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Effect of Seed Priming Practices on Dry Matter Production, Yield and Yield Attributes of Aerobic Rice in Coastal Deltaic Region of Karaiakal

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Authors' contributions

This research work was carried out in collaboration among all authors. Authors SP and AN conceptualized, designed and carried out this research. Authors SP and VS recorded the data and performed statistical analysis. Authors SP, VS, AN and AS wrote the protocol and wrote the first original draft of the manuscript. Authors SP, VS and AS managed the literature searches. Author AKS reviewed and edited the manuscript. Authors AN and AKS supervised the whole study. All authors have read and approved the final manuscript for publishing in the journal.

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ABSTRACT

A field experiment was conducted at Karaikal "the tail end of Cauvery Delta Zone" during *Navarai* season, 2017 (spring) to identify the optimum dates of sowing and seed priming practices on dry matter production (DMP), yield and yield attributes under aerobic rice condition. The treatment variables were replicated thrice and further evaluated in factorial concept of RBD. The treatments consisted of three dates of sowing by weekly interval (started from Feb. 6, 2017) and five seed priming practices *viz.,* water, 1% KCl, 2% moringa leaf extract, 1% pungam leaf extract and 5% cow dung slurry. Considering the seed priming practices, dry matter production, yield and yield attributes of aerobic rice were higher in seed primed with 2% moringa leaf extract which ultimately

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produced higher grain yield (2256 kg ha^{-1}) followed by the seeds primed with 5% cow dung slurry (1945.1 kg ha^{-1}) and 1% pungam leaf extract (1912.3 kg ha^{-1}), respectively. From the study, it has proved that seed priming @ 2% moringa leaf extract provides higher productivity of aerobic rice during *Navarai* season at Karaikal.

Keywords: Aerobic rice; seed priming; dry matter production (DMP); yield; yield attributes.

1. INTRODUCTION

Rice is the major staple food for more than half of the World's population. Rice consumes 40 per cent of all fresh water used in Asia and 80% in India [1]. The productivity of Asian irrigated rice system has been threatened every day by water scarcity (40-60%). Therefore, aerobic rice technology could be a possible way to reduce the water scarcity. Aerobic rice refers to grow rice in condition of non-flooded and non-puddled low land soil with supplemental irrigation. Aerobic rice recorded substantial water savings by minimizing seepage, percolation and greatly reduced evaporation [2]. Aerobic rice generally requires 30 to 50 per cent less water but it resulted in a yield penalty of 20 to 30 per cent [3]. Poor germination, uneven crop standing is the major constraints for the adoption of aerobic rice [4]. The adoption of aerobic rice is facilitated by the availability of seed priming technologies [5]. Seed priming is a pre-sowing treatment which leads to a physiological state that enables seed to germinate more efficiently. The majorities of seed treatments are based on seed imbibitions allowing the seeds to go through the first reversible stage of germination but do not allow radical protrusion through the seed coat. Seeds keeping their desiccation tolerance are then dehydrated and can be stored until final sowing. During subsequent germination, primed seeds exhibit a faster and more synchronized germination and young seedlings are often more vigorous and resistant to abiotic stresses than seedlings obtained from unprimed seeds [6]. Hence, by keeping these views in mind an experiment was conducted to study the effect of seed priming practices on dry matter production, yield and yield attributes during *navarai* season under aerobic rice technology.

2. MATERIALS AND METHODS

A field experiment was conducted at Agronomy farm of Department of Agronomy at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI) Karaikal, Union Territory of Puducherry, India, during *navarai* season from February to June, 2017 to identify the optimum dates of sowing and effect of seed priming practices on dry matter production (DMP), yield and yield attributes under aerobic rice technology at Karaikal. It is situated at 10^{o} 55' N latitude and 79^{o} 49' E longitude with an altitude of 4 meters above Mean Sea Level (MSL). Karaikal is a tropical climate and receives a normal rainfall of 1397 mm in a year with an average maximum and minimum temperature of 35.4 and 25.6^{o}C, respectively. The normal relative humidity is 87.9and 59.9 per cent. The soil of the experimental site was clayey having normal i.e., pH (7.1), EC (0.13dSm^{-1}), Organic carbon (0.60 %), low available N (191.29 kg ha^{-1}), high available P (163.00 kg ha^{-1}) and normal K (279.6 kg ha^{-1}). The experiment was laid out in a Randomized Block Design (Factorial concept) and the treatments were replicated thrice and the treatments consist three dates of sowing at weekly intervals *viz*., 6th February (S_1), 13th February (S_2), and 20th February, (S_3) with five seed priming practice *viz*.,P_1: Water, P_2: KCl (1%), P_3: Moringa leaf extract (2%),P_4: Pungam leaf extract (1%) and P_5: Fresh cow dung solution (5%). Rice variety PMK (R) 3 was used for the experimental studies and it is a temperature stress tolerance variety, released from Regional Research Station, Paramakudi, Tamil Nadu, India. Seeds were sown in line manually with 20 X 10 cm spacing by direct sowing in the well prepared field. Irrigation was immediately given after sowing. Later, lifesaving irrigations was given when hair line cracks were formed. Recommended fertilizer (150:50:50 NPK) was applied in splits (Phosphorus as basal, nitrogen and potassium at 15 DAS, tillering phase, panicle initiation and flowering phase equally). Additionally $ZnSO_4$ was applied @ 25 kg ha^{-1} at tillering phase and panicle initiation phase. Biometric observations were recorded in each plot as per the guidelines of All India Coordinated Rice Improvement Project (AICRIP), Hyderabad. Initially five hills were selected and tagged at random in the net plot area for recording the biometric observations at various growth phases *viz*., vegetative (30 DAS), reproductive (60 DAS), maturity phase (90 DAS)

