



Efficacy of dormancy breaking methods in paddy genotypes

D. Hanumanthappa^{*1}, S.N. Vasudevan², K. Maruthi¹, J.B. Maruthi¹ and Anil Sebastian³

¹Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences Raichur – 584 104, (Karnataka), INDIA

²Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences Raichur – 584 104, (Karnataka), INDIA

³Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore-641003 (Tamil Nadu), INDIA

*Corresponding author. E-mail: dasah4508@gmail.com

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Abstract: Paddy plays a pivotal role in Indian agriculture. It also possesses dormancy which needs to be studied thoroughly. Duration of dormancy usually ranges from 7 to 35 days. Environmental conditions that facilitate after-ripening in paddy is generally cool, moist substrate conditions referred to as stratification, chilling, or moist chilling, oxygen and other gases. 12 paddy genotypes were selected for the present investigation with various physical and chemical dormancy, breaking methods for freshly harvested seeds and the standard germination test was conducted thereafter. At 1% level of significance, heat treatment at 45 °C for 72 h showed significantly highest mean germination (82.86%), seedling vigour index (2753), dehydrogenase activity (0.0449) and alpha amylase activity (12.14 mm) compared to other treatments and control. The vigour index increased to 2753 (GA₃ @ 50 ppm) from 985 in control. Significantly higher EC leachates was recorded in control (0.602) and lowest in heat treatment at 45 °C for 72 hr (0.182) followed by HNO₃ @ 1.5% (0.202) and GA₃ @ 50 ppm (0.250) irrespective of the genotypes at 1% level of significance. Pre-heat treatment was followed by, HNO₃ @ 1.5% and GA₃ @ 50 ppm for germination (80.75%, 77.72%), dehydrogenase activity (0.0446, 0.0443) and alpha amylase activity (12.10 cm, 11.60 cm) respectively. The study is an exploration of cost effective treatment to alleviate seed dormancy in paddy with the background of biochemical observations for scientific explanation.

Keywords: Dormancy, Ethrel, Germination, Heat treatment, Paddy

INTRODUCTION

Paddy is the world's most important food crop and a primary food source for more than one third of world's population (Singh and Singh, 2008). Paddy occupies a pivotal role in Indian agriculture. It is the staple food for more than 70 per cent Indians and a source of livelihood for 120-150 million rural households. The total area under rice cultivation in India accounts to 43.95 million hectares with a production of 106.54 million tonnes and productivity of 2424 kilograms per hectare (DAC, 2014). It provides more than fifty per cent of daily calorie intake and considered as the cheapest source of food, energy and protein in the developing countries. It contributes about 43 per cent of total food grain production and 53 per cent of cereal production, thus continues to hold the key to sustain food sufficiency in the country. Presence of seed dormancy in paddy is both problematic as well as advantageous. It is problematic for postharvest seed testing and it is advantageous in avoiding viviparous germination in tropical cultivars grown during monsoon season. The premature germination of seeds within ears/pods (vivipary) occurs when the crops are exposed to a wet

weather favourable for germination just before harvest (Elizabeth Farnsworth, 2000). In such cases, a pre-harvest rain leads to deterioration in the quality of crop produce, it reduces seed quality and vigor, milling and backing quality and even grain.

There is a need for its safe removal, if the seeds are to be planted immediately after harvest. Various methods are being employed in many crops for breaking seed dormancy such as scarification, stratification (chilling), chemical treatment, leaching, priming *etc.*, depending on the nature of dormancy (Liela *et al.*, 2005; Lam and Edralina, 2011). Knowledge on the various seed dormancy breaking methods is very much useful to the farmer who takes up seed production or crop production immediately after harvest. Keeping in view of the above aspects, the present investigation was taken up with 12 paddy genotypes to overcome the seed dormancy in paddy genotypes by various dormancy breaking methods. Through this study, a cost effective dormancy breaking treatment can be provided to the farming community so as to avoid delay in sowing. Dormancy breaking treatments are required for faster breeder seed production as well.

