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Does ecology has an impact on seed dormancy???

P Sanghamitra*, RK Sahu, Lalan Kumar Singh, Debashis Moharana, TB Bagchi, Sushmita Munda, Sutapa Sarkar, Nabaneeta Basak, Gaurav Kumar, Manoj Kumar Yadav, LK Bose, BC Marandi, J Meher and HN Subuddhi

[1]ICAR-National Rice Research Institute, Cuttack, Odisha, India

**Corresponding author e-mail: p.sanghamitra1@gmail.com*

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ABSTRACT

About 91 varieties of different ecology released from National Rice Research Institute (NRRI),Cuttack were screened for duration of seed dormancy harvested after 25,30 and 35 days of heading. The varieties harvested after 25 days of heading showed 0-37 days of dormancy with Lunishree was observed as strongly dormant with 37days of dormancy duration. Moderate dormancy (≥20days) was observed in Jayanti, Kamesh, Jayantidhan, Nua chinikamini, Nua kalajeera, and Lunisree harvested at 30days after heading. The varieties that were collected after 35 days of heading showed 0-20 days of dormancy and were mostly non dormant and weakly dormant at this stage of sampling. Varieties Jayanti, Nua chinikamini, and Lunisree identified with moderate seed dormancy (≥15 days) may be useful for breeding programme. Highest duration of dormancy was observed in the varieties developed for coastal salinity followed by deep water ecology. Variation in duration of dormancy of the variety Luna Sampad grown in two different ecologies strengthen the influence of ecology on seed dormancy.

Key words: *Seed dormancy, ecology, rice, days after heading, duration of dormancy*

INTRODUCTION

Seed dormancy is the failure of the fully mature and viable seed to germinate to an appreciable degree under favorable environmental conditions; is an important trait in the breeding programs of cereal crops as it prevents pre-harvest sprouting (Seshu and Sorrells, 1986) thus associated with seed quality (Hu et al., 2003). Dormancy is typically under polygenic control, and its expression is heavily influenced by the environmental factors (Koornneef et al., 2002).This trait is controlled by the genotype of the mother plant and the embryo as well. The former affects the nature of the tissues surrounding the embryo, such as the seedcoat (testa). These tissues impose dormancy act as physical barriers to radicle growth on imbibitions which varies among the species. Whereas embryonic dormancy is acquired during seed maturation, in which the plant hormone abscisic acid (ABA) plays a fundamental role. In coastal Odisha, long spell of rainy weather during harvest time, causes heavy pre harvest sprouting (PHS) in the rice field. Sometimes, due to unavailability of concrete threshing floors and driers, most of the farmers are bound to delay harvesting, threshing and drying of seeds until weather becomes clear and sunny. Under such situations, pre and post-harvest sprouting (PHS) of seeds will lead to low returns to the farmers. Therefore, development of varieties possessing dormancy to suit to the demands of the coastal belts and cyclone affected regions especially during grain ripening in wet season, is envisaged as a major research strategy for which it is essential to know the duration of seed dormancy of rice cultivars. Therefore this study was undertaken to evaluate duration of seed dormancy in the varieties realeased from National Rice Research Institute. Also response of a salt tolerant variety grown simultaneously in two different ecology was evaluated for duration of seed dormancy to evaluate the impact of variation of ecology on seed dormancy.

MATERIALS AND METHODS

Ninty one rice varieties of different duration and of various ecology (released from NRRI) were evaluated

for duration of seed dormancy. These varieties were grown in augmented design in the experimental field, ICAR-NRRI (20.45° N, 85.93° E), Cuttack, Odisha, and one salt tolerant variety Luna Sampad was also grown in saline soil in farmers' field at Kankana, (12.68^0N and 30.76^0E) Ersama, Jagatsingpur Odisha. The water E.C (electrical conductivity) was ranged from 3.9 to 5.2 dSm^{-1} (desisimon per meter) throughout the plant growth period. Ten plants of each variety were planted in three rows with spacing of 20x15 cm during *Kharif,* 2016. Five middle plants in each row in each variety were selected. Panicles with same date of flowering were tagged at 50% flowering stage.Ten panicles per variety were harvested after 25, 30 and 35 days of heading (DAH). Panicles were threshed, pooled together and immediately put for germination to identify the period of dormancy. Three replicates of twenty five seeds each, a total of 75 seeds for each variety, were evaluated in a completely randomized design.