and the yield attributes were recorded at the time of harvest.

2.1 Seed Priming Methodology

As per the recommendation, viable seeds at 30 kg ha^{-1} were used for sowing. One per cent KCl was prepared by dissolving 1 g of KCl in 100 of ml water. Two per cent moringa leaf extract was prepared by dissolving 2 ml of moringa leaf extract in 100 ml of water (Tender leaves were grounded in pestle and mortar at 2 g per ml of water to obtained the moringa leaf extract as suggested by Rehman, [7]. One per cent pungam leaf extract was prepared by dissolving 1 ml of pungam leaf extract in 100 ml of water (Tender leaves were grounded in pestle and mortar at 2 g per ml of water to get the pungam leaf extract) [5]. Five per cent cow dung slurry was prepared by dissolving 5 g of fresh cow dung in 100 ml of water [5]. Initially the seeds were soaked in water or KCl or moringa leaf extract or pungam leaf extract or cow dung slurry as pre-treatment for 12-16 hours and then to shade dry for 24 hours to attain its original weight.

2.2 Statistical Analysis

The observations recorded during the investigation were statistically analyzed using factorial concept as per the procedure given by Panse and Sukhatme [8]. Wherever the results were significant, the critical difference was worked out at five per cent probability level. When the treatment differences were not significant, they were denoted at ‘‘NS’’.

3. RESULTS AND DISCUSSION

3.1 Effect of Seed Priming Practices on Dry Matter Production

The results evaluated that among the various seed priming practices, at vegetative phase higher DMP was noticed in seed priming with 2% moringa leaf extract (1810.6 $kgha^{-1}$) and it was on par with seed priming with 5% cow dung slurry (1763.0 $kgha^{-1}$). At reproductive phase more DMP was noticed in seed priming with 2% moringa leaf extract (8425.0 $kgha^{-1}$) which was on par with seed priming with 5% cow dung slurry and P_4 seed priming with 1% pungam leaf extract (8283.1 and 8014.3 $kgha^{-1}$ respectively). Lower DMP of 7553.1 kg ha^{-1} was observed in seed priming with 1%KCl (Table 1). However, seed priming practices had no significant effect on DMP at maturity phase. Afzal et al. [9] reported that in case of dry matter production especially in vegetative and reproductive phases a better performance of crop when primed with two per cent moringa leaf extract, due to increased metabolic activities at low water potential. Abdalla [10] stated that more zeatin hormone presence in the moringa leaf extract, which was responsible for the improved growth of the crop at vegetative and reproductive phase.

3.2 Effect of Seed Priming Practices on Yield Attributes

The results from the present investigation revealed that priming with two per cent moringa leaf extract produced higher number of panicle $hill^{-1}$ (9.3), panicle length (27.6 cm) and panicle weight (3.3 g) when compared to other priming practices (Table 1). The same trend of better performance was visualized when seeds were primed with two per cent moringa leaf extract for number of total grains per panicle (179.6) (Table 1), number of filled grains per panicle (134.8) and filling percentage (74.5%) (Table 2) also. However, lower was record in seed priming with water. The probable reason that could be quoted for the better performance might be due to vigorous growth and profuse tillering. Earlier tillering and higher tiller emergence by seed priming with moringa leaf extract are in agreement with the results of Yang and Zhang [11]. In case of test weight was higher in seeds primed with two percent moringa leaf extract (22.6 g) and lower in seed primed with water (22.2 g) (Table 2). Basra et al. [12] stated that moringa leaf extract being rich in amino acids, K, Ca, Fe, ascorbate and growth promoting substances like Zeatin, is an ideal plant growth enhancer. This accelerates germination and growth of young plants, thereby increasing the photosynthesis and increases the number of roots and shoots. Increase in root shoot ratio manages a good source sink relationship [13,14].

