

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.809.132>

## Pre-Sowing Seed Invigouration of Direct Seeded Rice for Early Seedling Vigour and Improvement of Yield in Organic Condition

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### ABSTRACT

An investigation was carried out using 'Luit' variety of paddy (*Oryza sativa* L. indica) seeds to see the effects pre sowing seed treatment using different bio-agents viz local commercial bio-formulations *Org-Trichojal*, *Org-Metajal*, *Org-Beauverijal*, three different commercial cold adaptive microbial consortiums and also priming with Zinc oxide nano-particle in order to improve field performance. In the present investigation, *Beauverijal* was found to be the best bio-agent for seed treatment as the results indicate better early seedling growth followed by higher number of seeds/panicle, seed yield and less disease infestation. Bio-agents viz. *Trichojal* and *Metajal* were also found to be effective in lowering the disease incidence and increase in seedling vigour followed by better yield performance. Comparative performance of Microbial consortium (C4), Microbial consortium (C7), although designated as cold adaptive strains, does not impart any significant influence in enhancing seed vigour and early seedling growth. Performance of nano-priming is found to better than hydration and cold tolerant microbial consortium for most of the characters. The better adaptability of local commercial bio-agents in *Trichojal*, *Metajal*, and *Beauverijal* may lead to better performance in seed vigour, early seedling growth and final seed production.

#### Keywords

Direct seeding, bio priming, seed vigour, spikelet fertility, seed yield

#### Article Info

##### Accepted:

18 August 2019

##### Available Online:

10 September 2019

### Introduction

Rice (*Oryza sativa* L.) is one of the most important and extensively grown food crops, feeding more than half of the global population (Virmani, 1999). It is the staple food for a larger segment of the Asian population. About 90% of rice is grown and

consumed in Asian continent alone. Rice is cultivated all around the globe in an area of 167 million hectares, with a total production of 769.9 million tonnes and productivity of 4636.6 kg/ha (FAOSTAT, 2018). India is the second-largest producer of rice after China, accounting for 20% of total rice production in the world.

Organic seed and crop production in rice have various limitations besides its low productivity and challenges of field establishment under direct-seeded condition. However, the limitations are compensated with higher market price along with various health benefits. There is an emerging need for development of techniques for better crop establishment and crop protection in organic crop and seed production. Bio-priming is a modern technique of seed treatment that integrates biological (inoculation of seed with beneficial organism to protect seed) and physiological aspects (seed hydration) of disease control. Biological seed treatments may provide an alternative to chemical control (Reddy P.P. 2012). Besides a faster speed of emergence, there are several benefits of using primed seed. Priming enables a seed to germinate and emerge even under adverse agro-climatic conditions such as cold and wet or extreme heat. Uniform emergence helps optimize harvesting efficiency which can increase yield potential. There is increasing interest in the use of bio-agents as a means of growth promotion through the efficient use of plant growth promoting bio-formulations as an economic and efficient means of treating crops (Murunde & Wainwright, 2018). Hence, bio-priming may play a significant role in organic crop production. Besides bio-agents, few nano-priming agents might also play a crucial role in early seedling establishment and improvement of ultimate yield in organic condition. To develop sustainable nano-agriculture, ZnO nanoparticles have been prepared using brown seaweed *Turbinaria ornate* extract as a priming agent to promote rice seed quality and crop yield attributing to rice seeds (Itrotwar *et al.*, 2019).

Direct seeding methods have played a critical role in the intensification of Asian rice systems. This method mostly helps in achieving higher water-use efficiency. Although, low rainfall at planting time, tends

to low production risk. The traditional system of direct seeding in some rain-fed areas of eastern India has evolved partly in response to rainfall uncertainty (Fujisaka *et al.*, 1993). In Assam *Ahu* rice covers 4 lakh hectares (16% of gross rice area) to contribute 11% of rice production. These are photoperiod insensitive and can be grown as both early *ahu*; a pre-flood crop in flood affected areas as well as normal *ahu*, grown in the areas where risk of flood is minimal. The problems related to *early ah* rice cultivation is low temperature at seedling stage can cause stunted seedling growth, yellowing of leaves, leaf spots, slow and delayed tillering and non-synchronous and delayed flowering (Lal *et al.*, 2013). Seedling mortality takes place during nursery stage due to long cold spells. The present study is an attempt to strengthen the early seedling growth by using different bio-formulations to overcome cold stress during *early ah* season in organic condition.

