

## Identification of modern Aman rice varieties suitable for salt affected Satkhira region of Bangladesh

#### Abstract:

Salinity is a serious problem for producing rice in Satkhira region, south-western district of Bangladesh. This area is occupied by huge number of *gher* where shrimp farming is very popular. Modern aman rice varieties were evaluated in those gher areas to validate and select the suitable varieties. The experiments were carried out consecutive three Transplanted Aman season (2011, 2012 and 2013) at polder 3-high saline areas, Kaliganj, Satkhira. Three sets of experiments were conducted in different sowing dates using ten varieties/genotypes in all the seasons with three replications. In first season, in gher-1 (high saline), most of the varieties like BRRI dhan44, BRRI dhan47, BRRI dhan52, BRRI dhan53 and BRRI dhan54 produced yield of 4.23 t/ha, 3.31 t/ha, 3.72 t/ha, 3.35 t/ha and 3.29 t/ha, respectively in 1st set and 2nd set was damaged due to high saline and water depth. The highest yielding varieties were BR23, BRRI dhan44 and BRRI dhan52, with yields consistently in the range of 3.9-4.3 t/ha in gher-2 (medium saline). In 2<sup>nd</sup> season, BRRI dhan52 (4.0 t/ha) produced the highest yield followed by BRRI dhan47 (3.4 t/ha), BRRI dhan28-Saltol and BR8371-4R-2 (2.8 t/ha) and the lowest in BRRI dhan54 & BINA dhan8 (2.3 t/ha). On the other hand, BR23 (3.7 t/ha) produced the highest yield followed by BRRI dhan41 (3.6 t/ha), BRRI dhan44 (3.1 t/ha) and the lowest in BRRI dhan53 and BRRI dhan54 (2.6 t/ha) in the following season. In case of sowing dates, 31 July sowing found better crop establishment and obtained higher yield in compare with 1<sup>st</sup> and 15 July seeding. Seeding on July 31 will be suitable for polder 3 with longer seedling age (45 days) because relatively older seedling can withstand salinity and submergence. Longer seedling age with tolerant varieties like BR23, BRRI dhan47, BRRI dhan53, BRRI dhan54 and BINA dhan8 are potential varieties for this area to boost up the productivity. Key word: Aman rice variety, gher, salinity, stress tolerance, time of sowing.

#### Introduction:

Satkhira district suffers the most from salinity intrusion, natural and man-made activities rising the salinity level and water logging is also common in Aman season in the field. The rice-shrimp gher farming system that locally known as "gher revolution", (Kendrick, 1994) diffused rapidly compared to green revolution in Bangladesh, mainly because of indigenous natural resources used at the early stage (Barmon et al. 2005). Gher means an enclosed area characterized by an encirclement of land along the banks of tidal rivers. The traditional cropping system in that area is *aman*- based cropping systems with the shrimp culture (Rahman and Ando, 2011). Traditional varieties adapted to salt affected areas are low yielding, sensitive to photoperiod and lodging and poor grain quality. Average rice productivity in salt-affected areas of Bangladesh ranges from 1.0 to 1.6 t ha-1 (Islam and Norton 2007). Yield enhancement from salinity and combination of other multiple stress-tolerant varieties in these areas could increase rice production significantly (Esperanza et al. 2009). Thus, improved varieties are needed, that combine high yield attributes with multiple tolerance like salinity, submergence and water stagnation. Bangladesh Rice Research Institute (BRRI) in collaboration with International Rice Research Institute (IRRI) tried for a long time to develop rice varieties suitable for coastal region to combat these problems. BRRI has developed BR23, BRRI dhan40, BRRI dhan41, BRRI dhan52, BRRI dhan53 and BRRI dhan54 which possess salinity tolerance up to EC 8 dSm<sup>-1</sup> and submergence tolerant, photoperiod sensitive and non-sensitive, non lodging and 15-40 days shorter growth duration and 50% higher yield potential (4.0-5.5 tha<sup>-1</sup>) than traditional rice varieties (Kumri, Jamaibabu) for rainfed ecosystem (Islam and Gregorio, 2013). Use of salt tolerant varieties is considered the most economic and most effective way of increasing production in saline soils. Varietal trials were conducted using newly developed rice varieties/genotypes to validate and identify the suitable varieties for high saline and submergence-prone areas in rice-shrimp system. The selection of well adapted suitable varieties will fit best into rice-shrimp system optimizing rice and shrimp production.



