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Effect of seed priming on growth and yield of direct-seeded rice under midland situation at bastar region of Chhattisgarh

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Abstract
Experiment was conducted during the *Kharif* season 2023 at Research cum Instructional Farm S.G. College of Agriculture and Research Station Jagdalpur, Chhattisgarh in Randomized Block Design using seven treatments which was replicated in three times. The results obtained under PSB seed treatment (T_4) revealed significantly higher growth parameters *viz.*, number of tillers, leaf area index, dry matter accumulation, crop growth rate, relative growth rate, net assimilation rate and yield attributing characters *viz.*, number of panicles m^{-2}, total number of grains $panicle^{-1}$. Early flowering and maturity were recorded with treatment T_4. The statistically highest grain and straw yield was recorded under treatment T_4. In case of harvest index, treatment T_4 was found higher. Maximum gross return, net return and B: C ratio was obtained by treatment T_4.

Keywords: Seed priming, direct seeded rice, PSB

Introduction
Rice (*Oryza sativa* L.) is one of the most important staple food crops in the world. Rice belongs to family Poaceae and was originated in South-East Asia. Direct seeding of rice (DSR) refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. Direct seeded rice culture is a promising cost effective technology requiring less labour and water than the conventional transplanted one (Balasubramanian and Hill, 2002; Farooq *et al.*, 2011) [4, 11].

Seed priming is a simple and low-cost hydration technique in which seeds are partially hydrated to a point where pre-germination metabolic activities start without actual germination and then re-dried until close to the original dry weight. Seed priming is employed for better crop stand and higher yields in a range of crops including rice (Khan, 1992; Farooq *et al.*, 2006 a) [9, 18].

Seed hardening is the best solution of germination related problems especially when crops are grown under unfavorable conditions. The various seed hardening treatments influence growth and yield parameters in almost all field crops particularly in rainfed areas and all crops in general. The hardening of seeds improved the initial establishment of plant significantly increased seed yield and seed quality compared to normal sowing (Jain *et al.*, 2022) [16].

Primed seeds, when planted, usually emerge faster with better, uniform, and vigorous crop stand persistent under less than optimum field conditions. Crop stands from primed seeds lead to earlier flowering and higher grain yield than non-primed seeds (Harris *et al.*, 2001) [14]. In some other studies, Farooq *et al*. (2006 a) [10] reported early emergence and seedling growth, better crop stand, allometric response, increased kernel yield, harvest index and improved quality from seeds primed with KCl and $CaCl_2$ in coarse and fine rice, respectively. Du and Tuong (2002) [8] also reported that priming with KCl and $CaHPO_4$ is an effective method of improving plant density, tillering, and grain yield in dry direct seeded rice. Hydro-priming plays an important role in the seed germination and radical and plumule emergence in different crop species. Hydro-priming involves soaking the seeds in water before sowing allows the seed to imbibe water and go through the first phase of germination in which pregermination metabolic activities are started while the latter two phases of germination are inhibited (Pill and Necker, 2001) [23].

Halo-priming refers to soaking of seeds in solution of inorganic salts *i.e.* NaCl, KNO_3, $CaCl_2$, $CaSO_4$, etc. A number of studies have shown a significant improvement in seed germination, seedling emergence and establishment and final crop yield in salt affected soils in response to halo-priming (Nawaz *et al.*, 2013) [22].

Trichoderma spp. not only promotes plant growth and development but also have broad-spectrum antagonistic activities against various soil borne phytopathogens (Singh *et al.*, 2013). *Trichoderma spp.* is one of the most common free living saprophytic fungi in rhizosphere which widely occupy the major share of fungal biocontrol agents in biopesticide industry (Woo *et al.*, 2014) [29]. The effects of seed treatment examined with trichoderma isolate on germination of seed exposed to biotic stress and abiotic stresses and evaluated the ability of the beneficial fungus to overcome physiological stress. They found under stress condition trichoderma isolate treated seed germinated consistently faster and more uniformly than untreated seeds (Mastouri *et al.*, 2010) [20].

Bacteria including species of Pseudomonas, Azospirillum, Azotobacter, Klebsiella, Enterobacter, Alcaligenes, Arthrobacter, Burkholderia, Bacillus and Serratia have been reported to enhance plant growth (Kloepper *et al.*, 1989) [19].

