



## Suitable rice (*Oryza sativa*) variety for rice–fish farming system in rainfed lowland ecosystem under organic nutrition

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### ABSTRACT

Field trials were conducted during 2003–07 to find out suitable rice varieties for rice–fish farming under organic nutrition in rainfed medium deepwater ecology at the experimental farm of Regional Rainfed Lowland Rice Research Station, Gerua, Assam. Among the rice varieties, highest grain yield (3.96 tonnes/ha) was recorded in Ranjit, followed by Durga, Piolee and Sarala. The combined direct and residual effect of *kharif* varieties on *kharif* rice–*rabi* rice sequence in terms of equivalent yield also revealed Ranjit as the best variety for *kharif* season followed by Durga and Piolee. In *rabi* season, long-duration variety Rupsundari performed better over the short-duration Vandana. Piolee showed better tolerance to natural submergence, which occurred for 10 days in 2004. Grain yield was highest (4.64 tonnes/ha) in the flood year due to inflow of nutrients (silt) with flood water. The fish yield was 472 kg/ha/10 months.

**Key words:** Organic farming, Rainfed medium deepwater ecology, Rice–fish farming, Rice varieties

Organic rice (*Oryza sativa* L.) possesses better nutritional quality (Saha *et al.* 2007) and fetches higher market price. About 40–50% of rainfed lowland areas in the eastern India (14 million ha) offer scope for rice–fish farming, especially under waterlogged, medium deep (up to 50 cm water depth) and deepwater (up to 100 cm water depth) ecologies (Sinhbabu 1997). In Asom alone, a substantial part of lowlands (1.5 million ha), mainly in Brahmaputra valley, is suitable for rice–fish farming system because of high rainfall resulting waterlogging for 3–8 months in the wet season (Sinhbabu 2003). Rice, the only crop possible in lowlands during wet season is constrained by varying magnitude of abiotic, biotic and socio-economic stresses resulting low and unstable productivity of about 1.0 to 1.5 tonnes/ha. Keeping in view the resources and socio-economic conditions in the eastern India, including Asom, an adoptable rice–fish farming system technology was developed for rainfed medium deep water lowland areas (Sinhbabu and Venkateswarlu 1995, Sinhababu 1997, Sinhababu *et al.* 2003, Sinhababu and Das 2004, Rautaray *et al.* 2005). Rice is an important component in this system as it occupies 60–65% of the transformed farm area. Information on suitable variety/ies of rice crop for rice–fish farming in Asom conditions is scanty. The present study

aimed at identifying suitable *kharif* rice variety/ies for integrated rice–fish farming system under organic nutrition in rainfed medium deep water situation in Asom.

### MATERIALS AND METHODS

A low lying rice field of 0.50 ha (125m×40m) area holding 20–60 cm water in *kharif* season but free from heavy flood was selected for rice–fish farming in the experimental farm of Regional Rainfed Lowland Rice Research Station, Gerua, Asom. Field design included wide dykes all around, a pond refuge connected to two side trenches (micro-watershed-cum-fish refuge) and one guarded outlet. The details of field design and construction (land shaping) was earlier reported by Rautaray *et al.* 2005. The soil in the rice field contained high organic carbon (1.1%) and medium levels of available N (295 kg/ha), P (22 kg/ha) and K (306 kg/ha).

A total of 6000 fingerlings (seven carp species) were released during May to first week of June. Manuring of pond with cow dung was done at the rate of 100 kg/month in weekly splits. A total of 150 kg of supplementary feed (rice bran and mustard oil cake at 1:1 ratio) was provided in the pond per annum. Live *Azolla* was provided for feeding of fish at three weeks interval by releasing within a floating bamboo quadrat.

Seven rice varieties were tried in randomized block design during 2003–07 with three replications using a plot size of 8 m × 7.8 m each. Thirty five to 45 days old seedlings

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Table 1 Yield and attributes of rice varieties in *kharif* season under rice-fish farming during 2003–07

Variety	Rice grain yield (tonnes/ha) in different years						Yield attributes (mean)				
	2003	2004	2005	2006	2007	Mean	Plant height (cm)	Days to 50% flowering	Ear bearing tillers	Panicle weight	Straw yield (tonnes/ha)
Ranjit	2.94	5.25	3.71	3.36	4.53	3.96	120.0	148.4	247.6	2.29	5.39
Durga	2.83	5.14	3.28	3.09	3.97	3.66	142.6	178.3	237.1	2.04	9.10
Piolee	2.53	5.28	3.26	3.17	3.68	3.58	111.2	150.3	286.5	1.75	4.83
Sarala	2.33	4.75	3.29	3.04	3.65	3.41	114.5	172.1	241.5	2.16	7.02
Pankaj	2.90	3.97	2.49	2.15	3.23	2.95	118.4	161.5	205.3	2.31	5.19
Mahsuri	2.23	4.14	2.55	2.02	2.86	2.76	130.7	134.8	255.6	1.59	4.44
Jaymati	2.29	3.96		1.93	2.74	2.73	121.5	117.4	240.9	1.92	3.77
Mean	2.58	4.64	3.10	2.68	3.52	3.30	122.7	151.8	244.9	2.0	5.7
CD ( $P=0.05$ )	0.36	0.44	0.31	0.47	0.33	0.28	1.9	2.3	18.5	0.16	1.24