## **Materials and Methods**

The present study was carried out at Assam Agricultural University, Jorhat which is situated in the Upper Brahmaputra Valley Zone of Assam lying at 26°45' N latitude and 94°12'E longitude at an elevation of 86.6m above the mean sea level. Certified seeds of a popular recommended rice variety *Luit* were taken for the study. Details of seed treatments are given in table 1. Three different local commercial bio-formulations and three cold adaptive bio-strains were employed in the present study. Besides this, seed treatment with Zinc Oxide nano-particles were also done along with hydration treatments. Experiment was laid out following randomized block design with three replications in the organic block using direct-seeding method by applying farmyard manure(FYM) @ 5 ton/ha. Recommended intercultural operation of weeding and irrigation were done periodically. Observations were taken for different seedling

vigour, field emergence, and fertility characters and yield and its attributes were taken in respective phases. Germination % was recorded following method

ISTA2004. Seed vigour index was calculated by following method given by Copeland and McDonald, 1985.

**Table.1** Treatments for field evaluation

Treatment No.	Treatment dose	Source
T <sub>1</sub>	Control (Untreated) without hydration	-
T <sub>2</sub>	Seed hydration/hydro priming- soaking in water for 6 hours	-
T <sub>3</sub>	Seed Priming with <i>Org- Metajal</i> (contains <i>Metarhizium anisopliae</i> ) @ 5ml/liter water/kg of seeds for 6 hours	Department of Plant Pathology, AAU, Jorhat
T <sub>4</sub>	Seed Priming with <i>Org- Trichojoal</i> (contains <i>Trichoderma harzianum</i> ) @ 5ml/liter water/kg of seeds for 6 hours	Department of Plant Pathology, AAU, Jorhat
T <sub>5</sub>	Seed Priming with <i>Org- Beauverijal</i> (contains <i>Beauveria bassiana</i> ) @ 5ml/liter water/kg of seeds for 6 hours	Department of Plant Pathology, AAU, Jorhat
T <sub>6</sub>	Seed priming with cold adaptive Plant growth promoting bacteria formulation (PGPB)@ 5ml/liter water/kg seeds for 6 hours	NBAIM, Mau
T <sub>7</sub>	Seeds are soaked for 6 hours than treated with Charcoal based cold-tolerant PGPB consortium (C4) @ 5mg/kg seed	ICAR - VPKAS, Almora
T <sub>8</sub>	Seeds are soaked for 6 hours than treated with Charcoal based cold-tolerant PGPB consortium (C4) @ 5mg/kg seed	ICAR - VPKAS, Almora

### Results and Discussions

Among all the field observations, field emergence was highest in seed treated with T<sub>3</sub>, *Org-Metajal* (85.02%). Seedling height was highest in T<sub>5</sub>, *Org-Beauverijal* (45.49cm) and also Seed Vigour Index (SVI)-I was highest in seed treated with *Org-Beauverijal* (table 2). Nano-primed seeds showed better field emergence in comparison to cold adaptive PGPB and microbial consortium (table 2). Plant height was recorded as highest in seed treated with *Org-Trichojoal* (60.18cm) (T<sub>4</sub>) followed by T<sub>3</sub>, *Org-Metajal* (59.71cm). Chlorophyll a & b content was recorded

highest in seed treated with *Trichojoal* and ZnO Nano-particles respectively (table 3). Whereas leaf area was recorded highest in T<sub>3</sub>, *Org-Metajal* followed by hydro priming (T<sub>2</sub>). While recording fertility characters, highest Pollen fertility was observed in T<sub>3</sub>, *Org-Metajal* (97.49%) followed by T<sub>4</sub>, *Org-Trichojoal* (93.61%) and T<sub>5</sub>, *Org-Beauverijal* (90.72%) (table 3). Lowest pollen fertility was observed in T<sub>1</sub> (control, 76.61%). Whereas highest spikelet fertility was observed in T<sub>9</sub> (ZnO Nano priming (82.17%) followed by *Org-Beauverijal* (81.62%) and T<sub>6</sub> (cold adaptive PGPB) (80.22%). For yield attributes, seeds /panicle was highest in T<sub>5</sub>, *Org- Beauverijal*

(149.23) followed by *Org- Trichojal* T<sub>4</sub> (140.77), whereas yield/plant was found to be highest in T<sub>4</sub> *Org-Trichojal* (14.31gm) followed by *Org-Beuverijal* (13.21gm). However significant increase in seed yield/plant was observed in all the treatments over control (table 4). Lowest disease incidence was found in seed treated with *Org-Beuverijal* (29.08). However, Disease incidence was lower in all the treatments in comparison to control.(table 3)

### **Response of bio-agents on early seedling growth**

The response of bio priming treatments was found significantly variable. However, highest field emergence was observed in T<sub>3</sub> (*Org-Metajal*) followed by T<sub>5</sub> (*Org-Beauverijal*) seeds. Higher seedling height in all the priming treatments as compared to the control implies significant response of treatments on seedling growth. Due to uniform cell division proceeds in all the cells ensuring uniform development of all parts of the seedling; this may be the basic reason of higher seedling height and plant height in all the priming treatments as compared to the control. Reports are available on seed enhancement with bio-agents improves the germination, vigour and uniformity of seedling emergence during early seedling growth. (Krishna *et al.*, 2008; Fallahi *et al.*, 2011). In the present study, seedling height differed significantly in response to various priming treatments. Highest seedling height was observed in T<sub>5</sub> (*Org-Beauverijal*, 45.49 cm.) followed by *viz.* and T<sub>4</sub>. (*Org-Trichojal*, 42.47 cm).

