

Prominence of Maturity Stage on Seed Germination Behaviour of Popular Rice Varieties

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ABSTRACT: Though rice is a well-studied crop in the context of crop improvement, many of the seed development parameters that are critical for crop establishment largely remain unexplored. The relevance of stage of seed maturity is one such important trait which has direct impact on seed quality and subsequent crop performance. The present study was conducted with twelve rice varieties to determine the germination behaviour based on the stage of crop maturity. The freshly harvested seeds during physiological and harvestable maturity stages were evaluated for seed germination and seedling vigour index as a measure of seed quality. There were significant differences in germination of all the varieties harvested at different maturity stages. Among the varieties, five varieties viz., ADT 36, ADT 37, ADT 38, CO (R) 50 and N 22 were found dormant immediately after harvest irrespective of the stage of maturity and the remaining seven varieties were non dormant.

Keywords: Dormancy, germination, harvestable maturity, physiological maturity, rice

Rice (*Oryza sativa* L.), domesticated over thousands of years, is a genetically diverse and polymorphic staple crop [1]. India, the world's second-largest rice producer after China, relies heavily on rice, which accounts for 43% of total food grain and 53% of cereal production. High-quality seed is fundamental to enhancing productivity, as it can increase yield up to 20%. Among seed quality traits, germination is crucial. However, freshly harvested seeds often fail to germinate due to dormancy—a temporary suspension of growth during seed development. In rice, dormancy arises from both embryo and seed coat (hull) factors [2,3].

In general seed dormancy is a qualitative and genetically inherited trait [4] whose intensity is modified by the environment during seed development. Seed dormancy is very much influenced by season / environment [5] and crop duration. However, safe removal of seed dormancy is necessary, whenever fresh seed is required for planting immediately after harvest. Several studies [6,7,8], also revealed the effect of stage of maturity on seed germination and seedling vigour index in rice and many other crops. However, being a genotype-specific trait, this parameter needs to be explored in all prominent rice varieties that are in seed production chain, since it is vital for ensuring effective field establishment.

Considering this, an experiment was designed to study the influence of maturity stage on the seed germination and occurrence and dissemination of seed dormancy in rice varieties.

MATERIALS AND METHODS

To determine the appropriate stage of harvest and status of seed germination and dormancy, field experiments were conducted. Seeds of 12 rice varieties were sown in the raised nursery beds. Twenty-five day old seedlings were transplanted in the main field with row-to-row spacing of 20 cm and plant-to-plant distance of 15 cm. The plot size consisted of 3 × 2 m². The crops were raised in RBD with three replications. The plants of each variety were harvested at physiological and harvestable maturity stages. Immediately after harvest, the panicles were threshed manually by taking proper care of avoiding any admixture and the seeds were sun dried to attain a moisture content of 12 per cent. The seeds were evaluated for their germination potential as well as seedling vigour.

Germination (%)

The germination test was carried out to find out the percentage of germination in fresh seeds. Four replicates of hundred seeds were taken at random from each variety

and in paper medium adopting between paper method and allowed to germinate at $25 \pm 2^\circ\text{C}$ temperature and 90 ± 2 per cent relative humidity which were maintained in a germination room illuminated with fluorescent light. After 14 days, the seedlings were evaluated and the normal seedlings produced were counted and the germination was calculated and the mean expressed as percentage [9].

Fresh ungerminated seeds (%)

The germination test was conducted as per International Seed Testing Association (9) and at the time of evaluation, the seeds which do not produce seedlings but remain fresh at the end of the test period were classified as fresh ungerminated seeds, and the mean was expressed as percentage.

Vigour index

Vigour index values were computed using the following formula and the mean values were expressed in whole number [10].

Vigour index = Germination (%) $\times$ Mean seedling length (cm)

Viability (%)

Viability of rice seeds was determined immediately after harvest by tetrazolium test as described by [11]. One hundred seeds from all the varieties were conditioned overnight in distilled water in two replications. The hull was removed by using forceps and needles by lifting up at the pointed end and tearing in a spiral manner. The prepared seeds were soaked in 1.0 per cent aqueous solution of 2, 3, 5-triphenyl tetrazolium chloride and placed in a small petri dishes covered with lid. The petri dishes were incubated at $40^\circ\text{C} \pm 1^\circ\text{C}$ in dark for 3 h and the seeds were evaluated as viable or dead on the basis of staining pattern in embryo. Based on red colouration the viability percentage was estimated by adopting the following formula.

$$\text{Viability (\%)} = \frac{\text{No. of seeds fully stained}}{\text{Total no. of seeds placed}} \times 100$$

