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Seed enhancement studies in hybrid rice (*Oryza sativa* L.)

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Abstract
Hybrid rice technology is practically feasible and readily adoptable genetic option to increase the productivity by 15-20% witnessed under irrigated ecosystem. The availability of high quality hybrid rice seed at affordable rate remained the real challenge. The inception of Cytoplasmic Male sterility system exhibiting partial panicle exertion, thus the delicate husk with opened glumes and higher doses of GA_3 for synchronization of flowering are responsible for seed quality deterioration at faster rate compared to traditional rice. Storage of seed till the next sowing season is an essential segment of seed industry. The knowledge of seed storability help in avoiding huge financial losses happens due to seed deterioration ultimately fails to meet out the minimum quality requirements. Hence, the study was undertaken to know the storage potential of hybrid seed of NDRH-2 and parental lines, IR-58025A and IR-58025B stored in moisture pervious/impervious containers after coating of polymer and treatment with botanicals, bio-agents and fungicides. Studies revealed that the highest seed quality attributes of F_1 seeds of NDRH-2 and its parental lines can be maintained till the next sowing season by coating with polykote @ 4ml diluted in 5ml of water and fungicidal treatment of vitavax 200 @ 2g/kg seed. Bio-agent Trichoderma viride seed treatment alone exhibited significantly at par germination but failed to preserve the other quality traits.

Keywords: Seed treatment, containers, vitavax, bio-agent, polykote.

1. Introduction
Rice (*Oryza sativa* L.) is a staple food for half of the planet, being cultivated in 156.68 million ha with annual production of 700 million tonnes. India has the word's largest area under rice crop (44.0 million ha) second largest producer (96.0 million tonnes) next only to China and contributes 21.60 per cent of global rice production. It is cultivated under varied situations ranging from below sea level in Kerala to about 2000 meter altitude in Himalayan region and from 8^0C latitude (Kanyakumari) to 35^0N (Kashmir). The annual productivity of rice in India has increased from 668 kg/ha to 2102 kg/ha which is still much lower than USA (5.4), Korea (4.3), China (4.2) and Vietnam (3.3) t/ha. Beyond doubt, like most Asian countries, India has been able to keep rice production growth rate above that of population growth during the last six decades. Further more, to meet the demand of increasing population maintain self-sufficiency, the present production level needs to be increase upto 120 million tonnes (milled rice) by the year 2020 and this projected increase has to be achieved I the back drop of shrinking and deteriorating resources base such as land, water, labour and other inputs and the most alarming climate change with adversely affecting the biodiversity and environment. Hybrid rice technology has witnessed the potential to increase rice yield by 15-20 per cent under irrigated ecosystem. It is fair to say that without successful hybrid rice programme, the China would have struggled to achieve its phenomenal growth that has made it the second largest economy in world. The heterosis otherwise known as hybrid vigour allowed the country to attain initial rice yields of above 6.0 t/ha, highest average in Asia. Till date, more than 43 rice hybrids have already been released with contribution from both the public and private sector, India rank second in area covered by hybrid rice (14 lac ha) next only after China (1 crore 70 lac ha) [1]. Among the major constraints, the synchronization of flowering as well as their susceptibility against various diseases owing to longer duration of floret opening. Similarly the delicate husk, opened glumes and higher doses of GA_3 favours the growth of storage fungi and all these ultimately affect the seed quality and storability. In the overall agricultural economy, seed forms the basis of successful crop production on which all other inputs depend upon. Storages of seed till the next sowing season is the essential segment of seed industry. The female parents of rice hybrids are well known poor storers because of the problem of male sterility. Maintenance of seed quality in vulnerable parental lines IR-58025A, IR-58025B and hybrid NDRH-2 of paddy during storage were investigated through the present studies.