3.3 Effect of Seed Priming on Grain Yield, Straw Yield and Harvest Index (HI) of Aerobic Rice

The result observed that seed priming with two per cent moringa leaf extract produced a higher grain yield of 2257 kg ha^{-1}, straw yield of 8963.9 kg ha^{-1} and harvest index (HI) of 20.0, which was 23.6, 7.3 and 14.5 percent, respectively higher than the water priming seeds (Table 2). Moringa leaf extract plays major role in rapid

Table 1. Effect of seed priming on dry matter production (kg ha^{-1}) at different growth phases, panicles hill^{-1}, panicle length (cm) panicle weight (g) number of grain panicle^{-1}of aerobic rice

Treatments	DMP(kg^{-1})			Panicles hill^{-1}	Panicle length (cm)	Panicle weight (g)	Number of grain panicle^{-1}
	Vegetative phase	Reproductive phase	Maturity phase				
Seed Priming (P)							
P_1: Water	1502.8	7569.6	8048.9	8.1	26.2	2.8	165.8
P_2: 1% KCl	1647.6	7553.1	8559.3	8.7	26.7	3.0	171.2
P_3: 2% Moringa leaf extract	1810.6	8425.0	9789.1	9.3	27.6	3.3	179.6
P_4: 1% Pungam leaf extract	1599.3	8014.3	9458.0	9.1	26.4	3.1	176.3
$P_{5:}$ 5%Cow dung slurry	1763.0	8283.1	9761.1	9.2	27.5	3.2	175.6
SEm±	75.80	324.74	807.42	0.40	0.34	0.08	5.06
CD (p= 0.05)	155.27	665.22	NS	0.81	0.69	0.17	NS
Dates of sowing(S)							
S_1: 6th February	1695.6	8974.4	10027.2	9.4	27.5	3.6	185.9
S_2: 13th February	1669.9	8708.1	9769.0	8.7	26.7	3.3	169.1
S_3: 20thFebruary	1628.4	6224.6	7573.2	8.6	26.4	2.4	166.0
SEd	58.71	251.55	625.4	0.31	0.26	0.06	3.92
CD (p= 0.05)	NS	515.28	1281.2	0.63	0.53	0.12	8.04
Interaction (SXP)							
SEd	131.29	562.74	1446.03	0.69	0.58	0.14	8.78
CD (p= 0.05)	268.94	NS	NS	NS	NS	NS	NS

Table 2. Effect of seed priming on number of filled grains panicle^{-1}, grain filling percentage, test weight (g), grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index (%) of aerobic rice

Treatments	Number of filled grains panicle^{-1}	Grain filling percentage (%)	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
Seed Priming (P)						
P_1: Water	115.4	68.0	22.2	1725.1	8309.2	17.1
P_2: 1% KCl	118.4	70.3	22.5	1837.7	8235.4	17.8
P_3: 2% Moringa leaf extract	134.8	74.5	22.6	2256.5	8963.9	20.0
P_4: 1% Pungam leaf extract	125.4	70.8	22.2	1912.3	8380.4	19.2
$P_{5:}$ 5%Cow dung slurry	127.6	73.0	22.4	1945.1	8642.3	18.6
SEm±	5.67	3.04	0.19	52.32	162.20	0.57
CD (p= 0.05)	11.61	NS	0.38	107.18	332.26	1.17
Dates of sowing(S)						
S_1: 6th February	139.5	74.1	22.8	2591.5	8882.2	23.2
S_2: 13th February	120.8	73.1	22.4	1977.7	8649.9	18.9
S_3: 20thFebruary	112.7	66.8	21.9	1236.8	7986.7	13.5
SEd	4.39	2.36	0.19	52.32	162.20	0.57
CD (p= 0.05)	8.99	4.83	0.38	107.18	332.26	1.17
Interaction (SXP)						
SEd	9.81	5.27	0.42	116.99	362.69	1.27
CD (p= 0.05)	NS	NS	0.86	239.65	NS	NS

emergence of seedlings and maintaining photosynthetic area by delaying senescence and promoting source-sink relationship. Similar results were reported by Rady et al. [13] and Rehman et al. [7].

4. CONCLUSION

From, the present study proved that seed priming with two percent (2%) moringa leaf extract markedly enhances the biomass and yield of

aerobic rice during *navarai* season in coastal deltaic region of karaikal. This practice also mitigate the untoward incidence of drought under aerobic rice cultivation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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