Research Paper

Bg 314, a Promising Rice Variety for Rainfed Areas of Dry and Intermediate Zones of Sri Lanka

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Abstract

Although rice varieties with three month maturity duration are comparatively more popular in drought prone rainfed areas, there is a considerable yield loss in these varieties under severe drought conditions as three months rice varieties with tolerance to drought are not available at present. With the aim of identifying such varieties, preliminary screening was carried out using seventy drought tolerant rice lines received from the International Rice Research Institute along with local varieties under rainfed moisture stressed conditions. Identified promising, drought tolerant rice lines were tested for yield in comparison to Bg 300 under both rainfed moisture stressed and irrigated conditions in research fields. Two promising lines were identified and they were tested for adaptability over diverse environments in the National Coordinated Rice Variety Testing Program and in farmers' fields under both rainfed and irrigated conditions. IRDTN 07-11 that matures within 95-100 days was identified as the most promising line considering the high yielding ability under moisture stressed and irrigated conditions, tolerance to pests & diseases and acceptable grain quality. It was released as Bg 314 for cultivation in drought prone rainfed areas of Dry and Intermediate zones of Sri Lanka in 2020.

Keywords: Drought tolerance, Moisture stress, Rain-fed & irrigated conditions, Rice

Introduction

Due to the erratic rainfall pattern in the past, drought has become the major abiotic stress causing significant yield losses in rice in Sri Lanka. Approximately 35% of rainfed rice farmers in both Dry and Intermediate zones abandoned their cultivations during the 2013 *Yala* compared to the 2012/13 *Maha*, mainly due to insufficient water availability (AgStat, 2014). Paddy production in 2014 *Yala* declined by 27% (3.38 million metric

tons) as the total drought affected extent of rice in 2014 was 11,723 ha (CBSL, 2014). The lowest paddy production of last 10 years was recorded in 2017 due to the drought situation in both 2016/17 *Maha* and 2017 *Yala*. The total sown extent this year declined by 28.9% (791, 679 ha) compared to 2016 and the total production was 2.38 million Mt (CBSL, 2017).

The reduction in the cultivated extent and crop losses threatens national rice production and food security of the country. To avoid this situation, introducing rice varieties which are adaptable to water limited situations together with water saving techniques is an essential requirement in rice cultivation. As a precaution, the rainfed farmers of Dry and Intermediate zones tend to cultivate rice varieties with the maturity duration ranging from 2½ to 3 months. However, the potential yield of rice varieties in the 2½ month maturity group is not adequate to make profits in rice cultivation. Although varieties in the 3 month maturity group are popular in rainfed cultivation, considerable yield loss can be observed in this maturity group under severe drought conditions. Thus, introducing varieties in the 3 month maturity group with a high yield potential that are tolerant to drought and perform well under both moisture stressed and non- stressed conditions, has become an urgent need.

Screening of drought tolerant lines received from the International Rice Research Institute (IRRI) along with local varieties for tolerance to moisture stress under research management and rainfed farmer field conditions and identification of promising rice lines for recommendation for drought prone rainfed areas of the Dry and Intermediate Zones are discussed in this paper.

Materials and Methods

Preliminary screening under moisture stress

Seventy drought tolerant lines belonged to International Rice Drought Tolerant Nursery (IRDTN) were received from the International Rice Research Institute through the INGER (International Network for Genetic Evaluation of Rice) program to the Rice Research and Development Institute (RRDI), Batalagoda in 2007. Preliminary screening for drought tolerance for rice lines/ varieties around 300 including IRDTN lines, local recommended and traditional varieties and promising breeding lines under rainfed moisture stressed condition was carried out from 2007/2008 *Maha* to 2009/2010 *Maha* at RRDI, Batalagoda, Ibbagamuwa (07° 31'N and 80° 26' E) as line screening with the spacing of 20cm x 15cm with a single plant per hill. To measure actual gravimetric soil moisture content (GMC), soil samples were taken randomly within the experiment site at 40 cm depth at regular intervals throughout the season. Promising lines were identified based on Number of days taken for 50% flowering and the average yield of 36 plants.

