Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 850-853

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Studies on performance of aerobic rice cultivars under different dates of sowing in Bihar

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Abstract
A field experiment was conducted at Bihar Agricultural University, Sabour, (Bihar) during the kharif seasons of 2012-13 in upland situation to find out suitable high yielding aerobic rice cultivars under different sowing times. Aerobic rice is a new technique of growing rice characterized by direct seeding condition without standing water in the field. The experiment was laid out in split plot design with three replications having three date of sowing viz., 10 June, 20 June and 30 June in main plots and six cultivars of rice viz., Prabhat, Susk samrat, MTU1010, MTU1001, PHB71 and A6444 sown in sub-plots (Early, medium and hybrids cultivars). Recommended dose of fertilizers were 80:40:20 kg N:P:K ha^{-1}. Herbicide Pendimethalin as pre-emergence @ 1.0 kg a.i. ha^{-1} was sprayed in saturated soil moisture as per the protocol of application time using knapsack sprayer fitted with flat fan nozzle at spray volume of 600 liters ha^{-1} just after sowing. Results of the experiment revealed that the sowing of aerobic rice on 20 June, significantly influenced most growth parameters, yield attributes, yield, nutrients uptake and economics was at par with 10 June sown aerobic rice, but it was significantly superior over later sowings (30 June). Delay in sowing resulted in reduction in grain yield, yield attributes and lower the economics. Amongst the aerobic rice cultivars PHB71 recorded significantly increased plant height (98.32 cm), leaf area index (3.86), crop growth rate(8.96 g m^{-2} day^{-1}) dry matter accumulation (979.3 g m^{-2}), effective tillers (316 m^{-2}), grain per panicle t (83.87),test weight(23.96 g) and grains yield (6.58 t ha^{-1}) followed by A6444. Lowest grain yield and yield attributes were recorded in 30 June with Prabhat rice cultivar during investigation.

Keywords: Aerobic rice, Cultivars, Economics, Grain yield**,** Sowing date

Introduction
In India, Rice (*Oryza sativa* L.) is one of the most important cereals grown under diverse environment and geographical ranges for human food, feed, fodder and raw materials for industries. In India it is grown on 43.39 million hectares and production of 104.32 million tonns with an average productivity of 2404 kg ha^{-1} [1], which is far below than that of most of the countries of the world. In Bihar, total area under this crop is 3.21 million hectares, producing 6.49 million tons and with an average productivity of 2019 kg ha^{-1} [1].
Aerobic rice is a new type of rice growing technique that is aerobic soil adapted and input responsive. It grows well in nonpuddled and nonsaturated soils with water content of 70% to 100% of water holding capacity throughout a growing season [2]. Aerobic rice is specifically developed rice, combining drought tolerance of upland rice. Therefore, aerobic rice is "improved upland rice" in terms of yield potential and drought tolerance. Aerobic rice can save as much as 50% of irrigation water in comparison with lowland or traditional rice. Growing rice in aerobic soil, with the use of external inputs such as supplementary irrigation, fertilizers and aiming at high yields. Aerobic rice emits 80-85 % lesser methane gas into the atmosphere thus keeping the environment safe and acts as climate smart cultivation. Savings are also from land preparation, no transplanting costs, seed costs and labor costs. Time of sowing is one of the most important non-monetary factor for influencing the crop growth and yield in prevailing agro-climatic conditions. Performance of a cultivar entirely depends upon the time of sowing. Delay in sowing generally results in yield reduction which cannot be compensated by any other means. Cultivars play a unique role in maximizing yield by improving the input-use efficiency as the genetic potential of cultivar limits the expression of its yield and affects plant growth in response to environment condition. The reasons of low productivity of rice in rainfed upland ecosystem are lack of suitable cultivars with stress tolerance at various stages of growth and reproductive is one of the limiting factor. Rice is the most water consuming crop, alternative strategies that require less water and produce stabilized production needs immediate attention. Developing high yielding drought resistant cultivars and the optimum date of sowing with good management practices are an important role under limited water

situation in aerobic rice production system. Information on suitable rice cultivars/hybrids and dates of sowing under unpuddled condition are meager for southern dry zone of Bihar. Keeping this in view, the present investigation was carried out to identify the promising cultivars and optimum date of sowing for enhancing higher productivity of aerobic rice.