Imbibition rate (%)

Four replicates of 25 seeds were weighed from each treatment and incubated in between moistened germination paper for 0 to 24 h at $25 \pm 1^\circ\text{C}$ to avoid the possible effect of temperature variation on water absorption during imbibition. The seed samples were

drawn at 0, 4, 8, 12, 16, 20 and 24 h and the surface water on the seeds was removed before weighing by gentle pressing between two layers of filter paper. Based on the difference between the weights, the imbibition rate was calculated as below and the mean expressed in percentage [12].

$$\text{Imbibition rate (\%)} = \frac{\text{Final weight} - \text{Original seed weight}}{\text{Original seed weight}} \times 100$$

RESULTS AND DISCUSSION

The result of germination and seedling vigour studies conducted in 12 varieties of rice harvested at two maturity stages are presented in Table 1. The results revealed that there were significant differences in seed germination with respect to stage of maturity viz., physiological and harvestable maturity stage for all the rice varieties. The percentage of germination immediately after harvest was nil in four varieties (ADT 36, ADT 37, ADT 38 and N 22) and less than 15 per cent in three varieties at physiological maturity stage as compared to harvestable maturity which was 12 and 86 per cent for ADT 40, 8 and 71 per cent for ADT 49, 15 and 18 per cent for CO (R) 50 at physiological maturity stage and harvestable maturity stage respectively. The remaining varieties viz., CO 43, CO 47, CO (R) 48, CO (R) 49 and CO 51 recorded a germination percentage of 85, 90, 98, 81 and 98 at physiological maturity stage and 94, 96, 98, 97 and 98 percentage at harvestable maturity. This was supported with the observation recorded on fresh ungerminated seeds. The percentage of fresh ungerminated seeds was 100 in four varieties (ADT 36, ADT 37, ADT 38 and N 22), nil in two varieties (CO 51 and CO (R) 48), 88 and 14 per cent for ADT 40, 92 and 29 for ADT 49, 84 and 82 per cent for CO (R) 50 at physiological maturity stage and harvestable maturity stage respectively. The varieties viz., CO 43, CO 47 and CO (R) 49 recorded a fresh ungerminated seeds of 15, 10 and 17 percentage at physiological maturity stage, 6, 4 and 3 percentage at harvestable maturity stage. Thus the results clearly revealed the presence of seed dormancy in rice varieties which was more in ADT 36, ADT 37, ADT 38 and N 22. The results are in agreement [13]. who reported the presence of dormancy in rice varieties of ADT 37 and ADT 38 up to 120 and 32 days after harvest respectively. Different environment and date of harvest induced dormancy in rice genotypes. The germination percentage was initially low and gradually increased with increasing days after harvest (0, 15, 30 and 45th day after harvest). The genotypes viz., IET 8116, KMP 101, IR 30864, KRH-1,

Table 1. Evaluation of physiological parameters of rice varieties at physiological maturity stage

Varieties (V)	Germination (%)	Fresh ungerminated seeds (%)	Vigour index	Viability (%)
ADT 36	0 (0.39)	100 (89.72)	0	97 (80.03)
ADT 37	0 (0.39)	100 (89.72)	0	98 (81.87)
ADT 38	0 (0.39)	100 (89.72)	0	96 (78.47)
ADT 40	12 (20.27)	88 (69.73)	369	95 (77.08)
ADT 49	8 (16.43)	92 (73.57)	182	97 (80.03)
CO 43	85 (67.22)	15 (22.79)	2515	95 (77.08)
CO 47	90 (71.57)	10 (18.44)	2547	98 (81.87)
CO (R) 48	98 (81.87)	0 (0.39)	2511	96 (78.47)
CO (R) 49	81 (64.16)	17 (24.35)	2059	97 (80.03)
CO (R) 50	15 (22.79)	84 (66.42)	433	96 (78.47)
CO 51	98 (81.87)	0 (0.39)	2969	99 (84.26)
N 22	0 (0.39)	100 (89.72)	0	96 (78.47)
Mean	40.58	58.83	1132	96.67
Sed	3.151	2.435	76.54	5.323
CD(P=0.05)	6.392	4.940	155.26	NS

(Figures in parenthesis indicate arcsine values)

IR-64 and MTU 1001 were found dormant, immediately after harvest as reported [14]. The increasing trend in seed germination was observed in 22 numbers of non dormant rice varieties with increase in the days after harvest [15]. In Berseem, the variety Warden recoded a low germination percentage of 40 immediately after harvest and 80 per cent which was the standard germination for certification at 60 days after harvest and recorded the maximum of 93.3 per cent at 240 days after harvest [16].