Seeds were sown in petriplate on one sheet of Whatman no. 3 filter paper moistened with 10 mL distilled water and kept at germination chamber at 30^0C for germination. At daily evaluations, seeds were considered germinated when the radicle just protruded (≥ 2mm). Varieties that germinated (<80% germination) within 5-6 days of first germination were considered as non dormant and those not germinated (<80% germination) were considered as dormant one. For these dormant varieties germination was recorded after every five days so that actual days taken for a variety to achieve 80% germination can be recorded. Days taken by a variety to achieve 80% germination from the date of harvest are considered as duration of seed dormancy. At the conclusion of each test, ungerminated seeds were checked for viability using the tetrazolium test (Delouche et al., 1976).

The data were subjected to analysis of variance (ANOVA) as per the standard procedures and the comparison of treatment means was made by critical difference (CD) at 5% error probability.

RESULTS AND DISCUSSIONS

Seed dormancy a complex agronomic trait, under control of both environmental and genetic factors, is considered as an important trait in plant breeding programme as it affects grain yield and seed quality. It is well established that early and medium duration rice varieties had shorter span of dormancy compared to late duration varieties (Sukumardev,1982; Murthy et al., 1990). Seed without dormancy or weak dormancy leads to a higher preharvest sprouting rate if harvest time coincides with favourable rainy weather and thus results in reduced seed quality and production losses. However, deep seed dormancy may prevent germination if subsequent crop is to be grown after previous crop. In cereal crops a moderate seed dormancy is desirable to prevent preharvest sprouting. Thus, understanding the genetic variation of seed dormancy is of great interest to plant breeders for balancing the advantages and disadvantages of seed dormancy.

In this study about 91 varieties released from NRRI, Cuttack for different ecology were screened for duaration of seed dormancy. The panicle of each varieties were carefully sampled at three different times *i.e.,* after 25, 30 and 35 days after heading (DAH).The seeds were allowed to germinate immediately after sampling and germination percentage was recorded. Days taken by a variety to achieve 80% germination was considered as duration of seed dormancy.

The varieties assessed in this study showed genetic variation for dormancy (Table 1, 2 and 3). These varieties were classified as non dormant(0 days of dormancy), weekly dormant (1-15 days of dormancy), moderately dormant (15-30 days of dormancy) and strongly dormant (>30 days of dormancy). The varieties harvested at 25DAH showed 0-37 days of dormancy. Geetanjali, Indira, Improved lalat, Improved Tapaswini, Kshira, Satabdi, Chandrama, Sattari, CR Dhan 204, CR Dhan 902 were found non dormant. Variety Lunisree was observed as strongly dormant with 37-days of dormancy duration.

A range of 0-26 days of dormancy was observed in the varieties harvested at 30 DAH. Some of the varieties which were dormant (harvested after 25 days of heading) were found non dormant on delaying the harvest for five days which envisages release of seed dormancy upon maturation. Moderate dormancy was observed in Jayanti, Narendra-1, CRDhan101, Kamesh, Vanaprabha, Virendra, Jalamani, Jayantidhan, Moti, Nua Chinikamini, Nua Kalajeera, Nua Dhusara, Savitri, Luna Burial, Luna Sankhi, Luna Suvarna and Lunisree.

Table 1. Dormancy duration (days) in rice varieties of irrigated and *Boro* ecology.