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#### Materials and Methods:

Evaluation of high yielding aman varieties and advanced lines was conducted in farmers' ghers during the rainy seasons of 2011, 2012 and 2013. The experimental sites were at Sehara village in Kaliganj Upazila, Satkhira District. Different ghers owned and managed by different farmers were used each year. In 2011, the experiments were repeated in two ghers owned by different farmers. Each year, two or three seeding/transplanting dates were used following randomized complete block design (RCBD) with three replicates using 10 varieties/advanced lines. Rice varieties were selected for evaluation based on tolerance to salinity, water stagnation and submergence (Table 1). In 1<sup>st</sup> season, seeding was done in two different dates (15 July and 30 July) and thirty-five days old seedlings were transplanted in the main field. In 2<sup>nd</sup> and 3<sup>rd</sup> seasons, seeding was done in three different dates (01 July, 16 July and 31 July). Transplanting was done on 3 September (1<sup>st</sup> and 2<sup>nd</sup> sets together due to heavy rain fall and high water depth) and 3<sup>rd</sup> set on 16 September in 2012 but in 2013 on 19 August (1<sup>st</sup> set), 09 September (2<sup>nd</sup> set) and 14 September (3<sup>rd</sup> set). The age of seedlings at the time of transplanting ranged from 46 to 64 days for 2<sup>nd</sup> and 3<sup>rd</sup> seasons. The seedlings were transplanted with using 2-3 seedlings per hill and plant spacing was 20 cm x 15 cm. The unit plot size was of Replication  $1 = 25m^2$ ; Replication 2 &  $3 = 12.5m^2$ . Basal dose of fertilizer (BRRI recommended dose Triple Super Phosphate-Muriate of Potash-Gypsum-ZnSO<sub>4</sub> @ 53-83-61-10 kgha<sup>-1</sup>) was applied in the final land preparation. Nitrogen fertilizer (75 kg N/ha) was applied as 1.8 g urea super granules at 7 to 10 days after transplanting within 4 hills at a depth of about 8-10 cm below the soil surface. Intercultural operations and pest management were performed as and when necessary.

Genotypes	Year	Varietal characteristics						
		Plant	Duration & grain type, photoperiod sensitivity and stress					
		height	responsiveness traits					
		(cm)						
BR23	2011-2013	120	Long duration (150 days), medium slender grain, PS					
BRRI dhan40	2011	110	Long duration (145 days), medium bold grain, PS, ST					
BRRI dhan41	2011-2013	115	Long duration (148 days), long bold grain, PS, ST					
BRRI dhan44	2011-2013	130	Long duration (145 days), bold grain, PS, TST					
BRRI dhan47	2011-2013	105	Long duration (152 days), medium bold grain, NPS, ST					
BRRI dhan52	2011-2013	116	Long duration (145-155 days), medium bold grain, FFST					
BRRI dhan53	2011-2013	105	Short duration (125 days), long grain, NPS, ST					
BRRI dhan54	2011-2013	115	Medium duration (135 days), long grain, PS, ST					
BRRI dhan57	2012-2013	115	Short duration (105 days), long grain, PS					
BINA dhan8	2011-2013	105	Long duration (155 days), medium bold grain, NPS, ST					
BR11-Saltol	2012-2013	115	Long duration (145 days), medium bold grain, NPS, ST					
BR28-Saltol	2012-2013	90	Medium duration (130 days), slender grain, NPS, ST					
BR8371-4R-2	2012	115	Long duration (145 days), long grain, NPS, ST					
IR8465-311-5-1-1-3	2011	105	Medium duration (135 days), bold grain, NPS, ST					