Yield trials to select promising lines under moisture stress

Multiplication and purification of promising lines were started from 2010 *Yala* onwards to obtain more seeds for ongoing trials. Yield trials for the promising lines from preliminary screening were

conducted with Bg 300 under both rainfed moisture stressed and irrigated conditions from 2011 *Yala* to 2013/2014 *Maha*. These trials were established as Randomized Complete Block Designs with three replications. To ensure uniform conditions within the plot and to maintain desired density, general management practices were adopted on land preparation and stand establishment under both conditions. After establishment, irrigated yield trials were maintained under irrigated condition while the rainfed yield trials were maintained under complete rainfed condition. A deep drench was made around the periphery of the rainfed experiment area to keep the trial in stress. To measure GMC, soil samples were taken randomly within the experiment site at 40 cm depth at regular intervals throughout the season. Number of days taken for 50% flowering and plot yields were obtained under both conditions.

Variety Adaptability Testing

The promising lines were nominated to National Coordinated Rice Variety Testing programme in 2014/2015 *Maha* for the adaptability testing. Small scale variety adaptability testing was done under both rainfed and irrigated farmer fields covering drought prone areas of the country in 2015 *Yala* and 2016 *Yala* in a Randomized Complete Block Design with two replications. Trials were managed according to the method proposed by Abeysiriwardena (2001).

Large scale (¼ ac) variety adaptability testing was done in 2017 *Yala* and 2017/2018 *Maha* to evaluate farmer preference of the most promising drought tolerant line. To obtain the potential yield under the research managed irrigated condition of the most promising line, replicated yield trials were conducted at rice research stations of Batalagoda, Paranthan, Murunkan, Samanthurei and Bombuwela in 2017 *Yala* and 2017/2018. All the data were analyzed with PROC ANOVA procedure in SAS 9.13 together with the least significant difference test (LSD) for the mean separation.

Evaluation for Pest and Disease, Grain Quality, Sensory Parameters and Plant Characteristics

Based on IRRI standards, continuous screening for major pest and diseases for promising lines was carried out by the Entomology and Pathology divisions of RRDI. Grain qualities for promising lines were evaluated by the Grain Quality division. Sensory evaluation of cooked rice was done on the farmer preference in LSVAT testing.

Shoot and root characteristics of plant height (cm), number of effective tillers/ plant, thousand grain weight (g), shoot dry weight/per plant (g), root dry weight/per plant (g), root volume/ per plant (cm^3), root surface area/ per plant (cm^2), average root diameter of plant (mm) were evaluated to identify the special characteristics related to drought tolerance in the most promising moisture stress tolerant line. Average of ten plants was measured to have per plant characteristics. In order to obtain shoot and root dry weights, plant

samples were oven dried at 60 °C over 72 hrs until the constant weight was reached. Root parameters of fresh root samples were measured using WhinRHIZO pro root scanning machine (Regent instruments Canada INC, Canada, model: STD 4800 scanner).

Based on the outputs of all activities and Distinct, Uniformity and Stability (DUS) testing done by seed certification centre, the most promising line for moisture stress was nominated to Variety Release Committee in 2018 for national release.

Results and Discussion

Preliminary screening under moisture stress

Among the seasons from 2007/2008 *Maha* to 2009/2010 *Maha* when the preliminary screening was carried out at RRDI, Batalagoda, comparatively more moisture stressed seasons under rainfed condition were 2007/2008 *Maha* and 2009 *Yala*. The GMC in different growth stages of vegetative, booting & flowering and grain filling of rice under rainfed moisture stressed condition for the two seasons are presented in Table 1.

All the growth stages during both seasons were under moisture stressed condition compared to the GMC of the saturated condition which was around 15% - 16% in these two seasons. The booting and flowering stage in both seasons was below GMC of 5%. Thus, the highest moisture stress was observed in the booting & flowering stages which is the most sensitive growth stage for moisture stress. Yield per plant and number of days taken for 50% flowering in the entries of preliminary screening trial are presented in Table 2.

The lines of IRDTN 07-11, IRDTN 07-08, IRDTN 07-22, IRDTN 07-37, IRDTN 07-56 were found to be promising in 2007/2008 *Maha* while the lines IRDTN 07-11, IRDTN 07-22, IRDTN 07-37, IRDTN 07-54, IRDTN 07-56 and the variety Bg 300 were found to be promising lines in 2009 *Yala*. They gave more than 2 g of grain yield per plant under the moisture stressed condition compared to that of other varieties/lines. Considering both seasons, IRRI drought tolerant lines; IRDTN 07-11, IRDTN 07-22, IRDTN 07-37, IRDTN 07-56 were selected for yield trials with Bg 300 under both rainfed moisture stressed condition and irrigated condition.