The evaluation of imbibition rate revealed that, the maximum rate of imbibition was recorded at harvestable maturity stage than at physiological maturity stage which was 19.17 and 20.50 per cent for ADT 40, 17.83 and 20 per cent for ADT 49, 13.50 and 16.67 per cent for CO 43, 17 and 18.17 per cent for CO 47, 16.83 and 20.83 per cent for CO (R) 48, 16.50 and 17 per cent for CO (R) 49 and 18.17 and 20.50 per cent for CO 51 at physiological maturity and harvestable maturity stages respectively (Fig

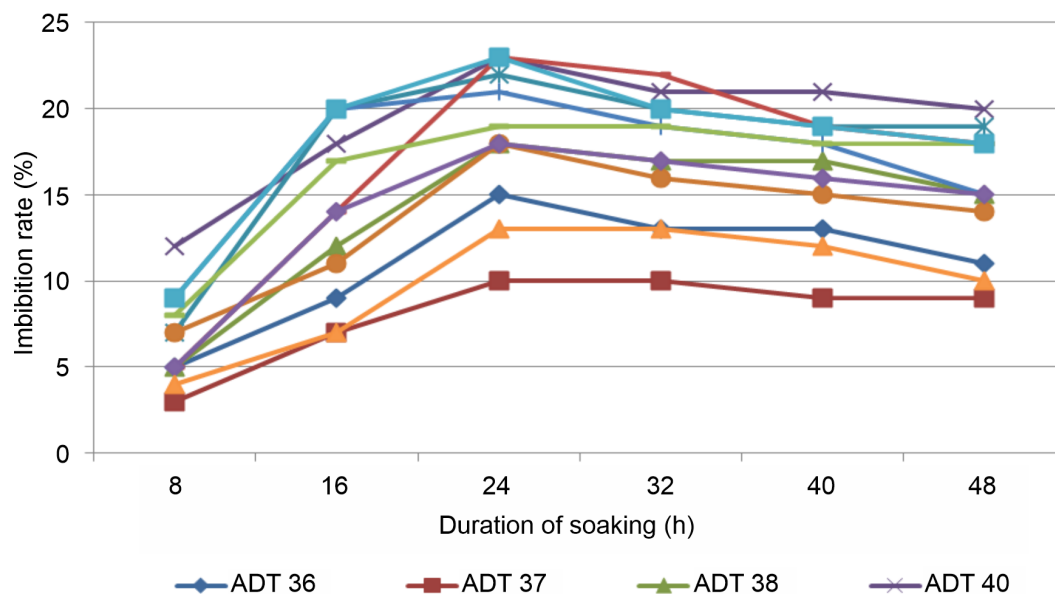
1 & 2). The rice varieties viz., ADT 36, ADT 37, ADT 38, CO (R) 50 and N 22 recorded minimum imbibition rate of 11, 8, 14, 14.17 and 9.83 per cent at physiological maturity stage than at harvestable maturity stage where the rate of imbibition was 14.67, 10.17, 16.33, 15.83 and 13.17 per cent, respectively. The mean imbibition rate for dormant varieties ranged from 8 to 14.17 per cent at physiological maturity and 10.17 to 16.33 per cent at harvestable maturity stage and comparatively the non dormant varieties recorded a higher range of imbibition rate which was ranged from 13.50 to 19.17 per cent at physiological maturity and 16.67 to 20.50 per cent at harvestable maturity stage respectively.

The observation on vigour index were significant at physiological and harvestable maturity stages. Maximum vigour index was recorded at harvestable maturity stage compared to physiological maturity stage due to the minimum value for germination at physiological maturity stage. The varieties viz., ADT 40, ADT 49, CO 43, CO

Table 2. Evaluation of physiological parameters of rice varieties at harvestable maturity stage

Varieties (V)	Germination (%)	Fresh ungerminated seeds (%)	Vigour index (%)	Viability
ADT 36	0 (0.39)	100 (89.72)	0	96 (78.47)
ADT 37	0 (0.39)	100 (89.72)	0	98 (81.87)
ADT 38	0 (0.39)	100 (89.72)	0	96 (78.47)
ADT 40	86 (68.03)	14 (21.97)	2605	95 (77.08)
ADT 49	71 (57.42)	29 (32.58)	1600	96 (78.47)
CO 43	94 (75.82)	6 (14.18)	2742	94 (75.82)
CO 47	96 (78.47)	4 (11.54)	2681	96 (78.47)
CO (R) 48	98 (81.87)	0 (0.39)	2474	96 (78.47)
CO (R) 49	97 (80.03)	3 (9.97)	2416	97 (80.03)
CO (R) 50	18 (25.10)	82 (64.90)	511	97 (80.03)
CO 51	98 (81.87)	0 (0.39)	2911	99 (84.26)
N 22	0 (0.39)	100 (89.72)	0	96 (78.47)
Mean	54.83	44.83	1495	96.33
Sed	2.909	1.740	63.41	4.649
CD(P=0.05)	5.901	3.530	128.63	NS