Table 1. Characteristics of aman varieties and advanced lines evaluated in *ghers* at Sehara, Kaliganj, Satkhira during 2011-2013 (BRRI 2017)

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PS=Photoperiod sensitive, NPS=Non-photoperiod sensitive, ST=Salt tolerant, TST=Tidal submergence tolerant, FFST=Flash flood submergence tolerant

Water depth (cm) and salinity (dS/m) were monitored weekly using a vertical gauge fixed permanently in the floor of the *gher* and an Electrical Conductivity meter, respectively. Analysis of variance (ANOVA) and mean comparisons based on Least Significant Difference (LSD) at 5% probability were performed using SAS Statistical Analysis System package (SAS, USA).

#### **Results and Discussion:**

In 2011, salinity level varied from 4.0-7.1 dS/m and 3.0-4.0 in gher-1 (High salinity) and gher-2 (medium salinity) respectively throughout the growing season (Fig. 1). In gher-1, most of the varieties like BRRI dhan44, BRRI dhan47, BRRI dhan52, BRRI dhan53 and BRRI dhan54 produced good yield of 4.23 t/ha, 3.31 t/ha, 3.72 t/ha, 3.35 t/ha and 3.29 t/ha respectively in 1<sup>st</sup> set (Fig. 3). Because the salinity level and water depth was low during transplanting therefore, seedling recovery was higher and no seedling damage. In 2<sup>nd</sup> set, seedling damage was higher due to high salinity (5.0 dS/m) and water depth was 13 cm. When 2<sup>nd</sup> set was transplanted, the seedling age was 26 days thus the seedling height was also shorter than the seedling of 1<sup>st</sup> set. Since the seedling age (36 days) and height was taller in case of first set during transplanting. The seedlings of 1<sup>st</sup> set comparatively recovered well due to aged and tall seedling. Consequently most of the varieties were not survived except the varieties (BRRI dhan47, BINA dhan8, BRRI dhan53 and BRRI dhan54) which have the salt tolerance at early seedling stage. Most part (3/4<sup>th</sup>) of the seedling was submerged at early seedling stage with EC 4.0-5.0 dS/m of water may cause huge damage and increased mortality rate. Submergence with saline water is highly detrimental for plant growth and development. Importantly, the water depth was varied from 15 to 22 cm on 12-18 September 2011 (Fig. 2). In gher-2, the water depth and salinity was lower compare to gher-1. The overall crop condition was better in gher-2. Duration in gher-2 ranged from 119-154 d in 1st sowing and 114-149 in 2nd sowing dates. The lowest duration was observed in BRRI dhan47 & BINA dhan-8 (114-119 d) and highest (149-154 d) in BR23 in both of the sowing dates (Fig. 4). Duration of the first sowing was consistently a few days higher than duration of the second sowing.

Yields in the medium salinity *gher* (*Gher-2*) were similar for the two seeding date/seedling age combinations and ranged from 2.7-4.3 t/ha (Fig. 5). The highest yielding varieties were BR23, BRRI dhan44 and BRRI dhan52, with yields consistently in the range of 3.9-4.3 t/ha. About 40% of the variation in yield was due to varietal duration (longer duration varieties tended to have higher yields). In the more saline *gher*, there was greater variation in yield (Fig. 5). Especially notable was the much poorer performance of the younger seedlings (26 d old) which were transplanted just 5 d after the older seedlings (36 d old). The younger seedlings did not survive the combination of salinity (5 dS/m) and high (relative to the height of the seedlings) water depth (13 cm) at the time of transplanting and submergence for about a week in mid September (Fig. 6) about 3 weeks after transplanting.