Table 1. Gravimetric soil moisture content (%) at different growth stages of rice in 2007/2008 *Maha* and 2009 *Yala* under rainfed moisture stressed condition (mean±SE)

Season	Vegetative stage	Booting & flowering stage	Grain filling stage
2007/2008 *Maha*	9.56±0.11	4.90±0.22	8.04±0.09
2009 *Yala*	6.60±0.26	3.67±0.15	7.88±0.12

Table 2. Grain yield per plant (Yield/P) and number of days taken for 50% flowering (NDF) of each entry in preliminary screening during 2007/2008 *Maha* and 2009 *Yala*

2007/2008 *Maha*						2009 *Yala*					
Entry	**Yield/ P(g)***	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**
IRDTN 07-01	1.51	54	IRDTN 07-51	1.09	75	IRDTN 07-01	1.12	52	IRDTN 07-51	1.16	75
IRDTN 07-02	0.88	56	IRDTN 07-52	0.46	73	IRDTN 07-02	0.92	54	IRDTN 07-52	0.68	74
IRDTN 07-03	0.28	70	IRDTN 07-53	1.03	73	IRDTN 07-03	0.35	67	IRDTN 07-53	1.28	76
IRDTN 07-04	0.63	70	IRDTN 07-54	1.27	71	IRDTN 07-04	0.52	72	IRDTN 07-54	2.08	78
IRDTN 07-05	1.12	57	IRDTN 07-55	0.13	77	IRDTN 07-05	0.92	58	IRDTN 07-55	0.42	77
IRDTN 07-06	1.16	58	IRDTN 07-56	2.16	70	IRDTN 07-06	1.18	58	IRDTN 07-56	2.34	79
IRDTN 07-07	0.98	66	IRDTN 07-57	0.25	83	IRDTN 07-07	0.85	71	IRDTN 07-57	0.28	85
IRDTN 07-08	2.28	71	IRDTN 07-58	0.22	82	IRDTN 07-08	1.19	61	IRDTN 07-58	0.34	82
IRDTN 07-09	0.39	70	IRDTN 07-59	0.71	89	IRDTN 07-09	0.41	72	IRDTN 07-59	0.82	89
IRDTN 07-10	1.53	71	IRDTN 07-60	0.60	83	IRDTN 07-10	1.12	73	IRDTN 07-60	0.76	85
IRDTN 07-11	2.33	72	IRDTN 07-61	0.48	81	IRDTN 07-11	2.78	73	IRDTN 07-61	0.45	83
IRDTN 07-12	0.45	73	IRDTN 07-62	0.59	86	IRDTN 07-12	0.62	76	IRDTN 07-62	0.63	86
IRDTN 07-13	0.57	71	IRDTN 07-63	0.43	86	IRDTN 07-13	0.61	70	IRDTN 07-63	0.81	85
IRDTN 07-14	0.82	73	IRDTN 07-64	0.85	82	IRDTN 07-14	0.85	75	IRDTN 07-64	0.76	82
IRDTN 07-15	1.40	61	IRDTN 07-66	0.94	79	IRDTN 07-15	0.69	65	IRDTN 07-66	1.14	78
IRDTN 07-16	0.40	65	IRDTN 07-67	1.24	59	IRDTN 07-16	0.56	68	IRDTN 07-67	1.19	62
IRDTN 07-17	0.38	82	IRDTN 07-68	0.91	53	IRDTN 07-17	0.60	88	IRDTN 07-68	1.12	56
IRDTN 07-18	0.98	75	IRDTN 07-69	0.59	67	IRDTN 07-18	0.78	81	IRDTN 07-69	0.87	70
IRDTN 07-19	1.05	72	IRDTN 07-70	0.69	66	IRDTN 07-19	1.18	76	IRDTN 07-70	0.81	68
IRDTN 07-20	1.18	71	IRDTN 07-71	0.35	62	IRDTN 07-20	1.25	73	IRDTN 07-71	0.56	65

Table 2 cont.