Material and Methods

The experiment was conducted during the month of June 2023. The experiment was consists of three replications with seven treatments that was laid out in Randomized Block Design (RBD). The treatment details are as follows, T_1: Hydropriming, T_2: Hardening, T_3: Priming with NaCl, T_4: PSB (*Pseudomonas putida*) seed treatment, T_5: *Trichoderma species* seed treatment, T_6: *Bacillus subtilis* seed treatment, T_7: Control (without seed priming). Climate of the region was hot sub-humid eco-region with an average annual rainfall of about 1386.7 mm. The crop encountered 1152.8 mm rainfall throughout its growth period and the maximum temperature was 29.9 °C in the third week of August and the minimum temperature was about 17.9 °C in the first week of October as well as the maximum sunshine hour was 7.6 hours in the second week of October.

The recommended dose of fertilizer (100:60:40 kg NPK ha^{-1}) applied in the experiment. The 50 per cent dose of nitrogen and 100 per cent recommended dose of phosphorus and potassium were applied as basal and enduring nitrogen was applied in two equal split at active tillering and panicle initiation stage of the crop. Pre emergence herbicides pyrazosulfuron ethyl 10% WP @ 200 g ha^{-1} applied before emergence of weed and post emergence herbicides bispyribac sodium 10% W/V SC @ 250 ml ha^{-1} was applied at 25 DAS to control both narrow and broad leaf weed. Roughing was done manually to remove off type of plant and weeds at panicle initiation stage. Insecticide (chlorpyrifos 50% + cypermethrin 5%) 20 EC was sprayed at the rate of 0.5 litre ha^{-1} to control stem borer and leaf folder. Streptocycline 90% w/w and carbebndazim 12%+ mancozeb 63% WP was sprayed at the rate of 30 gm ha^{-1} and 750 gm ha^{-1} respectively to control BLB (bacterial leaf spot) and BLS (brown leaf spot).

Table 1: Effect of different treatment on Germination %, Seedling length (cm), Vigor index, Days to 50% flowering and Days to Maturity growth of DSR

Treatments	Germination %	Seedling length (cm)					Vigor index					Days to 50% flowering	Days to Maturity
		7 DAS	14 DAS	21 DAS	28 DAS	35 DAS	7 DAS	14 DAS	21 DAS	28 DAS	35 DAS		
T1	92.67	6.03	11.93	20.66	25.66	31.33	558.66	1104.49	1912.29	2375.63	2902.26	81	116
T2	96.09	6.36	12.14	20.90	25.90	31.90	611.21	1165.20	2008.07	2488.51	3065.04	80	115
T3	93.23	6.48	13.39	22.56	27.56	33.56	604.04	1248.96	2104.26	2570.42	3129.81	79	114
T4	96.71	6.89	14.64	24.13	29.13	35.13	665.83	1415.05	2332.50	2816.06	3394.89	79	114
T5	95.70	6.81	13.49	23.58	28.58	34.24	652.00	1290.86	2255.53	2736.89	3280.38	79	114
T6	95.27	6.47	13.30	23.11	28.11	34.11	616.07	1266.15	2199.97	2676.32	3247.96	79	114
T7	88.27	5.96	11.58	19.41	24.07	29.07	525.86	985.01	1649.32	2045.84	2469.46	83	118
SEm±	5.23	0.19	0.38	0.76	0.78	0.95	14.43	26.46	52.96	65.50	79.18	2.16	2.16
CD at 5%	1.68	0.59	1.18	2.35	2.43	2.95	44.94	82.43	164.99	204.05	246.67	0.69	0.69
CV%	2.37	5.11	5.06	5.94	5.00	5.01	4.13	3.79	4.44	4.48	4.47	1.33	0.96

Result and Discussion

1 Growth parameters

1.1 Germination (%): The treatment T_4 recorded the significantly highest germination per cent but it had comparable with other treatments except treatment T_7 (Table 1.1). It might be due to seed priming increases the absorption of more water and faster metabolic turn out in the seed which leads to faster germination of the seed. Karthika and Vanangamudi (2013) [17] and Sivakumar *et al.* (2017) [27] also reported the same result.

1.2 Seedling length (cm)

The data clearly shows that significantly highest seedling length observed in treatment T_4 at the all growth stages but it had found on par with treatment T_5, T_3 T_6 and T_2 at 7 DAS, treatment T_5 at 14 DAS and treatment T_5, T_6 and T_3 at 21, 28 and 35 DAS. The lowest seedling length was observed in treatment T_7 (Table 1.1). It might be due to seed priming increases the absorption of more water and faster metabolic turn out in the seed which leads to faster growth of the seedling. The similar result was also reported by Karthika and Vanangamudi (2013) [17], Sivakumar *et al.* (2017) [27] and Prakash and Arora (2019) [24].