Sl No.	Varieties	Ecology	25DAH	30DAH	35DAH
1	Abhisek	Irrigated	7	0	0
2	Ajaya	Irrigated	9	0	0
3	Satyakrishna	Irrigated	8	0	0
4	CR Dhan 300	Irrigated	16	14	10
5	Hue	Irrigated	8	0	0
6	CR Dhan 303	Irrigated	7	0	0
7	CR Dhan 304	Irrigated	12	5	0
8	CR Dhan 305	Irrigated	15	0	0
9	CR Dhan 306	Irrigated	16	0	0
10	Maudamani	Irrigated	7	6	4
11	CR Dhan 310	Irrigated	9	0	0
12	CR Dhan 907	Irrigated	26	10	6
13	Geetanjali	Irrigated	0	0	0
14	Indira	Irrigated	0	0	0
15	Improved lalat	Irrigated	0	0	0
16	Improved Tapaswini	Irrigated	0	0	0
17	Jayanti	Irrigated	29	22	15
18	Khitish	Irrigated	18	15	11
19	Kshira	Irrigated	0	0	0
20	Narendra-1	Irrigated	19	16	13
21	Naveen	Irrigated	5	0	0
22	Radhi	Irrigated	17	12	6
23	Rajalaxmi	Irrigated	16	7	0
24	Ratna	Irrigated	9	4	0
25	Satabdi	Irrigated	0	0	0
26	Saket-4	Irrigated	10	6	0
27	Shaktiman	Irrigated	13	4	0
28	Sarasa	Irrigated	8	6	0
29	Supriya	Irrigated	10	0	0
30	Tapaswini	Irrigated	5	0	0
31	Udaya	Irrigated	14	10	6
	Mean		10	4	2
	C.D(0.05)		2.75	1.72	1.17
1	Chandrama	Irrigated boro	0	0	0
2.	Chandan	Boro	3	0	0
3.	CR Dhan 601	Boro	6	0	0
	Mean		3	0	0
	C.D(0.05)		3.51	0	0

DAH-days after heading

The varieties that were collected at 35 DAH showed 0-20 days of dormancy and were mostly non dormant and weakly dormant at this stage of sampling. Nua Chinikamini and Lunishree were found with moderate dormancy of 20 and 18 days respectively.

Such Variation in duration of seed dormancy has also been reported in different varieties of *Oryza sativa* (Sheshu and Dadlani, 1991; Rao, 1993). It was observed that seed dormancy gradually reduced on delaying the harvest from 25 to 35 days after heading. This increase in germination rate or reduction in dormancy with harvest date was also reported by Feyem et al. (2017) who demonstrated a negative influence of harvest date on seed germination and it can be explained that seeds from panicles harvested at 20 and 25 days after heading had a latency time and slow depletion of seed reserve is responsible for low germination rate.

In this study, a positive association of dormancy duration with maturity duration of varieties (Fig. 1) was proved at all the three stages of harvest *i.e.,* at 25, 30 and 35DAH indicating variety with early maturity duration has less duration of dormancy and vice versa. Duration of varieties had a linear positive regreesion for duration ofdormancy (25 DAH, R^2=0.131, 30 DAH,

Table 2. Dormancy duration (days) in rice varieties of upland and deep water ecology.

Sl No.	Varieties	Ecology	25DAH	30DAH	35DAH
1	Annada	Upland	6	0	0
2	Ankit	Upland	17	17	13
3	Kamesh	Bundedupland	25	20	12
4	Dhalaheera	Upland	14	7	0
5	Heera	Upland	25	14	9
6	Neela	Upland	7	0	0
7	Phalguni	Bunded upland	20	13	4
8	Sadabahar	Upland	11	6	0
9	Sahabhagidhan	Rainfed upland	19	11	0
10	Sattari	Upland	0	0	0
11	Satyabhama	Upland	21	14	10
12	Sneha	Upland	7	0	0
13	Tara	Upland	8	6	0
14	Vandana	Upland	18	12	8
15	Vanaprabha	Upland	20	17	10
16	Virendra	Upland	22	16	7
	Mean		**15**	**10**	**5**
	C.D(0.05)		**2.9**	**3.22**	**0.72**
1	Hanseswari	Semideep	14	10	0
2	CR Dhan 500	Deep water	9	0	0
3	CR Dhan 501	Semideep	17	12	6
4	CR Dhan 505	Deep water	19	13	7
5	Jalamani	Semi deep	26	18	14
6	Jayanti dhan	Deep water	28	20	12
7	Kalashree	Medium deep	15	6	0
8	Panidhan	Medium deep	9	5	0
9	Sarala	Medium deep	25	18	14
10	Tulsi	Medium deep	20	14	0
11	Utkalprava	Medium deep	24	14	8
12	Varsadhan	Semi deep	18	14	11
	Mean		**19**	**12**	**6**
	C.D(0.05)		**2.39**	**4.0**	**2.69**

R^2=0.158, 35 DAH, R^2=0.099). A highest regression coefficient at 30 DAH indicate a strong association of duration of dormancy in the sample harvested at 30 DAH. Most of the varieties were non dormant at 35 DAH for which a lower regression value of 0.099 was observed at this stage of harvest. Though environmental factors plays a significant role in deciding depth of dormancy, however elaborate study is needed to understand this relationship.