2007/2008 *Maha*						2009 *Yala*					
Entry	**Yield/ P(g)***	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**
IRDTN 07-21	0.81	73	IRDTN 07-72	0.38	62	IRDTN 07-21	0.84	76	IRDTN 07-72	0.62	64
IRDTN 07-22	2.17	70	GodaHeenati(Ac 5739)	0.78	71	IRDTN 07-22	2.08	64	GodaHeenati(Ac 5739)	0.65	73
IRDTN 07-23	0.72	73	PodiNiyan Wee (Ac 4913)	0.36	82	IRDTN 07-23	0.75	75	PodiNiyan Wee (Ac 4913)	0.23	83
IRDTN 07-24	1.46	70	Ld 99-12-38	0.40	70	IRDTN 07-24	1.38	73	Ld 99-12-38	0.24	72
IRDTN 07-25	0.62	72	Ld 356	0.30	74	IRDTN 07-25	0.92	75	Ld 356	0.24	75
IRDTN 07-26	1.24	73	Ld 3-12-36	0.37	76	IRDTN 07-26	1.48	75	Ld 3-12-36	0.42	76
IRDTN 07-27	0.54	84	Ld 99-17-04	0.61	76	IRDTN 07-27	0.38	86	Ld 99-17-04	0.53	76
IRDTN 07-28	1.19	73	At 632	0.69	76	IRDTN 07-28	1.21	76	At 632	0.59	76
IRDTN 07-29	1.81	75	At 581	0.44	70	IRDTN 07-29	1.74	77	At 581	0.56	72
IRDTN 07-30	0.76	77	At 353	0.32	72	IRDTN 07-30	0.82	81	At 353	0.35	74
IRDTN 07-31	1.22	75	At 307	0.42	65	IRDTN 07-31	1.15	76	At 307	0.53	68
IRDTN 07-32	1.75	76	At 605	0.43	84	IRDTN 07-32	1.54	77	At 605	0.46	84
IRDTN 07-33	1.26	72	Bg 250	1.55	48	IRDTN 07-33	1.41	75	Bg 250	1.93	48
IRDTN 07-34	1.67	72	Bg 359	0.58	76	IRDTN 07-34	1.52	73	Bg 359	0.46	76
IRDTN 07-35	0.37	81	Bg 360	0.16	86	IRDTN 07-35	0.69	83	Bg 357	0.72	86
IRDTN 07-36	1.30	73	Bg 357	0.90	83	IRDTN 07-36	1.41	75	Bg 352	0.86	74
IRDTN 07-37	2.02	62	Bg 3993	0.50	75	IRDTN 07-37	2.20	64	Bg 94-1	0.65	79
IRDTN 07-38	0.64	62	Bg 358	0.57	84	IRDTN 07-38	0.86	65	Bg 300	2.07	71
IRDTN 07-39	1.76	63	Bg 352	0.80	71	IRDTN 07-39	1.86	64	Bg 304	1.56	64
IRDTN 07-40	0.31	62	Bg 94-1	0.71	76	IRDTN 07-40	0.99	65	Bg 305	0.92	66
IRDTN 07-41	1.26	75	Bg 300	1.71	70	IRDTN 07-41	1.46	76	Suwandal	0.94	76

Table 2 cont.

2007/2008 *Maha*						2009 *Yala*					
Entry	**Yield/ P(g)***	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**	**Entry**	**Yield/ P(g)**	**NDF**
IRDTN 07-42	1.45	71	Bg 304	1.37	65	IRDTN 07-42	1.51	73	Heenati(Ac 6738)	0.82	69
IRDTN 07-43	1.63	72	Bg 305	0.62	68	IRDTN 07-43	1.68	76			
IRDTN 07-44	0.59	82	Suwandal	0.68	74	IRDTN 07-44	0.46	82			
IRDTN 07-45	1.54	65	Heenati(Ac 6738)	0.60	70	IRDTN 07-45	1.63	64			
IRDTN 07-47	0.21	85				IRDTN 07-47	0.32	86			
IRDTN 07-48	0.28	84				IRDTN 07-48	0.36	85			
IRDTN 07-49	1.29	76				IRDTN 07-49	1.35	78			
IRDTN 07-50	0.17	84				IRDTN 07-50	0.35	86			

Yield trials to select promising lines under moisture stress

Out of the seasons from 2011 *Yala* to 2013/2014 *Maha* when yield trials were conducted, more moisture stressed seasons under rainfed condition of the research field at RRDI were 2011 *Yala* and 2011/ 2012 *Maha*. The fluctuation of GMC of rainfed trials throughout those seasons are shown in Figures 1a and 1b. The panicle Primodia Initiation (PI) or the initiation of the reproductive stage of lines from preliminary screening occurred at 4th week after sowing (WAS). In 2011 *Yala*, the GMC of 4th WAS was around 11.02% and it decreased drastically within the booting stage and reached to GMC around 2-3% at the end of the booting stage. The flowering and grain-filling occurred in between the 8th WAS and 12th WAS (number of days taken for 50% flowering (NDF) of promising lines of the preliminary screening were in between the 60-80 days). The GMC of that period was around 3 - 4% (Fig. 1a).