MATERIALS AND METHODS

The seed material used to study the efficacy of seed dormancy breaking treatments consisted of 12 paddy genotypes with different duration of maturity and was obtained from Agricultural Research Station, Ganga-vathi, University of Agricultural Sciences, Raichur. The laboratory experiment was carried out during the year 2013-14 with three replications with two factorial completely randomized design (CRD). Various physical and chemical dormancy breaking treatments *viz.*, control, exposure to 45 °C for 24 hr, exposure to 45 °C for 48 hr, exposure to 45 °C for 72 hr, Soaking in GA₃ at 25 ppm, Soaking in GA₃ at 50 ppm, Soaking in KNO₃ at 0.5 per cent, Soaking in KNO₃ at 1 per cent, Soaking in HNO₃ at 1 per cent, Soaking in HNO₃ at 1.5 per cent, Soaking in ethrel at 50 ppm, Soaking in ethrel at 100 ppm, exposure to sun light for 48 hr and water soaking for 24 hr were imposed to break the dormancy of freshly harvested seeds. For the chemical treatments, soaking duration was 24 hr and the standard germination test was conducted thereafter.

The treated paddy seeds were surface dried and tested for germination. Between paper methods of germination test as prescribed by the International Seed Testing Association (2013) was followed. Four replication of 100 seeds each were randomly counted and placed on the germination paper at uniform spacing of 25 mm between seeds in row. The rolled paper towels with seeds were secured at both the ends with rubber bands and placed vertically in cabinet of seed germinator by maintaining a constant temperature of 25±1 °C and relative humidity of 90 %. The germination was recorded on 14th day and based on normal seedlings produced. The germination was recorded on 14th day and based on normal seedlings produced; the germination percentage was worked out. The seedling vigor index was determined by multiplying the percentage germination and total seedling length (Abdul-Baki and Anderson, 1973). Dehydrogenase activity was reported as the optical density (OD) value obtained as suggested by Shenoy *et al.* (1990). Representative seeds (25) from each treatment were taken and preconditioned by soaking in water for overnight at room temperature. Seeds were taken at random and the embryos were excised. The embryos were steeped in 0.25 per cent solution of 2, 3, 5-triphenyl tetrazolium chloride solution and kept in dark for two hours at 40 °C for staining. The stained seeds were thoroughly washed with water and then soaked in five ml of 2 methoxy ethanol (methyl cellosolve) and kept overnight for extracting the red colour formazan. The intensity of red colour was measured using ELICO UV-VI Spectrophotometer (model SL-159) using blue filter (470 nm) and methyl cellosolve as the blank. The OD value obtained was reported as dehydrogenase activity. The α -amylase activity was analyzed as per the method suggested by Simpson and Naylar (1962) with slight modifications. The mean values of the data were statistically analyzed

Table 1. Effect of dormancy breaking methods on seed germination percentage of paddy genotypes.