(Figures in parenthesis indicate arcsine values)

**Figure 1.** Evaluation of seed imbibition rate (%) of rice varieties at physiological maturity stage

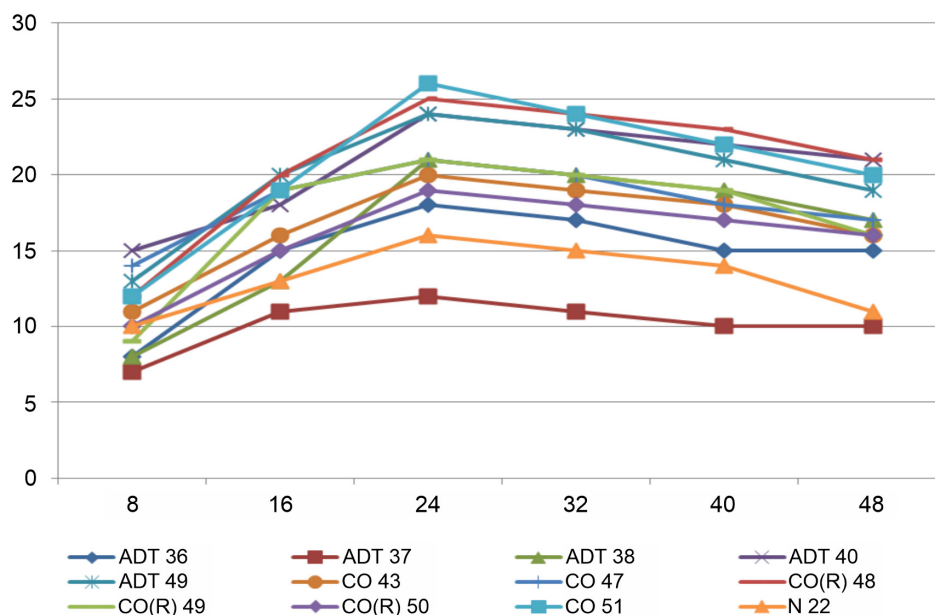


Figure 2. Evaluation of seed imbibition rate (%) of rice varieties at harvestable maturity stage

47, CO (R) 48, CO (R) 49, CO (R) 50 and CO 51 recorded a vigour index of 369, 182, 2515, 2547, 2511, 2059, 433 and 2969 at physiological maturity stage, and which was 2605, 1600, 2742, 2681, 2474, 2416, 511 and 2911 respectively at harvestable maturity stage.

The influence of physiological maturity on seedling vigour of rice has been reported [17]. The prevalence of dormancy in rice to the extent of 96 per cent has been observed [18]. The study on determination of seed quality with reference to stage of harvest in bottle gourd var. ABG-1 revealed that, among the three stages of harvest viz., 40, 50, 60 days after anthesis, the seeds harvested at 50 days after anthesis recorded maximum seed germination, seedling length, seedling weight and seedling vigour than other two stages of harvest [19].

There was no significant variation among the varieties for viability percentage and it was more than 95 for all the varieties at both stages of physiological and harvestable maturity. Thus the present study indicated that the varieties viz., ADT 36 ADT 37, ADT 38 and N 22 were found to be dormant which was occurred during the physiological maturity stage and continued up to harvestable maturity stage. The other varieties viz., ADT 40, ADT 49, CO 43, CO 47, CO (R) 48, CO (R) 49 and CO 51 were non dormant and a minimum level of dormancy was expressed by ADT 40 (12%) and ADT 49 (8%) at physiological maturity stage and at harvestable maturity stage they recorded a germination of above 70

per cent. The other varieties recorded germination percentage of above 80 per cent at both stages of maturity. With reference to variety CO (R) 50 which recorded very low germination at physiological (15%) and at harvestable (18%) maturity stage with maximum viability indicated the presence of dormancy in CO (R) 50.