In 2011/2012 *Maha* the GMC of booting stage was in between 13.8% and 12.04%. The GMC of flowering and grain-filling of 2011/2012 *Maha* became more stressed compared to that of booting stage with the drastic reduction of GMC from 12% to 1.8% (Fig. 1b). Thus, in both seasons, the sensitive growth stages of booting, flowering and grain-filling were highly affected by moisture stress. The grain yield (t ha^{-1}), number of days taken to 50% flowering for lines/varieties in the yield trials conducted under rainfed and irrigated conditions during 2011 *Yala* and 2011/2012 *Maha* seasons in the research fields are presented in Table 3.

Under the rainfed moisture stressed condition, drought tolerant lines of IRDTN 07-11 and IRDTN 07-56 showed higher yields in both 2011 *Yala* and 2011/12 *Maha* than that of other entries including Bg 300. Out of those lines, the most promising line, IRDTN 07-11 took 65-67 days for 50% flowering revealing it's maturity around 95-100 days. This line gave the highest average yield (2.17±0.04 t ha^{-1}) under rainfed moisture stressed condition while yielding (4.60±0.15 t ha^{-1}) similar to that of Bg 300 under irrigated condition in the research fields. Thus, IRDTN 07-11 showed its potential to withstand drought and potential to produce an economical yield in the rainfed rice cultivation in Sri Lanka.

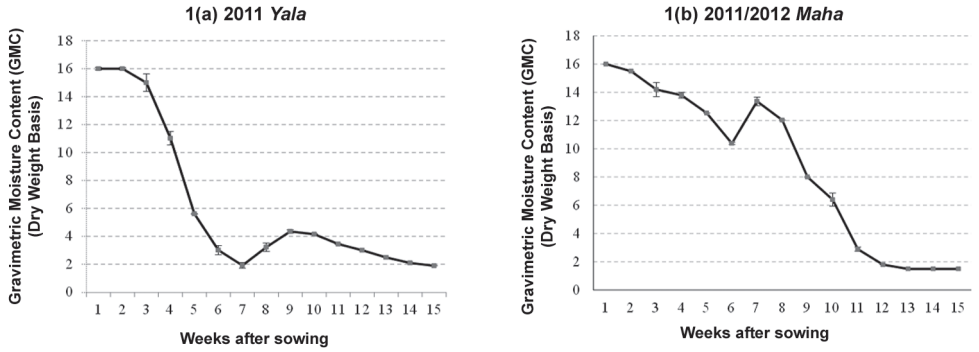

Figure 1. Fluctuation of the Gravimetric Moisture Content (GMC) of rainfed trials of 2011 *Yala* and 2011/2012 *Maha*

Table 3. Grain yield (t/ha) and number of days taken to 50% flowering for lines/ varieties in the yield trials conducted under rainfed moisture stressed (RMS) and irrigated (IRI) conditions during 2011 *Yala* and 2011/2012 *Maha* seasons at Rice Research and Development Institute, Bathalagoda.

Line/Variety	Days to 50% flowering		Grain yield (t/ha)*	
	RMS	IRI	RMS	IRI
2011 *Yala*				
IRDTN 07-11	68	65	2.13^{a}	4.75^{a}
IRDTN 07-22	65	61	1.45^{c}	3.77^{b}
IRDTN 07-37	59	56	1.40^{c}	3.42^{b}
IRDTN 07-56	63	60	1.79^{b}	3.50^{b}
Bg 300	66	62	1.41^{c}	5.09^{a}
2011/2012 *Maha*				
IRDTN 07-11	66	64	2.21^{a}	4.45^{ab}
IRDTN 07-22	60	56	1.35^{cd}	3.91^{c}
IRDTN 07-37	55	53	1.60^{bc}	4.16^{bc}
IRDTN 07-56	58	56	1.82^{b}	4.03^{bc}
Bg 300	64	63	1.29^{d}	4.76^{a}
Mean yields and days to 50% flowering				
IRDTN 07-11	67±1	65±1	2.17±0.04	4.60±0.15
IRDTN 07-22	63±3	59±3	1.40±0.05	3.84±0.07
IRDTN 07-37	57±2	55±2	1.50±0.10	3.79±0.37
IRDTN 07-56	61±3	58±2	1.81±0.02	3.77±0.27
Bg 300	65±1	63±1	1.35±0.06	4.93±0.17