1.3 Vigour index

Significantly highest vigour index observed in T_4 among all the treatments in all the growth stages but it had found significantly on par with treatment T_5 at 7 DAS and treatments T_5 and T_6 at 21, 28 and 35 DAS. The lowest vigour index was observed in treatment T_7 (Table 1.1). It might be due to seed priming improves the germination and seedling length. The similar result was also reported by Karthika and Vanangamudi (2013) [17] and Sivakumar *et al.* (2017) [27].

1.3 Days to 50% flowering and days to maturity

Days to 50% flowering and days to maturity were ranged between 79 to 83 days and 114 to 118 days respectively. The early days to 50% flowering and days to maturity were observed in treatment T_4 which was statistically at par with all the treatments except treatment T_1 and T_7 (Table 1.1). A similar result was also recorded by Anitha *et al.* (2013) [3].

1.4 Plant height (cm)

The significantly taller plant was observed under treatment T_4 but it had found on par with treatments T_5, T_6, T_3 and T_2 at harvest (Table 2). It might be due to PSB bacteria present in T_4

which facilitates absorption of phosphorus which increases the root area which further increases the absorption of other nutrients. Hence more height of plants was observed under this treatment, Musa and Ikhajiagbe (2023) [21], Qureshi *et al.* (2012) [25] and Sivakumar *et al.* (2017) [27] also reported the same result.

1.5 Number of tillers (hill^{-1})

Treatment T_4 produced significantly maximum number of tillers but it was found significantly at par with treatment T_6, T_5 and T_3 at harvest. The lowest number of tillers was recorded under treatment T_7 (Table 2). It might be due to phosphorus solublizing bacteria (PSB) facilitates absorption of phosphorus, which increases the root area and increases the absorption of nutrients therefore more number of tillers was observed. The result was also proven by Musa and Ikhajiagbe (2023) [21] and Sivakumar *et al.* (2017) [27].

1.6 Leaf area index (LAI)

The highest leaf area index was observed under treatment T_4 which was at par with treatment T_5 and T_6 at all the crop growth stages. The lowest LAI was recorded under treatment T_7 at all the growth stages of crop (Table 2). It might be due to PSB bacteria promote the root proliferation which absorbed more amount of nutrients, that is why increasing more number of leaves and leaf area. Anand and Kamaraj (2017) [2] and Yadav *et al*. (2014) [30] also reported the similar results.

1.7 Dry weight (g hill^{-1})

The significantly maximum plant dry matter accumulation was observed under treatment T_4 but it was found at par with treatments T_5 and T_6 at harvest. However, the lowest dry matter accumulation was recorded under treatment T_7 at all the growth stages (Table 2). The dry matter accumulation reflects the growth and the metabolic efficiency of the plant which ultimately influences the economic yield. Similar result was also reported by Deshwal and Kumar (2013) [7], Karthika and Vanangamudi (2013) [17] and Prakash and Arora (2019) [24].

2 Yield attributes and yield

2.1 Panicle Length (cm): The seed priming techniques was found statistically non-significant but numerically longest panicle was observed under treatment T_5 among the all treatment and shortest panicle was observed under treatment T_7 (Table 2). It might be due to the sufficient amount of nutrient supplied at the critical stages which would have been maintained the continuous supply of nutrient, which ultimately led to the meristematic activity and stimulation of cell elongation in the plants which resulted in higher length of panicle. Anand and Kamaraj (2017) [2], Chamani *et al.* (2015) [6] and Ahmad *et al.* (2013) [1] also reported the same result.

2.2 Number of seeds (panicle^{-1})

The significantly maximum number of seeds per panicle was observed under treatment T_4 among the all treatments but it was found at par with the treatments T_5, T_6 and T_1. The lowest number of seeds per panicle was observed under treatment T_7 (Table 2). Anand and Kamaraj (2017) [2], Chamani *et al.* (2015) [6] and Ahmad *et al.* (2013) [1] also reported the same result.

Test weight (g)

Test weight was recorded non-significant effect due to different seed priming treatments but treatment T_4 produced numerically maximum test weight of rice and the lowest test weight was reported in treatment T_7 (Table 2).

3 Yields of rice

3.1 Grain yield (q ha^{-1}): Grain yield of rice was influenced significantly due to various methods of seed priming. The significantly maximum grain yield was observed in treatment T_4 which was at par with treatment T_5, T_6 and T_3 and minimum grain yield was observed in treatment T_7 (Table 1.3). Qureshi *et al.* (2012) [25] and Ahmad *et al.* (2013) [1] also reported the same result.