Materials and Methods

The field experiment was conducted during rainy seasons (*Kharif*) of 2012-2013 at Bihar Agricultural University, Sabour, Bihar (25^{O} 04' N Latitude, 87^{O} 04' E Longitude and 37.19 meter above mean sea levels), The experimental soil was silty-loam in texture with pH 7.21.The organic carbon, electrical conductivity, available nitrogen, phosphorus and potash were 0.46%, 0.47dSm^{-1}, 241.21, 31.89 and 182.87 kg ha^{-1}, respectively. The total rainfall received during the crop growth season of respective years was 592.3 mm and 991.0 mm respectively. The experiment was laid out in split plots design with three replications. The treatments comprising three date of sowing viz.10 June, 20 June and 30 June in main plots and six cultivars of rice viz., Prabhat, Susk samrat, MTU1010, MTU1001, PHB71 and A6444 sown in sub-plots (Early, medium and hybrids cultivars). Recommended dose of fertilizers were 80:40:20 kg N:P:K ha^{-1}. The crop received full dose of P (40 Kg ha^{-1}) and K (20 Kg ha^{-1}) and half dose of N (40 Kg ha^{-1}) as basal and the remaining nitrogen (40 kg ha^{-1}) were applied in two splits dose, half at active tillering and the rest half before panicles initiation stage. The test cultivars of rice were sown in rows 20 cm apart as per scheduled. Grain yield of aerobic rice along with other yield attributing characters like effective tillers m$^{-2,}$ number of grain per panicle and test weight were recorded at harvest. Grain yield was converted to t ha^{-1} at 14% moisture content. Cost of cultivation and net return were calculated on the basis of prevailing market prices of different inputs and produces, respectively. All the other recommended agronomic and plant protection measures were adopted to raise the crop as per needs.

Results and Discussion

Growth characters

Significant differences were exhibited with date of sowing and cultivars on growth characters (Table 1). Date of sowing significantly influenced the growth characters viz.plant height, dry matter accumulation, leaf area index and crop growth rate of rice at different growth stage [4]. Noted that the plant height of 20 June sown aerobic rice was higher than other date of sowing. Dry matter accumulation was decreased with delay in sowing after 20 June, maximum dry matter accumulation was recorded with 20 June and was at par with 10June sown crop. Decreased in plant height, dry matter accumulation, LAI and CGR in late sown aerobic rice it was due to shorter growing period. These results are in line with those reported by [3].

The data noted in (Table 1) Cultivars showed significant difference for plant height, dry matter accumulation, LAI and CGR. Among cultivar hybrid PHB71 and A6444 recorded significantly the highest growth parameters viz. plant height (98.32 and 99.73 cm), dry matter accumulation at harvest (979.3 and 985.7g m^{-2}) Leaf area index (3.86 and 3.89) and CGR (8.96 and 8.94 g m^{-2} day^{-1} respectively) similar result has been reported by [4]. This can be ascribed to provided better soil-water status and improved plant canopy in terms of biomass, root growth and leaf area index which subsequently resulted in higher water and nitrogen uptake and their use efficiencies increased in aerobic rice crop under this treatment.

Table 1: Effect of sowing dates and cultivars on growth and yield attributes of aerobic rice. (Pooled data of two years)

Treatments	Plant height (cm)	Dry matter accumulation at harvest (g m^{-2})	Leaf Area Index 75 DAS	CGR g m^{-2}day^{-1} from (75-Harvest)	Effective tillers m^{-2}	No. of grains Panicle^{-1}	1000- grain weight (g)
Sowing dates							
D1: 10th June	92.64	987.1	3.83	8.64	297.3	80.34	24.25
D2: 20th June	95.54	991.9	3.85	8.77	300.5	81.81	24.45
D3: 30th June	88.49	956.1	3.72	7.87	283.4	78.87	24.18
SEm±	2.1	11.4	0.1	0.23	2.33	0.46	0.03
CD (P=0.05)	6.12	32.0	0.3	0.69	7.91	1.63	NS
Cultivars							
V_1 Prabhat	85.51	783.9	3.12	8.59	274.24	78.55	23.11
V_2 Susk samrat	92.25	857.2	3.25	8.65	279.27	79.36	24.02
V_3 MTU1010	96.43	965.3	3.37	8.89	294.94	79.38	24.24
V_4 MTU1001	96.61	978.8	3.35	8.86	289.98	80.54	24.34
V_5 PHB71	98.32	979.3	3.86	8.96	315.99	83.87	23.96
V_6 A6444	99.73	985.7	3.89	8.94	313.88	81.65	25.58
SEm±	2.3	14.2	0.1	0.33	2.21	0.67	0.03
CD (P=0.05)	6.27	43.7	0.4	0.94	6.74	2.12	NS