Materials and Methods

The freshly harvested seed lots of rice hybrid NDRH-2 (F_1) developed by the university and the parental lines IR-58025A and IR-58025B produced during Kharif at Main Experimental Station, NDUAT, Kumarganj, Faizabad (U.P.) were used for the experimentation. The initial seed quality (Before treatment and storage) was worked out in the Notified Seed Testing Lab of the university. The initial germination percentage of hybrid seed was 92.00% and of A line (87.00%) and B line (89.00%). All the three seed lots were sequentially coated with polymer (polykote) and treated with botanicals (Garlic, Marigold and Neem leaf extract), biological agents (*Trichoderma viride*, *T. harzianum* and *Pseudomonas fluorescence*), fungicide (Vitavax, 200) and insecticide (Imidachloprid). A combination of carbendazim and thiram @ 2.0 g/kg seed 1:1 ratio served as control. Because, overall the seed treatment is stated as a generic term which does not specify the application method but indicate that the seeds subjected to a physical, mechanical, chemical or biological process designed to approve and enhance the quality of seed so that the emerging seedlings could be healthy and vigorous. The details of seed coating and treatment schedule is given below. Thus, the coated and treated seeds were packed in 700 gauge polyethylene packets and cloth bags and stored under ambient conditions. The observations regarding moisture content through digital moisture meter, germination (ISTA, 1991), root-shoot length, seedling dry weight and vigour index (Abdul Baki and Anderson, 1973) were recorded. Besides, the total fungal count and insect infestation wrer also worked out after 3 and 6 months (Next sowing season of Kharif). Various observations recorded were pooled trait wise and statistically analysed using CRD Factorial design suggested by [2]. Finally, interactions studies between genotypes, containers and seed treatments were calculated.

Seed coating and treatment schedule

T_0 - Carbendazim+thiram @ 2 g/kg seed in 1:1 ratio.
T_1 - Garlic extract @ 5 ml diluted in 5ml acetone/kg seed.
T_2 - Marigold leaf extract @ 5 ml diluted in 5 ml acetone/kg seed.
T_3 - Neem leaf extract @ 5 ml diluted in 5 ml acetone/kg seed.
T_4 - *Trichoderma viride* @ 4 g/kg seed.
T_5 - *T. harzianum* @ 4 g/kg seed.
T_6 - *Pseudomonas fluorescence* @ 4 g/kg seed.
T_7 - Polykote @ 4 ml diluted in 5 ml water/kg seed.
T_8 - T_7+Vitavax 200 @ 2 g/kg seed.
T_9 - T_7followed by vitavax 200 @ 2 g/kg seed and insecticide (Imidachloprid @ 6 ml) kg seed.

Result and Discussion

Efforts were made to evaluate the effect of seed coating with polymer, botanicals, bio-agents, polymer coating alone and in combination of fungicide and/or insecticide in relation to seed enhancement in hybrid rice NDRH-2 (F_1) and parents (IR-58025A and IR-58025B). The seed moisture content reduced invariably in all the three genotypes. However, seed stored in moisture impervious container exhibited a little variation came down from 9.12 to 9.01 per cent which should have been remained constant throughout the storage period (Table-1). Also, the moisture impervious containers proved significantly superior with respect to higher germinability (84.60%) as compared to 81.87. [3] also reported the fluctuations specially in moisture pervious containers. The decline in germination with extended storage period irrespective of genotypes is a natural phenomenon happens due to in evitable natural ageing reported by [3].The more reduction in root-shoot length in moisture pervious containers as compared to impervious containers irrespective of genotypes was confirmed as reported earlier [4]. Maximum shoot length (5.10 cm) recovered into followed by T_8 (4.32 cm) 6 months after treatment and packing. Similar pattern was also recorded with respect to root length. Regarding seedling dry weight, it was found maximum (261.10 mg) in F_1 seed lot decline with the increase of storage period irrespective of the genotypes. [3] also reported the reduction in dry weight starting from 4th months of storage onwards in KRH-2, KMR-3 (restorer) and IR-58025B (maintainer) also remained, maximum in moisture impervious container. The significant difference among the genotypes in respect to the seedling vigour were recorded with maximum (1206) after 6 months of storage in NDRH-2 (F_1). The higher vigour index in seeds stored in polythene bags was also evident due to lowest rate of deterioration. The various type of seed treatments influenced the vigour index invariably and the maximum (1348) was recorded in T_8 at the time of termination of the experiment. The positive effect of seed treatments on total fungal counts was also remarkable with minimum in T_8 (0.25) which was significantly superior over T_9 which was the second best option for treatment. The fungal floras isolated from different genotypes were *Fusarium moniliforme*, *F. semitectum*, *Curvularia lunata*, *Trichoconiella padwickii*, *Aspergillus flavus* and *A. niger*. Most of these fungi were recorded on rice seeds earlier [5]. Interaction studies between the genotypes and containers indicated that the maximum germination, seedling length, dry weight, vigour index in case of F_1 seed can be maintained through packaging in moisture impervious container (700 gauge polyethylene bags) upto next sowing season. The superiority of seeds stored in polythene bags in respect of seed enhancement was due to slow rate of deterioration, as the polythene bags are moisture impervious, which might have not allowed the movement of moisture as evident through the data generated and presented in table-1for periodic variation in moisture content less influenced from the environment owing to the hygroscopic nature, hence not allowing the seed to deteriorate at faster rate [6].