Genotypes	Treatments													Mean
	Control	Heat treatment (45 °C)			GA ₃ 25 ppm	KNO ₃		HNO ₃		Ethrel 50 ppm	100 ppm	Sunlight (48 hr)	Water soaking (24 hr)	
		24 hr	48 hr	72 hr		0.5%	1%	1%	1.5%					
Gidda emergency	76.00	95.00	96.00	96.67	93.33	96.67	88.00	96.33	77.67	82.33	98.67	77.33	90.24	
GGV-05-02	83.33	96.33	97.00	97.00	94.33	95.67	87.00	96.33	95.00	96.00	98.00	93.00	93.88	
IR-64	9.33	24.00	47.67	81.67	65.33	80.00	17.00	45.33	10.00	13.00	18.67	12.33	37.57	
NES-07-03-01	46.00	84.00	92.00	95.33	87.00	95.00	65.00	93.00	54.33	72.33	84.00	47.33	78.17	
IE-T-19251	53.00	92.33	95.67	97.00	90.33	91.33	90.67	92.00	68.33	80.67	83.67	65.00	84.67	
Chrinmaponni	68.00	88.67	95.33	97.00	88.00	88.33	91.33	93.67	78.67	84.67	81.33	69.00	86.02	
JGL-1798	21.33	30.67	56.33	81.67	76.33	78.00	61.67	63.67	28.33	38.33	32.67	77.67	56.40	
CSR-22	13.00	33.00	82.00	92.67	70.67	84.33	33.00	38.00	21.67	22.00	55.67	28.33	52.60	
IE-T-19828	11.00	20.67	71.00	85.33	72.67	80.00	49.67	69.33	11.67	23.33	36.33	56.67	52.95	
GGV-05-01	22.00	41.00	89.67	93.00	55.00	88.33	27.00	33.00	26.50	27.00	22.67	27.00	50.49	
Ratan sagar	14.33	24.67	40.00	52.33	44.00	46.00	62.33	68.33	19.67	33.00	55.33	39.33	42.31	
GV-SAT-05-01	12.00	14.00	18.67	24.67	17.00	18.33	13.33	18.00	12.00	13.33	13.00	13.33	16.24	
Mean	35.78	53.69	73.44	82.86	70.75	77.72	60.67	65.39	41.99	48.83	56.67	50.53		
	S.Em±													
Genotype	0.046													
Treatment	0.054													
Interaction	0.644													
	CD at 1%													
	0.168													
	0.196													
	2.358													

Table 2. Effect of dormancy breaking methods on seedling vigour index of paddy genotypes.

Genotypes	Control	Treatments												Mean		
		Heat treatment (45 °C)			GA ₃			KNO ₃			HNO ₃				Sunlight (48 hr)	Water soaking (24 hr)
		24 hr	48 hr	72 hr	25 ppm	50 ppm	0.5%	1%	1.5%	1%	1.5%	1%	1.5%			
Gidda emergency	2203	2733	2845	2857	3085	3762	2845	2834	3127	3237	2216	2513	2862	2355	2820	
GGV-05-02	2086	2534	2635	2725	2740	3639	3021	3126	3202	3422	2876	2912	2646	2149	2837	
IR-64	246	784	1618	1964	2489	1256	703	840	903	1053	303	337	470	301	948	
NES-07-03-01	1258	2482	2559	2602	2769	3173	1823	1904	2864	3058	1510	2063	2167	1271	2250	
IET-19251	1556	2893	3022	3288	3013	3472	2845	3148	2964	3204	2077	2535	2343	1743	2722	
Chinnaponni	2250	3028	3136	3444	3281	3539	2686	3420	3023	3298	2665	2677	2548	2309	2950	
JGL-1798	508	740	1264	1454	1795	3137	504	1344	2105	2258	726	1026	771	803	1317	
CSR-22	386	1122	2697	2706	2762	3605	996	2242	801	2438	675	704	1780	887	1700	
IET-19828	250	453	2235	2428	643	2422	1279	2070	2042	2109	276	521	896	305	1281	
GGV-05-01	469	1029	2169	2212	1003	1140	809	822	824	1042	213	351	504	565	939	
Ratan sagar	388	571	1613	1709	2603	2822	1250	1322	2204	2315	522	577	1259	1033	1442	
GV-SAT-05-1	224	327	452	502	656	1065	166	262	602	801	268	280	289	280	441	
Mean	985	1558	2187	2324	2237	2753	1577	1944	2055	2353	1194	1375	1545	1167		
		S.Em±														
Genotype		5.520														
Treatment		6.440														
Interaction		77.278														
		CD at 1%														

Table 3. Effect of dormancy breaking methods on electrical conductivity (dSm⁻¹) of paddy genotypes.