In irrigated ecology, dormancy duration was ranged from 0-29, 0-22 and 0-15 days at 25, 30 and 35 DAH respectively with highest dormancy period observed in the variety Jayanti at all the three stages of harvest.0-6 days of dormancy was observed in boro rice at 25 DAH and later varieties were found non dormant at 30 and 35 DAH (Table 1).

The range of dormancy duration varied from 0-25, 0-20 and 0-13 days at 25, 30 and 35 DAH

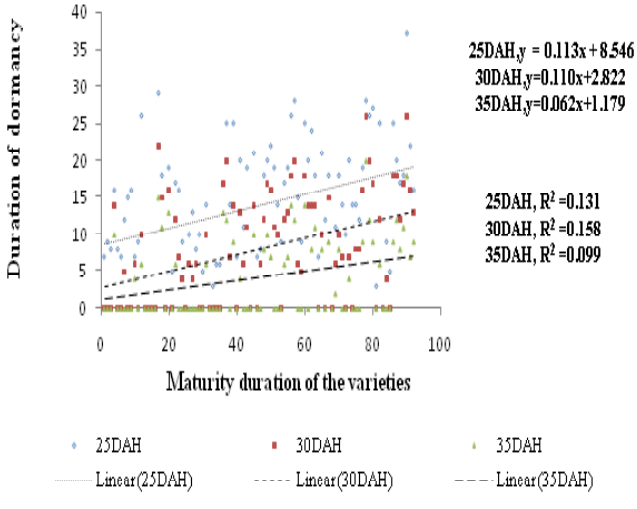

Fig. 1. The relationship of maturity duration of the varieties with dormancy duration (days).

Table 3. Dormancy duration (days) in rice varieties of aerobic, low land and coastal saline ecology.

Sl No.	Varieties	Ecology	25DAH	30DAH	35DAH
1	Pyari	Aerobic	7	0	0
2	CR Dhan 201	Aerobic	21	10	8
3	CR Dhan 202	aerobic	12	0	0
4	CR Dhan 203	Aerobic	18	15	9
5	CR Dhan 204	Aerobic	0	0	0
6	CR Dhan 205	Aerobic	11	6	2
7	Gopinath	Aerobic	18	10	8
	Mean		**12**	**6**	**4**
	C.D(0.05)		**2.69**	**3.46**	**2.35**
1	Sumit	Shallow lowland	14	7	0
2	CR Dhan 407	Shallow lowland	10	0	0
3	Chakaakhi	Shallow lowland	20	7	4
4	CRHR 32	Shallow lowland	14	0	0
5	Dharitri	Shallow lowland	14	8	0
6	Ketkijoha	Shallow lowland	12	8	0
7	Moti	Shallow lowland	19	16	9
8	Nua chinikamini	Shallow lowland	28	26	20
9	Nua kalajeera	Shallow lowland	26	20	12
10	Nua dhusara	Shallow lowland	27	17	9
11	Padmini	Shallow lowland	3	0	0
12	Pooja	shallow lowland	25	12	6
13	Poornabhog	shallow lowland	0	0	0
14	Reeta	Shallow lowland	9	4	0
15	Samalei	Shallow lowland	5	0	0
16	Savitri	Shallow lowland	25	18	9
	Mean		**16**	**9**	**4**
	C.D(0.05)		**3.68**	**2.79**	**2.50**
1	Luna burial	Coastal saline	20	18	12
2	Luna sampad	Coastal saline	17	12	8
3	Luna sankhi	Coastal saline	18	17	11
4	Lunisree	Coastal saline	37	26	18
5	Luna suvarna	Coastal saline	22	16	7
6	Sonamani	Coastal saline	16	13	9
	Mean		**22**	**17**	**11**
	C.D(0.05)		**3.28**	**4.09**	**3.50**

respectively in upland ecology with Ankit and Heera observed with highest dormancy duration of 25 days at 25 DAH, Kamesh was observed with 20days of dormancy at 30 DAH and 13 days highest dormancy duration was observed in the variety Ankit at 35 DAH (Table 2). In deep water ecology,no variety was dormant at 25DAH.The dormancy period was 0-20 and 0-14 days at 30 and 35 DAH with the varieties Jalamani and Jayanti dhan were observed with highest dormancy period at all the three stages of harvest.