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Fig. 3: Variety yield (t/ha) in the higher salinity gher-1 as affected by seedling age

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Fig. 4: Duration of aman varieties in the medium salinity gher-2 in 2011

Fig. 5: Variety yields in the gher-2 with two sowing date/seedling age treatments in 2011



In 2012, water salinity level varied from 2.1-6.3 dS/m throughout the growing season (Fig. 6). 1st and 2nd sets of experiment were transplanted at the gher on same date because 1<sup>st</sup> set was not able to transplant on scheduled date due to high depth of water. 1<sup>st</sup> and 2<sup>nd</sup> sets were completely submerged from 6-10 September 2012 immediate after transplanting and varietal recovery was very low except BRRI dhan52. Finally no data was collected from 1<sup>st</sup> and 2<sup>nd</sup> sets. In 3rd set, all the varieties established but BRRI dhan41 and BRRI dhan44 were completely damaged by flood. All genotypes showed significant variation for all the characters except tiller number per hill and panicle length (Table 2). Plant height showed significant THE EXPERIMENT

difference among the varieties. The highest plant height (94.0 cm) found in BRRI dhan52 followed by BRRI dhan47 (93.0 cm), BR11-Saltol (90.0 cm) and BRRI dhan54 (85.5 cm) and the lowest in BRRI dhan28-Saltol (74.0 cm).Growth duration showed highly significant variation among the varieties. The highest and lowest growth duration was observed in BR11-Saltol (125 days) and BRRI dhan53 (109 days) respectively. Highly significant variation was observed among the varieties for yield performance. The yield ranged from 2.3-4.0 t/ha. BRRI dhan52 (4.0 t/ha) produced the highest yield followed by BRRI dhan47 (3.4 t/ha), BRRI dhan28-Saltol and BR8371-4R-2 (2.8 t/ha) and the lowest in BRRI dhan54 & BINA dhan8 (2.3 t/ha). Sterility was comparatively lower for all genotypes in this polder and ranged from 9.7-30.9 %. The highest sterility (%) was observed in BRRI dhan54 (30.9%) and lowest in BRRI dhan52 (9.7%).





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#### Table 2: Yield and agronomic characteristics of 10 genotypes at Sehara, Kaliganj, Satkhira, T. Aman 2012-13

#### (3rd set)

Sl.	Variety	Duration	Plant height	Panicle len	% Sterility	Yield (tha-	Remarks
No.		(days)	(cm)	(cm)		1)	
1	BR11-Saltol	125a	90.0b	21.5b	22.2ab	2.7c	
2	BRRI dhan28-Saltol	113d	74.0e	24.0a	21.2b	2.8c	
3	BRRI dhan41	-	-	-	-	-	Flood damage
4	BRRI dhan44	-	-	-	-	-	Flood damage
5	BRRI dhan47	119e	93.0a	23.5ab	11.6c	3.4b	
6	BRRI dhan52	121b	94.0a	21.5b	9.7c	4.0a	
7	BRRI dhan53	109e	78.5d	21.5a	29.9ab	2.7c	
8	BRRI dhan54	115d	85.5c	23.5ab	30.9a	2.3d	
9	BINA dhan8	122b	81.0d	21.5b	21.4b	2.3d	
10	BR8371-4R-2	122b	84.0c	21.5b	23.5ab	2.8c	
	Significance						
	Genotype	***	***	ns	**	***	
	LSD (0.05)	1.8	2.8	2.1	8.9	0.2	
	CV (%)	0.6	1.4	4.0	17.6	3.2	

\*, \*\*and \*\*\* Significant at p< 0.05, p< 0.01 and p< 0.001. Different letters (a-e) within a column denote significant at p< 0.05; ns= not significant.