The microbial cultures reported to have impact on regulations of growth hormones (Doni *et al.*, 2014; Zheng and Shetty, 2000; Hameed and Iqbal, 2010). The better adaptability of 1 bio-agents in *Trichojal*, *Metajal* and *Beauverijal* may lead to better performance in seed vigour and other seed production

qualities as these formulations were constituted with local microbial agents.

### **Effects of seed treatment on seedling vigour**

The assessment of seed vigour has many important implications to evaluate seed physiological potential. Seed vigour and its associations with field stand establishment and crop productivity is an important area of seed quality assessment. In the present study, the highest seed vigour index-I was observed in T<sub>5</sub> (*Org-Beauverijal*, 3803.84). Chlorophyll a, and Chlorophyll b content showed variability in response to different priming treatments, highest in T<sub>4</sub> (*Org-Trichojal*, 13.67) and in T<sub>8</sub> (Charcoal based cold-tolerant PGPB consortium C7, 5.05). Various reports are available in this direction. Panhwar *et al.*, (2017) also reported that biochemical parameter like chlorophyll content showed a significant increase due to seed priming.

### **Effect of seed treatments on vegetative growth of rice**

The vegetative stage of the crop is an important phase where maximum dry matter accumulation takes place. The vegetative development of the crops depends on various factors including climate, soil, nutritional status and also the seed quality. We have recorded the three most important growth parameters *viz.* plant height, the number of effective tillers and leaf area to evaluate the response of different bio-agents on these parameters. The plant height was found to be responsive due to treatment effect. The number of tillers per plant also varied significantly. Our study is in accordance to Rehman *et al.*, 2011 and Yadav *et al.*, 2018 who reported the use of microbes in combination with reduced fertilizer dose is beneficial to increase the growth and productivity of the baby corn for sustainable agriculture.

**Effect of seed treatments on the fertility characters**

Highest Pollen fertility was observed in T<sub>3</sub> (*Org-Metajal*, 97.49) followed by T<sub>4</sub>(*Org-Trichojal*, 93.61) and T<sub>5</sub> (*Org-Beauverijal*, 90.72).Lowest pollen fertility was observed in T<sub>1</sub>(control, 76.61). Highest spikelet fertility was observed in T<sub>9</sub> (ZnO Nano priming, 82.17) followed by T<sub>5</sub> (*Org-Beauverijal*, 81.62) and T<sub>6</sub> (cold adaptive PGPB, 80.22).There are reports on pollen viability and spikelet fertility which are more sensitive under stress condition (Saragih *et.al.* 2013).In the present study, pollen and spikelet fertility is found to be higher in treated seeds as compared to control and hydration treatment.

This may be attributed due to better root growth and vegetative growth in treated plants which enables plants to absorb water and plant nutrients more efficiently and translated into better fertility.

**Effect on seed priming on yield and disease incidence**

There is a significant difference due to

treatments on disease incidence as indicated by analysis of variance. Lowest disease incidence was observed in the T<sub>5</sub> (*Org-Beauverijal*, 29.08%) followed by treatment T<sub>4</sub>(*Org-Trichojal*, 31.51) (Table 2).

Reports are available that resistance against diseases by up-regulation of plant defence hormones salicylic acid, ethylene, and jasmonic acid signalling in plants treated with various bio-priming agents (Van Wees *et al.*, 2008).

The response of priming treatments for all the yield and yield attributing characters was statistically significant.

Highest yield per plant was obtained in T<sub>4</sub> (*Org-Trichojal*, 14.31) followed by T<sub>5</sub> (*Org-Beauverijal*). Sukanya *et al.*, (2018) reported that bio-priming affects plants by different indirect means viz., phyto-hormones production stimulation, modulation in different secondary metabolites, alteration in gene expression, tolerance to abiotic and biotic stress.