In aerobic condition, the variety CR Dhan 204 was found non dormant while others were dormant up to 21 days, 0-15 and 0-9 days dormancy period was observed in the varieties at 30 and 35 DAH respectively with CR Dhan 203, CR Dhan 201 and CR Dhan 206 observed with highest duration of dormancy (8-9 days) at 35DAH (Table 3). In lowland ecology, Nua Chinikamini, Nua Kalajeera, Pooja and Savitri observed with ≥ 25 days dormancy duration at 25 DAH. 0-26 and 0-20 days dormancy period was observed at 30 and 35 DAH respectively with highest dormancy

Table 4. Variation in seed dormancy(days) of different rice varieties of different ecology.

Ecology	25 DAH	30 DAH	35 DAH
Coastal saline	22	17	11
Lowland	16	9	4
Deep water	19	12	6
Upland	15	10	5
Aerobic	12	6	4
Irrigated	10	4	2
Boro	3	0	0

observed in Nua Chinikamini. However coastal saline ecology identified with wider range of dormancy duration that varied from 16-37, 12-26 and 7-18 days at 25, 30 and 35 DAH respectively with Lunisree observed with strong dormancy at all the three stages (Table 3).

It is reported that the level of dormancy is affected by the seed maturity stage (Robert 1962; Anderson et al., 1993), the storage temperature (Robert 1965; Cohn et al., 1981), seed moisture content during the dry after-ripening period (Cohn et al., 1981) and the environmental variation such as the temperature during seed set (Steven Penfield and Dana R. Mac Gregor, 2017), the day length (Takahasi, 1997), soil salinity (Zhang et al., 2010) among others. Besides the environmental factors, seed dormancy is also regulated by a number of plant hormones such as abscisic acid, gibberellic acid, auxin, ethylene and brassinosteroids (Koornneef et al., 2002; Finkelstein et al., 2004).

In the present study, highest duration of dormancy was in the varieties developed for coastal salinity (22, 17 and 11 days at 25, 30 and 35 DAH respectively) followed by deep water (19, 12 and 6 days 25, 30 and 35 DAH respectively) from which it was conceptualized that ecology may have some impact on duration of seed dormancy (Table 4). Though depth of dormancy depend on the variety, environmental factors but variation in depth of dormancy in different ecology may be interpreted as a survival mechanism adopted by a crop. Report on differential behaviour of a crop in terms of duration of seed dormancy in changing ecological condition in a particular variety is limited.To study the effect of growing ecology on duration of dormancy and to strengthen the above finding, one salt tolerant variety Luna sampad also grown at Erasama block, Cuttack, Odisha at E.C level 3.9-5.2 dSm^{-1} during *Kharif,* 2016 was evaluated for duration of seed dormancy. The variety was observed with 20 days of seed dormancy harvested after 30 days of heading where as the same variety was observed with 12 days of seed dormancy (Fig. 2) when grown at irrigated condition at NRRI, Cuttack at E.C level 0.52 dSm^{-1}. This delay in germination under increased soil salinity reported for reduced α-amylase activity as a result of an increase in bioactive Gibberellins (GAs) inactivation (Liu et al., 2018). The differences in the dormancy period between the two ecology indicated that not only

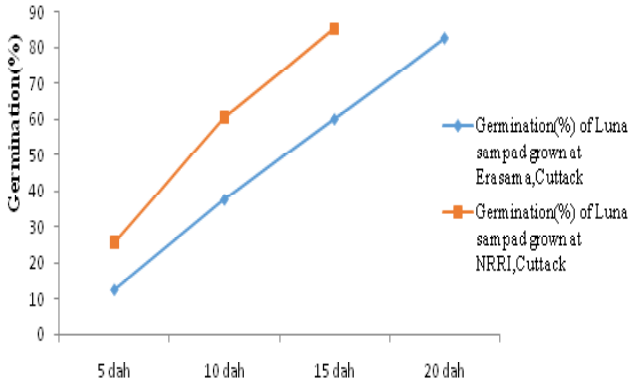

Fig. 2. Difference in duration of dormancy (days) of Luna sampad grown at Erasama and NRRI Cuttack. (dah-days after harvest).

salinity but variations in temperature, radiation, humidity during flowering, ripening and post ripening period may have profound influence in determining the dormancy period of a variety.