Studies by [20] suggest that seed maturity and moisture content significantly influence oxidative metabolism and moisture imbibing capacity, thereby affecting seed germination behavior. Additionally, seed maturity and seed storage potential are also reported to have significant impact on seedling emergence under abiotic stress condition [21, 22].

REFERENCES

1. SARLA N, CN NEERAJA AND EA SIDDIQ (2005). Use of anchored (AG) n and (GA) n primers to assess genetic diversity of Indian landraces and varieties of rice. *Current Science*, 1371-1381.
2. TAKAHASHI N (1997). Inheritance of seed germination and dormancy. *The Science of the Rice Plant*, 348-359.
3. SESHU DAND M SORRELLS (1986). Genetic studies on seed dormancy in rice *Rice Genetics I: (In 2 Parts): World Scientific*, 369-382.
4. NAYLOR JM (1983). Studies on the genetic control of some physiological processes in seeds. *Canadian Journal of Botany*, **61**(12): 3561-3567.
5. PADMAJA RAO S (1994). Studies on seed dormancy in traditional rice varieties as affected by season. *Indian Journal of Plant Physiology*, **37**(2): 113-5.

6. AGRAWAL PK (1981). Genotypic variation in seed dormancy of paddy and simple methods to break it. *Seed Research*, **9**: 20-27.
7. BIRADAR BB AND M MAHADEVAPPA (1993). Dormancy and Germination Studies in CTH-1-a Cold Tolerant Rice. *Seed Research*, 494-494.
8. PADMA V AND BM REDDY (2000). Evaluation of rice genotypes for dormancy duration and seed stability under natural accelerated ageing. *Seed Research*, **28(2)**: 158-165.
9. ISTA (2011). International Rules for Seed Testing. Bassersdorf, Switzerland: International Seed Testing Association.
10. ABDUL-BAKI AA AND JD ANDERSON (1973). Vigour determination in soybean seed by multiple criteria. *Crop Sci*, **1**: 630-633.
11. ISTA (1999). International Rules of Seed Testing. *Seed Sci. and Technol*, **27**: 27-32.
12. AL-MUDARIS M AND S JUTZI (1998). Influences of genotype, priming material, temperature and osmotic potential of priming solution on imbibitions and subsequent germination of sorghum and pearl millet seeds during and after treatment. *Journal of Agriculture in the Tropics and Subtropics*, **99**: 133-145.
13. KOTA J (2004). Studies on seed dormancy in rice (*Oryza sativa* L.) varieties. Ph.D (Ag.) Thesis, Indian Agricultural Research Institute, New Delhi.
14. ARUMUGAM M, M RAJANNA AND R GOWDA (2008). Seed dormancy and seedling vigour as influenced by planting time environment and date of harvest in rice (*Oryza sativa* L.). *Caspian Journal of Environmental Sciences*, **6(1)**: 1-9.
15. SOOGANNA LV, P SUBBARAO, P KIRAN BABU, U CHAITANYA AND K KESAVALU (2012). Effect of Maleic hydrazide on induction of seed dormancy and seed quality parameters in rice. *Seed Research*, **40(2)**: 124-133.
16. MAITY A AND SANJAY KUMAR (2018). After ripening period impacts the seed germination of berseem. *Seed Research* **46(2)**: 156-159.
17. SINGH AR AND ST BORIKAR (1990). Seed dormancy and quality in relation to seed development and maturity in rice. *Seed Research*, **18(2)**: 121-125.
18. SOEJADI US AND R NUGRAHA (2001). Evaluation of seed quality of several rice genotypes during storage. *Journal of Agricultural Food Crop Research*, 14-15.
19. DHIMANT DESAI, KALYANRAO, BHUMIT PATEL AND N SASIDHARAN (2016). Effect of harvesting stages and post-harvest ripening on seed yield and seed quality of bottle gourd var.ABG-1 *Seed Research*, **44(2)**: 127-132.
20. RAJU RS, SAHOO C AND HANJAGI PS, (2024). Oxidative metabolism, moisture imbibing capacity and their association with pre-harvest sprouting in rice. *Cereal Research Communications*, **52(1)**: 115–128.
21. KRUTHIKA N AND JITHESH MN (2023). Morpho-physiological profiling of rice (*Oryza sativa*) genotypes at germination stage with contrasting tolerance to salinity stress. *Journal of Plant Research*, **136(6)**: 907–930.
22. RAJAK, THIRUSENDURAD SELVI, R GEETHA, C MENAKA, T EEVERA AND N PUNITHAVATHI (2023). Assessment of seed storage potential of traditional rice varieties. *Seed Research*, **51(1)**: 18-25.