 $1^{st}$  set= Flood damage

2<sup>nd</sup> set= Flood damage



In 2013, water salinity level was low and varied from 2.9-3.7 dS/m throughout the growing season (Fig. 7). The 1<sup>st</sup> and 2<sup>nd</sup> sets of experiment were transplanted at the gher but completely damaged due to high depth of water. Finally no data was collected from 1<sup>st</sup> and 2<sup>nd</sup> sets. In 3rd set, all the varieties established but BR11-Saltol, BRRI dhan28-Saltol and BINA dhan8 were completely damaged by flood. All genotypes showed significant variation for all the characters (Table 3). Plant height showed highly significant difference among the varieties. The highest plant height (91.5 cm) found in BRRI dhan41 and BR23 followed by BRRI dhan44 (84.5 cm), BRRI dhan52 (82.0 cm) and BRRI dhan54 (75.0 cm) and the lowest in BRRI dhan53 (71.0 cm). Growth duration showed highly significant variation among the varieties. The highest and lowest growth duration was observed in BR23 (147 days) and BRRI dhan53 (128 days) respectively. Highly significant variation observed among the varieties for panicle length and varied from 19.3-24.5 cm. BRRI dhan41 had the highest length of panicle (24.5 cm) followed by BR23 (24.1 cm) and BRRI dhan44 (22.2 cm). BRRI dhan53 (19.3 cm) produced the lowest panicle length.



Highly significant variation was observed among the varieties for yield performance. The yield ranged from 2.6-3.7 t/ha. BR23 (3.7 t/ha) produced the highest yield followed by BRRI dhan41 (3.6 t/ha), BRRI dhan44 (3.1 t/ha) and the lowest in BRRI dhan53 and BRRI dhan54 (2.6 t/ha). Sterility (%) showed significant variation among the varieties and varied from 11.4-37.2%. The highest sterility (%) was observed in BRRI dhan52 (37.2%) and lowest in BR23 (11.4%).

# Fig. 7: Water salinity level (dS/m) and water depth (cm) in the farmer's field at Sehara, Kaliganj, Satkhira, T. Aman 2013-14.



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Sl	Variety/Genotypes	Duration	Plant height	Panicle length	Sterility	Yield	Remarks
No.		(days)	(cm)	(cm)	(%)	(t/ha)	
1	BR11-Saltol	-	-	-	-	-	Damage
2	BRRI dhan28-Saltol	-	-	-	-	-	Damage
3	BRRI dhan41	129	91.5	24.5	23.7	3.6	
4	BRRI dhan44	130	84.5	23.2	16.1	3.1	
5	BRRI dhan47	145	74.0	19.5	20.9	2.8	
6	BRRI dhan52	143	82.0	22.1	37.2	2.8	
7	BRRI dhan53	128	71.0	19.3	26.0	2.6	
8	BRRI dhan54	135	75.0	21.1	31.9	2.6	
9	BINA dhan8	-	-	-	-	-	Damage
10	BR23	147	91.5	24.1	11.4	3.7	
	Significance	***	***	***	*	***	
	LSD (0.05)	0	0.92	0.86	11.06	0.06	
	CV (%)	0	0.46	1.60	18.91	0.84	

#### Table 3: Yield and agronomic performance of 10 genotypes at Sehara, Kaliganj, Satkhira, T. Aman 2013-14 (3rd set)

\*, \*\*and \*\*\* Significant at p< 0.05, p< 0.01 and p< 0.001.

1<sup>st</sup> set= Flood damage

2<sup>nd</sup> set= Flood damage

#### **Conclusion:**

The optimum seeding date is 31 July because if seeding is done at 1<sup>st</sup> and 15 July there is a possibility to submerge due to high rainfall immediate after transplanting in the main field. Seeding at 31 July found better crop establishment and obtained higher yield in compare with 1<sup>st</sup> and 15 July seeding. Seeding on July 31 may be recommended for polder 3 with longer seedling age (45 days) because relatively older seedling can withstand salinity and submergence. Water stagnation is also a problem immediately after transplanting due to heavy rainfall which may cause severe damage due to salinity with submergence. Longer seedling age with tolerant varieties like BR23, BRRI dhan47, BRRI dhan53, BRRI dhan54 and BINA dhan8 are potential varieties for boost up productivity in this fragile environment.

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