Yield attributes and yield

All yield attributing characters were significantly affected by the date of sowing and cultivars. Delayed sowing decreased grains panicle^{-1} (78.87), effective tillers m^{-2} (283.4) and 1,000-grain weight (24.18 g). Effective tillers and grains per panicle considered as the most important yield determinant varied significantly under different date of sowing. Sowing of aerobic rice at 20 June, significantly influenced the entire yield attributing character and was statistically at par with June 10 sowing and significantly superior over other dates of sowing [7].

Maximum grain yield (6.03 t ha^{-1}) was recorded from the crop sown on 20 June and significantly differed from crop sown on 10 June (5.79 t ha^{-1}) and 30 June (5.55 t ha^{-1}) reported by [8]. The increased yield might be due to result of optimum growth and development parameters and yield contributes associated with favourable weather condition responsible for more growth and development of crop. These results are in the

conformity with the work done by [5 & 6]. Late sowing of aerobic rice significantly produced poor yield attributes during cropping seasons. This might be due to shorter growing period due to photoperiodic response and decreased in temperature in late sown condition which adversely affected by heat stress leading to potentially small reproductive organs and reduced yield [9]. Further, data revealed that grains per panicle and length of panicles were maximum with June 20 sown and was at par with June 10 sown aerobic rice crops. Less number of grains per panicle in late sown condition was due to less production of photosynthates due to shorter growing period and lower temperature. These results are in line with those of [3].

Data indicated in (Table 2) showed that the cultivars hybrid PHB71 and A6444 recorded significantly higher values for all yield attributes as compared to the other cultivars. The enhanced early vegetative growth in term of plant height, dry matter accumulation, higher leaf area index and crop growth rate resulted in more panicles, which consequently increased the number of panicles bearing tillers, grains panicle^{-1} and test weight significantly, which was higher than the other tested cultivars. Conventional variety MTU1001 and MTU1010 also performed better in yield due to more conversion of photosynthates into economic produce, which resulted in higher yield contributing characters in the respective varieties. Similar results were reported by [4, 9 &10]. It might be due to favorable environmental conditions during reproductive stages. Similar results were reported by [7].

Economics

Net returns of Rs. 78,390 were maximum with 20 June sown aerobic rice followed by 10 June sowing Rs.75, 270 ha^{-1} [7]. These treatments also recorded higher benefit: cost ratio of 1.76 and 1.69, respectively compared to all other treatments (Table 2). Amongst cultivar the highest net return and benefit: cost ratio (85,540 and 1.83, respectively) were recorded in PHB71and it was significantly at par with A6444(Rs.84,760 and 1.81) both cultivars are superior as compared to remaining treatments has been reported by [5].

Nutrient uptake

Total nutrient uptake pattern is directly related to growth and yield pattern of aerobic rice crop. Nutrient uptake pattern varied distinctly with various treatments and produced significant response with date of sowing and cultivars (Table 2). Among all sowing date, maximum uptake of nitrogen (93.6 kg ha^{-1}) was with 20 June sown aerobic rice crop and was at statistically similar (92.9 kg ha^{-1}) with 10 June sowing. This was might be due to higher biomass production per unit area [7]. Uptake of phosphorus (25.3 kg ha^{-1}) and potassium (116.3 kg ha^{-1}) was also highest with 20 June sowing and showed parity in response with 10 June sowing during cropping seasons of observation. Amongst cultivar the highest uptake of nitrogen, phosphorus and potassium (98.7, 25.8 and 122.5 kg ha^{-1}, respectively) were recorded with PHB71 and it was significantly similar with A6444 (97.9, 25.1 and 121.9 kg ha^{-1}, respectively) both cultivars are superior as compared to remaining treatments has been reported by [5].

