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Influence of varieties and crop establishment methods on production potential, economics and energetic of wet-seeded rice (*Oryza sativa*) under Island ecosystem*

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Due to the fast changing scenario of rice production and marketing, farmers are encountering the problem of low returns from rice (*Oryza sativa* L.) cultivation. Hence there is an urgent need to improve the returns from rice cultivation. There are 2 ways by which returns can be improved by improving the productivity and in reducing the cost of production while maintaining productivity at same level. The first option has been almost exploited by way of improved high-yielding varieties and other necessary package of practices. In the present context second option needs to be exploited. Transplanting of rice accounts for 21% of the operational cost and critically it takes energy of 30 persons/ha/day for random planting and 40 persons/ha/day for line planting (Santhi *et al.* 1998). Another major impediment encountered in transplanting technique is delayed land preparation due to late onset of rainfall which may render the seedlings in the nursery over grown. Any alternative to transplanting will be widely accepted by farmers. In Bay Islands, though much thought has been given on for replacement of rice with the other economically important crops, it did not materialize due to the waterlogging in the lowlying areas during rainy season. So the rice cultivation is being practised in 10 500 ha of low-lying valley areas. Direct seeding is alternative to transplanting that can save labour and capital cost. However in surface wet seeding the problem of rain splashing during the initial stage of establishment is common in Bay Islands which necessitates the anaerobic wet seeding. The anaerobic wet seeder opens furrow, places the seed and closes the furrow, so that seeds are protected from rain splashing and also to direct exposure of light, birds and the other biotic and abiotic stresses. Hence an experiment was conducted to study the response of different varieties and establishment methods for its production potential, economics and energetics.

Field experiments were conducted during rainy (*kharif*) seasons of 2003 and 2004 at field crops research farm of the Institute, Port Blair. The soil was sandy loam in texture, medium in organic carbon (0.54%), low in available N (268.2 kg/ha), medium in P (15.20 kg/ha) and high in K (288.49 kg/ha) having *p*H of 5.9. Experiment was laid out in split-plot design with 3 replications having varieties in the main plots and establishment methods in sub-plots. Varieties comprised of 'C14-8' (V_1), 'Quing Livan No. 1' (V_2) and 'Zen-Gui-AT-1' (V_3) and crop establishment methods surface wet seeding (S_1), anaerobic wet seeding (S_2), line transplanting (S_3) and random transplanting (S_4) in sub-plots. Among the varieties 'C 14-8' is a long-duration, photo-sensitive traditional variety of Bay Islands which matures in 145 to 155 days. 'Quing Livan No 1' is medium-duration and 'Zen-gui-AT-1' is short - duration variety. In the case of line and random transplanting treatments, 21, 25 and 28-days-old seedlings was transplanted for short, medium and long-duration varieties respectively with spacing of 15 cm × 10 cm, 20 cm × 10 cm and 20 cm × 15 cm respectively. In the case of direct seeding, seeds were sown with TNAU paddy seeder and anaerobic paddy seeder (developed by IRRI, Philippines) for surface wet seeding and anaerobic wet seeding treatments. Need-based weeding was done with cono weeders. Recommended seed rate (40 kg/ha) was adopted with a fertilizer dose of 60 : 40 : 30 kg NPK/ha. Half N along with full dose of P and K were applied as basal and remaining N was applied in 2 equal splits, first at maximum tillering and second at panicle initiation. Need-based intercultural and plant protection measures were adopted for all the treatments. Growth and yield parameters were recorded as per the specifications.

Growth attributes, viz plant height and number of tillers/m^2 were significantly influenced by varieties and establishment methods. Among the varieties, indigenous traditional photosensitive long-duration variety registered

*Short note

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Table 1 Growth and yield attributes of rice varieties influenced by establishment methods (mean data of 2 years)

Treatment	Plant height (cm)	Tillers/ m^2	Panicles/ m^2	Filled grains/ panicle	1 000-grain weight (g)
Varieties					
'C14-8'	154.2	163	142	79.6	21.3
'Quing Livan No.1'	105.6	226	201	117.8	22.4
'Zen-Gui-AT-1'	98.7	204	192	99.5	23.5
CD (P=0.05)	7.1	10	9	5.2	1.3
Establishment method					
Surface wet seeding	120.4	187	164	94.6	22.4
Anaerobic wet seeding	117.2	206	187	103.5	22.1
Line transplanting	122.3	211	192	106.2	22.5
Random transplanting	118.1	186	169	91.7	22.5
CD (P=0.05)	NS	16	14	7.8	NS

significantly taller plants, followed by 'Quing livan No. 1' and 'Zen-Gui-AT-1' which were at par (Table 1). In terms of number of tillers/m^2, all the 3 varieties were significantly different. 'Quing Livan No. 1' registered significantly higher number of tillers (226/m^2), followed by 'Zen-Gui-AT-1' (204/m^2) and 'C 14-8' (163/m^2). Lower tillers in traditional variety might be due to the genetic character of the variety linked with photo-sensitiveness. Similar finding were reported earlier by Singh (1990). Establishment methods did not differ themselves with respect to plant height. However number of tillers/m^2 was influenced by establishment methods. Line transplanting registered maximum number of tillers (211/m^2) which was at par with anaerobic wet seeding (206/m^2). Surface wet seeding and random transplanting recorded almost equal number of tillers (186/m^2). Higher number of tillers under anaerobic wet seeding might be due to optimum population present in the anaerobic wet seeding, whereas in surface wet seeding owing to rain splash, the seeds are washed away thus reducing the population which might be the cause for reduced number of tillers in wet seeding (Yamauchi *et al.* 1993). First week after sowing received 104 mm of rainfall favoured the splashing of seeds in surface wet seeding, whereas in the case of anaerobic seeding the seeds are covered with thin layer of mud that might have prevented from rain splashing. This is in conformity with findings of Borlagdon *et al.* (1995).