Table 1: Influence of genotypes (NDRH-2, IR58025A and IR58025 B), containers and seed treatments on seed moisture content (%), germination (%), root length, shoot length, seedling dry weight (mg) seed vigour and total fungal count

Treatments	Moisture content (%) after storage		Germination (%) after storage		Root length (cm) after storage		Shoot length (cm) after storage		Seedling dry wt. (mg) after storage		Seed vigour after storage		Total fungal count after storage	
	3 months	6 months	3 months	6 months	3 months	6 months	3 months	6 months	3 months	6 months	3 months	6 months	3 months	6 months
V_1	11.57	11.05	84.43	82.58	11.41	10.22	5.11	4.32	298.85	268.10	1397.66	1206.29	5.70	6.05
V_2	11.71	10.17	89.75	83.43	9.10	6.79	3.50	2.92	298.00	266.25	1134.40	819.89	9.75	5.33
V_3	11.60	9.76	87.70	83.70	7.25	5.25	3.92	3.18	277.75	224.60	983.79	715.94	7.65	5.00
CD	NS	NS	2.06	NS	0.08	0.07	0.04	0.03	2.73	2.28	31.98	24.16	0.25	0.19
C_1	9.12	9.01	87.22	84.60	0.23	0.20	0.11	0.10	7.63	6.39	1165.04	959.20	7.90	5.28
C_2	14.12	11.64	87.37	81.87	9.45	7.82	3.91	3.46	293.90	267.80	1178.86	868.88	7.50	5.63
CD at 5%	NS	0.20	NS	1.51	9.05	7.02	4.44	3.49	289.17	238.17	NS	19.73	0.21	0.16
T_0	11.18	10.17	90.08	86.58	0.07	0.06	0.03	0.03	2.23	1.86	1442.48	1197.73	4.17	1.42
T_1	11.43	10.62	85.42	79.75	0.19	0.17	0.09	NS	NS	5.22	1065.96	668.93	9.00	5.58
T_2	11.63	10.20	82.33	76.67	10.97	9.57	5.12	4.32	309.67	276.00	885.58	552.50	15.00	13.00
T_3	11.48	10.12	85.58	80.83	9.18	6.08	3.33	2.32	259.17	226.00	1000.84	567.88	14.00	12.17
T_4	11.75	10.37	89.17	87.25	7.97	5.28	2.80	1.92	257.67	214.67	1229.15	1136.81	3.00	3.17
T_5	11.78	10.25	88.08	85.08	8.35	4.98	3.38	2.02	262.33	209.67	1187.74	1029.64	4.00	4.00
T_6	11.75	10.30	87.08	83.17	9.28	8.38	4.55	4.67	319.67	286.50	1068.05	875.40	6.00	5.50
T_7	11.65	10.25	87.42	83.50	9.07	7.83	4.47	4.30	305.83	265.83	1176.07	928.12	12.17	8.67
T_8	11.60	10.32	89.92	86.83	8.38	7.08	3.90	3.47	297.50	250.17	1419.33	1348.62	1.00	0.25
T_9	11.97	10.67	87.83	82.67	9.23	7.60	4.25	3.48	296.67	248.50	1244.30	834.77	8.67	0.83
CD at 5%	0.49	0.44	3.76	3.39	10.50	10.42	5.35	5.10	327.00	295.67	58.39	44.11	0.46	0.35
Interaction V×C														
V_1C_1	9.24	9.20	84.10	83.00	11.35	10.57	5.18	4.70	302.80	286.20	1393.34	1274.54	10.20	5.80
V_1C_2	13.89	12.90	84.75	82.15	11.47	9.86	5.04	3.93	294.90	250.00	1401.99	1138.04	9.30	6.30
V_2C_1	9.44	9.26	90.20	85.95	9.23	7.13	3.13	2.70	304.90	281.80	1117.49	852.56	6.20	4.40
V_2C_2	13.98	11.08	89.30	80.90	8.96	6.45	3.87	3.14	291.10	250.70	1151.31	787.23	5.20	5.60
V_3C_1	18.69	8.57	87.35	84.85	7.78	5.76	3.42	2.97	274.00	235.40	984.30	750.51	7.30	5.65
V_3C_2	14.50	10.94	88.05	82.55	6.72	4.74	4.42	3.39	281.50	213.80	983.29	681.37	8.00	5.00
CD (P=0.05)	NS	0.34	2.91	2.62	0.12	0.10	0.06	0.05	3.86	3.23	45.23	34.17	0.36	0.27

V = Variety, C = Container, T = Treatment

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