3.2 Straw yield (q ha^{-1})

Among different rice seed priming techniques, treatment T_4 method recorded significantly superior over other methods and produced highest straw yield but it was found at par with other treatments T_5, T_6 and T_3 and the lowest straw yield was reported from treatment T_7 (Table 3). It might be due to the better rates of photosynthesis and more dry matter accumulation, resulting in higher straw yield. Qureshi *et al.* (2012) [25] also reported the same result.

Harvest Index (%)

Among different seed priming techniques, harvest index did not influenced by different treatment but T_4 shows the numerically maximum harvest index which was comparable with treatment T_5, T_6 and T_3. The lowest harvest index was resulted by treatment T_7 (Table 1.3). Anitha *et al.* (2013) [3] and Farooq *et al.* (2006 b) [10] also reported the same result.

4 Economics (Rs ha^{-1})

The data on economics of direct seeded rice emphasized that the maximum total cost of cultivation was recorded under treatment T_4 and it was followed by treatment T_6 and T_2. The minimum cost of cultivation was noted under treatment T_7 of rice seed priming. Among different rice seed priming techniques, maximum gross return, net return and B: C ratio was obtained by treatment T_4 followed by T_5, T_6 and T_3 respectively. The minimum gross return, net return and B: C ratio was obtained by treatment T_7 (Table 4). Ahmad *et al.* (2013) [1] and Veerendra *et al.* (2023) [28] also reported the same result.

Conclusion

On the basis of a one year study during *Kharif* 2023 at Bastar Plateau zone of Chhattisgarh. The experiment on the "Effect of seed priming on growth and yield of Direct Seeded Rice under midland situation at Bastar Region of Chhattisgarh." concluded that:

The highest growth parameter of rice *viz*., number of tillers, leaf area index, dry matter accumulation, crop growth rate, relative growth rate, net assimilation rate and yield attributes characters i.e. Number of panicles, number of filled grains per panicle, test weight were obtained higher under PSB (*Pseudomonas putida*) seed treatment with comparison to other priming treatments.

The highest grain and straw yield of rice were noticed under treatment PSB (*Pseudomonas putida*) seed treatment.

The gross return, net return and B: C ratio-were found highest under treatment PSB (*Pseudomonas putida*) seed treatment.

Table 2: Effect of different treatment on growth and yield attributes of DSR

Treatments	Plant height (cm)	No. of tillers hill^{-1}	Dry weight of plant (g)	LAI	Panicle length (cm)	No. of grains Panicle $^{-1}$	Test weight (g)
T_1	85.67	5.51	21.58	1.83	21.97	57.61	25.19
T_2	88.56	5.73	21.67	1.90	22.59	55.29	25.68
T_3	90.28	5.87	22.76	1.54	22.40	56.24	26.11
T_4	95.66	6.76	30.05	2.71	21.29	61.02	26.71
T_5	95.23	6.53	27.00	2.42	22.63	59.87	26.55
T_6	95.20	6.54	28.65	2.28	22.55	59.13	26.27
T_7	84.65	5.42	18.83	1.45	21.10	51.06	25.58
SEm±	2.65	0.31	0.78	0.15	0.49	3.769	NS
CD at 5%	8.26	0.96	2.44	0.46	NS	11.742	0.47
CV%	5.06	8.84	5.57	12.69	3.87	6.751	3.16

Table 3: Effect of different treatment on grain yield, straw yield and harvest index

Treatments	Grains yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Harvest Index (%)
T_1	40.41	54.13	42.80
T_2	40.64	54.23	42.86
T_3	42.99	57.13	42.89
T_4	48.81	63.63	43.42
T_5	45.79	60.45	43.10
T_6	44.21	58.20	42.98
T_7	35.41	47.27	42.80
SEm±	2.05	2.35	0.68
CD at 5%	6.04	7.32	NS
CV	10.98	9.468	0.97

Table 4: Effect of different treatment on economics of DSR

Treatments	Cost of cultivation (Rs ha^{-1})	Net income (Rs ha^{-1})	Gross income (Rs ha^{-1})	B: C ratio
T_1	47500	40724.68	88224.68	1.86
T_2	47800	40908.40	88708.40	1.86
T_3	47550	46292.43	93842.43	1.97
T_4	48200	58346.08	106546.08	2.21
T_5	47700	52265.25	99965.25	2.10
T_6	47800	48711.85	96511.85	2.02
T_7	47200	30098.11	77298.11	1.64
SEm±				0.10
CD at 5%				NS
CV%				10.87

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