Yield attributes, viz number of panicles/m^2, filled grains/panicle and 1 000-grain weight were significantly influenced by varieties and establishment methods (Table 1). 'Quing livan No. 1' registered significantly higher number of panicles/m^2 (201/m^2), followed by 'Zen-Gui-AT-1' (192/m^2) and 'C 14-8' (142/m^2). Similar trend was observed for filled grains/panicle and 1 000-grain weight. Improved yield attributes of 'Quing Livan No. 1' and 'Zen-Gui-AT-1' than the 'C 14-8' might be due to its genetic potential as reported earlier by Singh (1990). Establishment methods significantly influenced the yield attributes. What was true for growth attributes was also true for yield attributes. Line transplanting and an aerobic wet seeding being at par and registered significantly higher number of panicles/m^2 and filled grains/panicle than the surface wet seeding and random transplanting which were at par. Establishment methods failed to influence 1000-grain weight. Similar findings were earlier reported by Solaiappan and Veerabadran (1997).

Among the varieties, 'Quing Livan No. 1' gave highest yield (3 635 kg/ha), followed by 'Zen-Gui-AT-1' (2 663 kg/ha) (Table 2). Traditional long-duration photo-sensitive variety of Bay Islands ('C 14-8') yielded lowest (2 195 kg/ha). In terms of straw yield 'C 14-8' gave higher biomass compared to 'Quing Livan No. 1' and 'Zen-Gui-AT 1'. Establishment methods significantly influenced the grain and straw yield. Line transplanting registered highest grain yield (3 167 kg/ha). However it was statistically at par with

Table 2 Yield, economics and energetics of rice varieties influenced by establishment methods (mean data of 2 years)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Economics		Energetics	
			Net returns (Rs/ha)	B : C ratio	Specific energy (MJ/kg)	Energy ratio
Varieties						
'C14-8'	2 195	5 872	2 876	1.23	5.89	8.26
'Quing Livan No.1'	3 635	4 863	8 187	1.65	3.83	8.28
'Zen-Gui-AT-1'	2 663	3 599	3 568	1.32	4.84	6.58
CD (P=0.05)	145	257				
Establishment methods						
Surface wet seeding	2 704	4 615	5 353	1.48	4.90	7.55
Anaerobic wet seeding	2 993	5 103	7 087	1.64	4.45	8.34
Line transplanting	3 167	5 217	4 928	1.35	4.40	8.30
Random transplanting	2 459	4 176	2 139	1.13	5.65	6.63
CD (P=0.05)	227	384				

anaerobic wet seeding (2 993 kg/ha). Surface wet seeding gave significantly lower yield than anaerobic wet seeding. Random transplanting recorded the lowest yield, however difference between surface wet seeding and random transplanting was not significant. Straw yield also exhibited similar results. Higher yield under line transplanting and anaerobic wet seeding might be due to presence of optimum population (not affected by high rainfall) and improved growth and yield attributes.

'Quing Livan No. 1' registered higher net returns (Rs 8 187/ha) with higher B : C ratio (Table 2) and 'C 14-8' was least. Higher net returns and B : C ratio in 'Quing Livan No. 1' can be attributed to higher grain yield obtained from optimum growth and yield attributes. Anaerobic wet seeding gave highest net returns (Rs 7 087/ha) and B : C ratio, followed by surface wet seeding (Rs 5 353/ha), line transplanting and random transplanting. Higher net returns under wet seeding methods (anaerobic and surface wet seeding) might be due to reduced cost of cultivation through saving of labour for sowing and weeding (cono weeding). Findings of Ravisankar *et al.* (2007) also confirms similar trend.

The amount of energy required to produce one kg of grain (specific energy) is more for 'C 14-8' compared with the 'Quing Livan No. 1' and 'Zen-Gui-AT-1' (Table 2). Energy ratio indicates ratio between energy output and input. Energy ratio was higher for 'Quing Livan No. 1' compared with the other varieties. Higher specific energy for 'C14-8' was due to lesser grain yield coupled with more energy intake in terms of inputs. Direct wet seeding (anaerobic and surface wet seeding) recorded lower specific energy and higher energy ratio compared to line transplanting and random transplanting which clearly envisages the advantages of saving in energy due to direct seeding.

Thus it can be concluded that direct seeding could be recommended for Bay Islands. Anaerobic wet seeding in rainfed lowlands would be safe and it would lead to better seedling establishment. Hence, anaerobic wet seeding of high-yielding varieties, like 'Quing Livan No.1' and 'Zen-Gui-AT-1' is recommended for obtaining higher yield, economics and energetics.

SUMMARY

Field experiments were conducted during rainy (*kharif*) seasons of 2003 and 2004 with 3 varieties, viz 'C 14-8', 'Quing Livan No. 1' and 'Zen-gui-AT 1' and 4 establishment methods, namely surface wet seeding, anaerobic wet seeding, line transplanting and random transplanting in split-plot design with 3 replications. 'Quing livan No. 1' gave higher yield (3 635 kg/ha), net returns (Rs 8 187/ha) and lower specific energy of 3.83 MJ/kg than the other 2 varieties. In case of establishment methods, anaerobic wet seeding led to higher grain yield (2 993 kg/ha), net returns (Rs 7 087/ha) and energy ratio (8.34) over the surface wet seeding and transplanting.

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