Genotypes	Control	Treatments												Mean		
		Heat treatment (45 °C)			GA ₃			KNO ₃			HNO ₃				Sunlight (48 hr)	Water soaking (24 hr)
		24 hr	48 hr	72 hr	25 ppm	50 ppm	0.5%	1%	1.5%	1%	1.5%	50 ppm	100 ppm			
Gidda emergency	0.479	0.412	0.407	0.108	0.314	0.215	0.474	0.196	0.353	0.108	0.351	0.327	0.337	0.324	0.315	
GGV-05-02	0.624	0.418	0.414	0.110	0.251	0.177	0.426	0.228	0.254	0.113	0.398	0.342	0.245	0.430	0.316	
IR-64	0.740	0.628	0.618	0.202	0.334	0.203	0.430	0.420	0.582	0.174	0.365	0.327	0.733	0.408	0.440	
NES-07-03-01	0.653	0.623	0.604	0.172	0.396	0.222	0.553	0.344	0.348	0.222	0.368	0.318	0.354	0.487	0.405	
IET-19251	0.542	0.512	0.445	0.175	0.358	0.215	0.527	0.379	0.314	0.175	0.389	0.349	0.322	0.418	0.366	
Chinnaponni	0.424	0.368	0.344	0.153	0.375	0.236	0.415	0.348	0.385	0.153	0.362	0.291	0.377	0.335	0.326	
JGL-1798	0.563	0.557	0.472	0.260	0.458	0.393	0.463	0.449	0.417	0.260	0.328	0.277	0.403	0.453	0.411	
CSR-22	0.590	0.588	0.548	0.215	0.356	0.266	0.383	0.315	0.357	0.267	0.219	0.182	0.521	0.366	0.369	
IET-19828	0.610	0.501	0.468	0.221	0.443	0.363	0.588	0.360	0.497	0.221	0.337	0.312	0.601	0.567	0.435	
GGV-05-01	0.775	0.763	0.624	0.178	0.348	0.217	0.418	0.375	0.439	0.178	0.192	0.145	0.692	0.294	0.403	
Ratan sagar	0.476	0.463	0.456	0.142	0.338	0.215	0.387	0.264	0.353	0.313	0.321	0.163	0.450	0.366	0.336	
GV-SAT-05-1	0.747	0.705	0.643	0.247	0.348	0.283	0.453	0.417	0.530	0.247	0.332	0.235	0.715	0.470	0.455	
Mean	0.602	0.545	0.503	0.182	0.360	0.250	0.460	0.341	0.402	0.202	0.330	0.272	0.479	0.410		
		S.Em±														
Genotype		0.0003														
Treatment		0.0003														
Interaction		0.0036														
		CD at 1%														

following completely randomized factorial design (CRFD) for laboratory studies; significance was tested by referring to 'F' table of Fisher and Yates (1963).

RESULTS AND DISCUSSION

The various dormancy breaking pre-treatments had different effect on germination in different paddy genotypes. Untreated paddy seeds generally showed low germination indicating initial poor germination, which showed that pre-treatments are required to overcome the dormancy so as to improve the germination. The pre-heat treatment at 45 °C for 72 hr recorded maximum mean germination (82.86%) followed by HNO₃ @ 1.5% (80.75%) and GA₃ @ 50 ppm (77.72%) and minimum in control (35.78%) (Table 1). This increased germination due to heat treatment possibly helped in overcoming the restriction of availability of oxygen to the embryo by increasing cracks in the hulls or reducing the peroxidase activity in the seed covering structures thereby promoting the degradation and evaporation of short chain saturated fatty acids (SCSFAs) from the dormant seeds thereby increasing the germinability. This confirms the earlier findings of Kota *et al.* (2006), who suggested dry heat treatment and Abdul *et al.* (2012), who observed increase in germination of hulled rice seeds after heat treatment at 50 °C in rice cultivars.