**Table.2** Effect of seed enhancement treatments on seedling growth

Treatment	Field Emergence (%)	Seed Vigour Index-I	Seedling Height(cm)	Plant Height(cm)	No. of tillers
T <sub>1</sub>	73.08	2721.40	37.23	53.59	6.57
T <sub>2</sub>	78.92	3246.34	41.13	57.49	6.57
T <sub>3</sub>	85.02	3552.52	41.79	59.45	7.67
T <sub>4</sub>	80.39	3414.76	42.47	60.18	7.89
T <sub>5</sub>	83.61	3803.84	45.49	59.71	8.72
T <sub>6</sub>	81.12	3189.24	39.32	56.86	7.04
T <sub>7</sub>	78.09	3212.33	41.15	56.72	6.58
T <sub>8</sub>	77.93	3203.81	41.12	56.72	6.81
T <sub>9</sub>	82.54	3479.16	42.15	59.20	7.23
CD (5%)	2.54*	221.27*	2.62*	2.24*	1.3*
CD (1%)	3.50**	304.87**	3.6**	3.09**	1.9

\* Significant at 5%, \*\*Significant at 1% probability level (indicates the same for table 3 & 4)

**Table.3** Effect of seed enhancement treatments on seedling vigour, chlorophyll content (Chl), fertility parameters, leaf area & disease incidence during field evaluation

Treatment	Chl a	Chl b	Pollen fertility (%)	Spikelet fertility (%)	Disease Incidence (%)	Leaf Area(cm <sup>2</sup> )
T <sub>1</sub>	8.94	3.67	76.61	72.64	57.92	28.96
T <sub>2</sub>	8.88	4.16	86.25	77.50	52.55	26.28
T <sub>3</sub>	9.93	3.67	97.50	79.52	33.00	16.50
T <sub>4</sub>	13.67	4.61	93.61	78.82	31.52	15.76
T <sub>5</sub>	9.62	2.50	90.72	81.62	29.08	14.54
T <sub>6</sub>	9.29	2.02	87.64	80.22	34.23	17.12
T <sub>7</sub>	10.12	3.46	80.65	78.42	47.14	23.57
T <sub>8</sub>	12.48	5.05	87.46	77.96	42.29	21.14
T <sub>9</sub>	9.73	3.89	90.13	82.18	31.87	15.94
CD (5%)	1.94*	1.83*	1.98*	1.44*	4.61*	5.04*
CD (1%)	2.82**	2.67	2.73**	1.98**	6.35**	7.33

**Table.4** Effect of seed enhancement treatments on seed yield/plant and yield related attributes in field evaluation

Treatment	Panicle Length(cm)	No. of seeds/panicle	1000 seed weight(gm.)	Seed yield/plant(gm.)
T <sub>1</sub>	24.01	80.67	17.47	10.09
T <sub>2</sub>	24.68	117.66	17.58	10.64
T <sub>3</sub>	24.39	130.25	18.08	12.53
T <sub>4</sub>	24.30	140.77	18.07	14.31
T <sub>5</sub>	23.87	149.23	17.76	13.12
T <sub>6</sub>	23.99	95.16	17.50	11.82
T <sub>7</sub>	23.72	81.01	18.58	11.86
T <sub>8</sub>	23.36	85.13	18.38	11.36
T <sub>9</sub>	24.68	95.83	17.84	12.49
CD (5%)	1.06*	11.59*	1.05*	1.52*
CD (1%)	1.46	15.97**	1.45	2.1**

Significant variation for seed yield/plant for different bio priming treatments indicates that, there is a possibility of improving yield with the present set of priming agents with proper nutrient management practices.

This warrants planning of experiment with various enriched bio-agents which might result in yield advantage with priming

technology. Genetic potential for the yield of a particular variety is affected by external environmental factors. There are reports on the promotion of lateral root growth and root hair development of *Arabidopsis seedlings via the production of auxin*, indole-3-acetic acid (IAA) using *Trichoderma* as bio-priming agent(Contreras-Cornejo *et al.*, 2009).

The present investigation signifies better adaptability of local bio-agents in *Org-Trichojal*, *Org-Metajal* and *Org- Beauverijal* which may lead to better performance in seed vigour and other seed production qualities. The significant role of local micro flora in improvement of seed vigour characteristics indicates its importance in exploration and characterization for use in amendments of soil and seed characters during seed production process.

### Acknowledgement

The authors acknowledge with thanks for the supply of cold adaptive bio-formulations from NBAIM, Mau, and ICAR - VPKAS, Almora.

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**How to cite this article:**

Prithviraj Pegu, Sharmila Dutta Deka, Pranab Dutta and Prakash Borah 2019. Pre-Sowing Seed Invigouration of Direct Seeded Rice for Early Seedling Vigour and Improvement of Yield in Organic Condition. *Int.J.Curr.Microbiol.App.Sci*. 8(09): 1152-1159.  
doi: <https://doi.org/10.20546/ijcmas.2019.809.132>