Thus growing ecology has an impact on duration of seed dormancy on rice varieties and the varieties Jayanti, Nua Chinikamini and Lunisree identified with moderate seed dormancy (≥15 days at 35 DAH) may be useful for breeding programme. The difference in dormancy period of a variety grown in two difference ecology need to be studied further at biochemical and molecular level. Also variation in depth of dormancy among various ecology and in the areas of their release need to be further explored at molecular level for strengthening the relationship of ecolgy with seed dormancy.

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REFERENCES

Anderson JA, Sorrells ME, Tanksley SD (1993). RFLP analysis of genomic regions associatedwith resistance to pre-harvest sprouting in wheat. Crop Science 33: 453-459

Cohn MA and Hughes JA (1981). Seed dormancy in red rice (*Oryza sativa*). I. Effect oftemperature on dry-afterripening. Weed Science. 29: 402-404

Delouche JC, Still TW, Raspet M and Lienharo M (1976). O teste de tetrazolio para a viabilidade da semente.

Brasilia:Agiplan 103

Feyem FMelie MN, Bell JM, MalaaKenyi D, FankouDougoua MY, Moche K, Tandzi LN, MapiemfuLamare D, LikengLingue B and WoinNoe (2017). Harvest Date Influence on Seed Germination of Some NericaRainfed Rice Varieties. Journal of Rice Research 5:1

Finkelstein RR (2004). The role of hormones during seed development andGermination. In: Davies PJ, editor. Plant Hormones - biosynthesis, signaltransduction, action! Dordrecht: The Netherlands: Kluwer Academic Publishers pp. 513-537

Hu WM, Ma HS, Fan LJ and RuanSL (2003). Characteristics of pre-harvest sprouting in sterile lines in hybrid rice seeds production. Acta Agronomica Sinica 29(3): 441-446

Koornneef M, Bentsink L and Hilhorst H (2002). Seed dormancy and germination. Current Opinion Plant Biology 5: 33-6

Li L, Xia W, Li H, Zeng H, Wei B, Han S and Yin C (2018). Salinity Inhibits Rice Seed Germination by Reducing α-Amylase Activity via Decreased Bioactive Gibberellin Content. Frontier in Plant Science 9(275): 1-9

Murthy PSS, Reddy PJR and Prasad SSR (1990). Seed dormancy of rice varieties released by Andhra Pradesh Agricultural University (APAU). International Rice Research News Letter 15 : 6-7

Rao SP (1994). Studies on seed dormancy in traditional rice varieties as affected by seasons .indian journal of Plant physiology 35(2): 113-115

Roberts EH (1962). Dormancy in rice seed. III. The influence of temperature, moisture and gaseous environment. Journal of Experimental Botany13: 75-94

Roberts EH (1965). Dormancy in rice seed. IV. Varietal responses to storage andgermination temperatures. Journal of Experimental Botany 16: 341-349

Seshu DV and Dadlani M (1991). Mechanism of seed dormancy in rice. Seed Science Research1(3) : 187-194

Seshu DV and Sorrells ME (1986). Genetic studies on seed dormancy in rice. In: Rice Genetics. IRRI, Philippines pp. 369-382

Steven Penfield and Dana R MacGregor (2017). Effects of environmental variation during seed production on seed dormancy and germination, Journal of Experimental Botany 68(4): 819-825

Sukumardev VP (1982). Post harvest dormancy of important high yielding paddy varieties cultivated in Kerala. Seed Research 10(2): 167 - 171

Takahashi N (1997). Inheritance of seed germination and dormancy. In: Science of rice plant: genetics. Tokyo: Food and Agric Policy Research Center pp. 348-359

Zhang H, Louis JI, Craig McG, Cory M, Daowei Z and Peter K (2010). The effect of salanity and osmotic stress on barley germination rate: sodium an osmotic regulator. Annals of Botany 106: 1027-103