were transplanted in between June and first week of July in different years adopting a spacing of 20 cm × 15 cm. Varietal performance was evaluated under organic nutrition with farmyard manure (FYM) at 25 kg equivalent N/ha except during 2003 in which organic fertilizer could not be applied due to early rise in water level and evaluation was done that year under native fertility.

During 2003–04 and 2004–05, *kharif* rice-*rabi* rice sequence was adopted while in the remaining three years *kharif* rice-vegetable sequence was adopted. For the rice-rice sequence, *kharif* rice was harvested at a height of 10 cm from ground level for all the varieties. Due to constant waterlogging in rice-fish field and soft mud, there was no need of tillage operation. The residual effect of *kharif* rice varieties on succeeding *rabi* rice varieties was studied using the same experimental layout. Each plot of the lay-out for *kharif* season was divided into two sub-plots of 4 m × 7.8 m area each. Rice varieties Vandana and Rupsundari were grown in the sub-plots in strip-plot design. Thirty days old seedlings were transplanted between two rows of the previous rice crop with a spacing of 20 cm × 15 cm. FYM was applied uniformly in each plot at 20 and 40 kg N/ha to the *rabi* rice crop in the first and second year, respectively. Chemical fertilizers and pesticides were not used.

In order to assess the combined direct and residual effect of *kharif* rice varieties, productivity of the varietal sequences was calculated in terms of equivalent yield. Vandana equivalent yield of rice varieties were calculated considering the market value for different grain types. Market price of short slender grains of Mahsuri was @ ₹ 7 500/tonne, while it was @ ₹ 7 000/tonne for Joymati, Ranjit, Piolee and Durga. Market price was @ ₹ 6 000/tonne for the medium coarse grain of Pankaj and the *rabi* rice varieties Rupsundari and Vandana.

Submergence tolerance of the *kharif* rice varieties was evaluated under natural flooding condition during 12–21 July 2004. Thirtythree days old seedlings were transplanted

on 2 July. After 10 days of transplanting, the crop was submerged completely for 10 days. Submergence tolerance of the varieties was recorded seven days after receding of the flood water following Standard Evaluation System (SES) scoring (International Rice Research Institute 1980). Natural field incidence of Rice Tungro Disease (RTD) incidence occurred during 2003–05. Total number of infected hills in a plot were counted and represented as per cent of infected hills. Total number of infected leaves from 10 sampled hills were counted and represented as per cent of infected leaves. Disease incidence was calculated by multiplying per cent of infected hills in a plot with per cent of infected leaves.

## RESULTS AND DISCUSSION

Highest mean grain yield of 3.96 tonnes/ha was recorded with rice variety Ranjit during 2003–07 (Table 1). This was followed by varieties Durga, Piolee, Sarla and Pankaj. The performance of the other two varieties, Mashuri and Jaymati was on par. During 2004, early natural flooding occurred but after recession of flood, the crop recovered very fast taking advantage of the nutrient, organic matter and silt deposited due to settling of flood water. In this situation, highest grain yield of 5.28 tonnes/ha was recorded with Piolee which was closely followed by Ranjit (5.25 tonnes/ha). Performance of Durga and Sarala was also better in the flood year. Grain yield of all varieties were highest (mean grain yield 4.64 tonnes/ha) in this year. Lowest mean grain yield (2.58 tonnes/ha) was recorded in 2003. This was due to non-application of FYM and exhaustive rice-rice cropping sequence in the previous year. There was gradual decline in yield in 2005 and 2006, which might be due to diminishing residual fertility and also deficit rainfall in 2006. However, in 2007, mean grain yield increased to 3.52 tonnes/ha. This might be due to improved soil condition from rice-vegetable cropping sequence in the previous year and normal rainfall in 2007 *kharif* season. The yield of fish was 472 kg/ha within a period of 10 months. Comparable fish productivity in rice–

Table 2 Mean grain yield of *kharif* rice, *rabi* rice and equivalent yield of the sequence during 2003–04 and 2004–05 under rice-fish farming

Kharif rice varieties	Yield (tonnes/ha) in <i>kharif</i> season	Yield(tonnes/ha) in <i>rabi</i> season		Vandana equivalent rice yield (tonnes/ha)		Mean
		Vandana	Rup-sundari	Vandana	Rup-sundari	
Ranjit	4.10	3.27	4.53	8.04	9.31	8.68
Durga	3.99	3.09	4.30	7.68	8.95	8.32
Piolee	3.91	2.98	4.38	7.54	8.93	8.23
Sarala	3.54	3.03	4.25	7.12	8.38	7.75
Pankaj	3.44	3.16	4.41	6.60	7.85	7.22
Mahsuri	3.19	3.32	4.53	7.30	8.51	7.90
Joymati	3.13	3.18	4.63	6.83	8.28	7.55
Mean	3.61	3.15	4.43	7.30	8.60	7.95
CD ( $P=0.05$ )	0.37	NS	NS	0.41	0.32	0.35

fish system was reported by Sinhababu *et al.* (2003).