Table 2: Effect of sowing dates and cultivars on grain yield, straw yield, harvest index, economics, water use parameters and nutrient uptake of aerobic rice. (Pooled data of two years)

Treatment	Grain Yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Net return (×10^{3}Rs. ha^{-1})	B:C ratio	CUW(cm)	WUC (Kg ha^{-1} cm)	Nutrient uptake (Kg ha^{-1})		
Sowing dates								N	P	K
D1: 10th June	5.79	8.31	41.1	75270	1.69	33.1	141.2	92.9	24.6	110.7
D2: 20th June	6.03	8.22	42.3	78390	1.76	32.4	140.4	93.6	25.3	116.3
D3: 30th June	5.55	8.71	38.9	72150	1.62	30.9	131.5	83.3	21.2	104.1
SEm±	0.07	0.14	0.32	4314	-	-	-	1.6	0.6	2.1
CD (P=0.05)	0.24	0.41	0.97	2394	-	-	-	5.1	1.4	6.5
Cultivars										
V_1 Prabhat	4.92	6.85	41.8	63960	1.43	27.9	124.0	74.2	19.6	92.4
V_2 Susk samrat	5.14	7.01	42.3	66820	1.50	29.6	124.4	85.1	21.2	106.7
V_3 MTU1010	5.77	7.43	43.7	75010	1.68	30.8	128.1	90.8	22.9	113.2
V_4 MTU1001	5.81	7.47	43.8	75530	1.69	32.5	142.0	96.3	24.5	120.3
V_5 PHB71	6.58	8.12	44.8	85540	1.83	32.8	143.2	98.7	25.8	122.5
V_6 A6444	6.52	7.98	45.0	84760	1.81	33.1	143.4	97.9	25.1	121.9
SEm±	0.06	0.08	0.41	1843	-	-	-	1.7	0.6	3.1
CD (P=0.05)	0.18	0.21	1.2	5743	-	-	-	5.6	2.1	9.7

Conclusions

It is concluded that farmers achieved the higher yield with suitable rice hybrid cultivars and date of sowing under aerobic condition performing better than cultivars grown under puddle situation. Among the cultivars, PHB71 and A6444 resulted in maximum growth parameters, yield attributes and grain yield up to 6.52 to 6.58 t ha^{-1} with net income up to Rs. 84760 to Rs.85540 ha^{-1}. The most optimum date of sowing of upland aerobic rice was 20 June which gave maximum growth parameters, yield attributes and grain yield up to 6.03 t ha^{-1} with net income up to Rs. 78390 ha^{-1} and B:C ratio 1.76. Thus, variety PHB71 and A6444 sown on 20 June was suitable to obtain maximum productivity and economical grain yield from aerobic rice under upland conditions of Bihar.

References

1. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India, 2015-16.
2. Bouman B, Xeaogung AM, Huaqi Y, Zhiming W, Junfang W, Changui W. Aerobic rice (Han Dao): A new way of growing rice in water short areas. In: *Proceedings of the 12th Int. Soil Conservation Organisation Conf*., 26-31 May, Beijing, China, 2002, 175-181.
3. Kabat B, Satapathy MR. Effect of planting date and nitrogen level on grain yield of hybrid rice, *Oryza* 2011; 48(2):186-187.
4. Pandey IB, Mishra AK, Singh RP. Production potential

and economics of rice (*Oryza sativa* L.) varieties planted on different dates in lowland ecosystem of Bihar. *Oryza* 2007; 44(1):14-17.
5. Brahmanand PS, Sahoo N, Chowdhur SK, Kundu DK, Reddy GP. Productivity of rice varieties as influenced by sowing time in waterlogged ecosystem of Orissa. *Agric. Res* 2001; 19(1&2):150-152.
6. Gill MS, Kumar A, Kumar P. Growth and yield of rice (*Oryza sativa* L.) cultivars under various methods and times of sowing. Indian Journal of Agronomy. 2006; 51(2):123-127.
7. Singh AK, Chandra N, Bharti RC. Effects of genotype and planting time on phenology and performance of rice (*Oryza sativa* L.). *Vegetos* 2012; 25(1):151-156.
8. Pandey N, Verma AK, Tripathi RS. Effect of date of planting and nitrogen levels on yield and grain quality of scented rice varieties. *Oryza*. 2008; 42(2):75-80.
9. Ramana AV, Reddy DS, Reddy KR. Influence of sowing time and nitrogen levels on growth, yield and N uptake of rainfed rice varieties. The Andhra Agric. J. 2007; 54(3&4):114-120.
10. Kumar MR, Subbaiah SV, Padmaja K, Singh SP, Balasubramanian V. Nitrogen management through soil and plant analysis development and leaf colour chart in different groups of rice (*Oryza sativa* L.) varieties grown on vertisols of Deccan plateau. Indian Journal of Agronomy. 2001; 45(1):81-88.