Estimation of seedling vigour indices is an important seed quality parameter as reported by Abdul Baki (1980) in soybean. In the present study, the seedling vigour as reflected through seedling length and dry matter also increased due to GA₃ over the other chemical treatments. The vigour index increased to 2753 (GA₃ @ 50 ppm) from 985 in control (Table 2.). Asborno *et al.* (1999) reported that GA₃ increased the coleoptiles elongation and field emergence whereas, Taegsu and byunwoo (2000) found mesocotyl elongation with the application of GA₃ @ 500 ppm in paddy. Omkar singh and Kumar (1999) observed that GA₃ increased germination, speed of germination and field emergence index in pigeon pea. Higher seedling vigour index might be due to exogenous application of GA₃ which leads to activation of various enzymes responsible for conversion of complex food material into simpler form, which ultimately facilitates more availability of food reserves to the growing embryo thereby, increases the seedling vigour as observed by Ankaiah *et al.*, 1993 in sunflower and Gowda, 2003 in paddy during GA₃ exogenous application.

At 1% level of significance, higher EC leachates was recorded in control (0.602) and lowest in heat treatment at 45 °C for 72 hr (0.182) followed by HNO₃ @ 1.5% (0.202) and GA₃ @ 50 ppm (0.250) irrespective of the genotypes at 1% level of significance. (Table 3). Similar results were also reported by Liela *et al.* (2005) in paddy for thermal hardening treatment.

Similarly, dehydrogenase activity was also enhanced in all the dormancy breaking methods irrespective of the

genotypes. But its activity was highest in the seeds exposed to heat treatment at 45 °C for 72 hr (0.0449) followed by HNO₃ @ 1.5% (0.0446) and GA₃ @ 50 ppm (0.0443) compared to control (0.0403) (Table 4.). The results suggest that the dehydrogenase enzyme activity is an important indicator of breaking dormancy in paddy seeds and also an efficient indicator of the degree of dormancy in the paddy seeds. (Antonio *et al.*, 2002). It is postulated that release from dormancy is associated with an increased activity of pentose phosphate pathway (PPP) dehydrogenases (Hendricks and Taylorson, 1974) as catalases and PPP activity is more during germination due to increased respiration, hydrolysis of stored food materials and energy synthesis. The present study also confirms that dehydrogenase activity is increased in all the dormancy breaking treatments. However, Stephen and Ross (1981) in oats reported that there is no obvious connection between dormancy breakage and increased activity of pentose phosphate pathway dehydrogenases. But, the present study is contradictory to this finding.

Significantly higher alpha amylase activity at 1% level of significance was recorded in heat treatment at 45°C for 72 hr (12.14) followed by HNO₃ @ 1.5% (12.10) and GA₃ @ 50 ppm (11.60) and least in control (9.08) irrespective of the genotypes (Table 5). The present result are in conformity with Lam *et al.* (2011), who reported that, heat treatment method of breaking paddy seed dormancy is only effectively enhanced germination rate together with enhanced respiration rate, ethylene production and α -amylase activity. Dormant cultivars had higher O₂ uptake rate and peroxidase activity and lower amylase and dehydrogenase activities than the weakly dormant ones. Seshu and Dadlani (1991) and Garzia-Maya *et al.* (1990) reported that abscisic acid (ABA) inhibit the gibberellic acid induction of α -amylase synthesis and consequently, prevent seeds from initiating germination.

Conclusion

Among the dormancy breaking treatments, heat treatment at 45 °C for 72 h showed significantly highest mean germination, seedling vigour index, dehydrogenase activity and alpha amylase activity compared to other treatments and control at 1% level of significance and hence considered as the best dormancy alleviation treatment for dormancy in paddy. The outcome of the experiment will help in breaking the seed dormancy of various paddy genotypes, so that the crop scientists and seed producing organisations can take up the seed production of various classes *viz.*, nucleus seed, breeder seed, foundation seed, certified seed and truthfully labelled seed immediately after harvest in order to meet the required quantity of high quality seeds of improved genotypes and also it facilitates the paddy farmers to raise the second crop. The study is a new exploration towards revealing the cost effective treatment for dormancy breaking in paddy confirmed

through biochemical and physiological parameter analysis of the resultant seeds.

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