Plant height was highest in variety Durga (142.6 cm). Intermediate height, semi-tall and tall plant types are desired to overcome sudden rise in water level with harvested rain water in rice-fish system under rainfed medium deepwater lowlands (Sinhababu *et al.*, 2003). Varieties Piolee and Sarala had relatively less plant height, but these varieties performed better under flash flood situation of 2004. These non-elongating plant types tolerated submergence for 10 days. Days to 50% flowering was longest for Durga (178 days), followed by Sarala. These photo-period sensitive rice varieties flowered in second and first week of November, respectively. Usefulness of photoperiod sensitive rice varieties under rainfed lowland situations is known (Ahamad 1979).

Grain yield of *rabi* rice varieties Vandana and Rupsundari were not influenced due to the residual effect of *kharif* rice varieties (Table 2). Highest Vandana equivalent yield of 8.68 tonnes/ha was obtained from Ranjit-based sequence, followed by Durga and Piolee-based sequences. Out of two varieties studied during *rabi* season, long-duration Rupsundari yielded higher than the short-duration Vandana.

Table 3 Submergence tolerance under natural flooding and recovery of rice varieties after flash flood during 2004

Variety	SES score	Damage (%)	Tillers/hill		
			At flood damage	one month after flood damage	Increase in tillers (%)
Ranjit	7	26.5	2.1	9.7	78.4
Durga	5	14.3	2.8	11.5	75.7
Piolee	3	4.7	3.6	11.8	69.5
Sarala	5	11.7	3.0	11.4	73.7
Pankaj	7	36.8	1.7	7.6	77.6
Mahsuri	5	21.4	2.4	9.7	75.3
Jaymati	7	33.5	1.9	6.8	72.1
CD ( $P=0.05$ )		6.2	0.8	1.3	

Evaluation for submergence tolerance under natural flooding (Table 3) revealed that variety Piolee had highest tolerance (SES score 3). The performance of this variety was followed by Sarala, Durga and Mahsuri. The SES score of 3 for Sarala variety was earlier reported by Gangadharan *et al.* 1987. An SES score of 5 for Sarala noted in this experiment might be due to high silt content of flood water. Similar or higher submergence susceptibility of Mahsuri than Pankaj had been reported (Ram *et al.*, 2002). However, in the present experiment, variety Pankaj had highest damage (31.8%) by flood water. Recovery capacity of the varieties estimated from per cent increase in tiller number/hill at one month after flood damage revealed that Ranjit, Pankaj, Durga, and Mahsuri could recover from flood damage to a considerable extent.

Natural incidence of rice tungro disease (RTD) was more in 2005 than in 2003 (Table 4). Variety Mahsuri had lowest incidence of RTD, followed by Jaymati and these two varieties may be considered to have field tolerant to the disease. Highest incidence was noted in Pankaj, followed by Piolee and Durga. However, the effect of RTD incidence was not reflected on grain yield of rice varieties. This might be due to occurrence of this disease at early vegetative stage

Table 4 Rice tungro disease incidence in rice varieties

Variety	Rice tungro disease incidence (%)						
	2003			2005			Mean Incidence
	Hills	Leaves	Incidence	Hills	Leaves	Incidence	
Ranjit	29.3	9.0	2.7	86.7	45.0	41.7	22.2
Durga	34.7	13.3	4.6	80	50.0	46.0	25.3
Piolee	28.7	11.0	3.4	86.7	50.0	47.3	25.4
Sarala	26.0	8.7	2.2	73.3	40.0	35.3	18.8
Pankaj	42.3	16.3	6.9	93.3	71.7	67.0	37.0
Mahsuri	0.7	0.3	< 0.1	0.3	0.2	< 0.1	< 0.1
Jaymati	2.5	6.2	0.2				0.2
CD ( $P=0.05$ )	2.8	1.7	0.7	3.5	1.6	0.9	0.8

(mid August) of the crop, thereby having time for natural recovery. Early recovery from the disease might not have interrupted in expression of yield potential of varieties. Similar results were also reported (Gangwar *et al.* 1986).

The study revealed that rice variety Ranjit is suitable for rice-fish farming under organic nutrition during *kharif* season in rainfed medium deep water situation in Asom in view of the higher grain yield and equivalent yield of *kharif* rice-rabi rice sequence. Rice varieties Durga and Piolee were also found promising for this situation.

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