3 seeds by F_2 plants

Cross	Numbers of Group of F³ seeds — Days at Germinator: 2	3	4	5	6	7	Total
Kanto 55 × Hokuriku No. 53	♂			3 5 ♀ 4	3 1	3 2	21
Hoyoku × Hatsuminori			♀ 1 2 2 ♂ 1	3 6	2 1		18
Senshuraku × Manryo			1 1 ♀ 8 ♂	6 6	1		23
Hokuriku 52 × Koshihikari	♀ 2	6 6	5		♂	1	20

layer, having no dominant effect in F_1 (as homogenoeus covering layer on F_2 seeds), showed wide segregation in F_2 (as the covering layer on F_3 seeds) (Table 2) so that practical selection on dormancy may be possible mainly depending upon factors in covering layers.

In addition only for small sample population, the heritability of germination speed was estimated by F_3~F_4 regression, and significant values (40~80%) were obtained with the exception of one cross. And also significant correlations were pointed out between the germination speed of seeds and the heading date but the correlations were thought to be brought about by environmental conditions.

References

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