**Values with the same letter within a column are not significantly different at 5% probability level*

Variety Adaptability Testing

Farmers' field multi-locational adaptability testing trials of 2015 *Yala* and 2016 *Yala* included the most promising line IRDTN 07-11 together with the line IRDTN 07-56 which showed the next level of tolerance to drought and the standard check of Bg 300. These trials were conducted under both rainfed and irrigated conditions in 25 locations. The results of the multi-locational farmer field adaptability testing trials of 2015 *Yala* and 2016 *Yala* for the promising drought tolerant lines of IRDTN 07-11 and IRDTN 07-56 together with Bg 300 under rainfed and irrigated conditions are represented in Table 4.

Variety or line with the significantly lowest D and non-significant V_2 was the most adaptable variety/line with the adaptability rank 1 in the test. As IRDTN 07-11 had the adaptability rank 1 in both seasons under the rainfed condition, it was the most adaptable line under rainfed moisture stressed condition. Similarly, even under irrigated condition IRDTN 07-11 was found to be the most adaptable line with the adaptability rank 1 in both seasons. The average yield of IRDTN 07-11 under the rainfed farmer fields was 2.32 ± 0.24 t ha^{-1} and average yield under the irrigated farmer fields was 4.13 ± 0.40 t ha^{-1}.

Table 4. Adaptability parameters of mean deviation (D) and variance in deviations (V2) along with adaptability rank and average yield of lines/variety under rainfed and irrigated conditions in farmer fields.

Parameter	Rainfed farmer fields Line/ Variety			Irrigated farmer fields Line/ Variety		
	IRDTN 07-56	IRDTN 07-11	Bg 300	IRDTN 07-56	IRDTN 07-11	Bg 300
			2015 *Yala*			
Mean Deviation (D)	1.70a	0.47c	0.92b	1.13a	0.39b	0.54b
Variance(V^2)	4.79*	0.31	1.57*	0.04	0.03	0.06
Adaptability Rank	3	1	2	2	1	1
			2016 *Yala*			
Mean Deviation (D)	1.36a	0.15c	0.79b	0.76a	0.64a	0.97a
Variance(V^2)	0.002	0.08	0.35*	0.49	0.48	2.10*
Adaptability Rank	3	1	2	1	1	2
Average yields	1.89± 0.66	2.32 ± 0.24	1.76 ± 0.12	3.82± 0.36	4.13 ± 0.40	4.21± 0.03

*Values with the same letter within a row are not significantly different at 5% probability level *Variances are significant at 5% probability level*

The maximum yield of this promising line under the rainfed farmer fields in the Dry and Intermediate Zones was 3.97 t ha^{-1} at Narammala of Kurunegala district and in the Wet Zone was 5.6 t ha^{-1} at Dahamana of Ratnapura district. The maximum yield recorded by this line under the irrigated farmer fields was 8.06 t ha^{-1} at Siyabalanduwa.

Evaluation of yield potential of IRDTN 07-11 under research managed irrigated condition

Grain yields recorded by IRDTN 07-11 in comparison to Bg 300 under the research managed irrigated condition in five research stations in 2017 *Yala* and 2017/2018 *Maha* are presented in Figures 2(a) and 2(b), respectively.

Grain yields recorded by IRDTN 07-11 were not significantly different from that of Bg 300 at all locations in both seasons. The average grain yield of IRDTN 07-11 over t ha^{-1} all locations and seasons was 5.1 t ha^{-1} while the highest yield recorded was 6.19 t ha^{-1} at the Rice Research Station, Murunkan. This clearly indicated that although the line IRDTN 07-11 was identified as a promising rice line for cultivation under moisture stressed conditions, it also has a potential to give high yields when sufficient water is available.

Farmer perceptions in Large Scale Variety Adaptability Testing (LSVAT) in farmer fields

The farmer preferences for the plant characteristics under the LSVAT are presented in Table 5. Farmers observed that IRDTN 07-11 line showed less yellowing symptoms at the vegetative phase compared to that of Bg 300 indicating the potential of IRDTN 07-11 to withstand under low nitrogen fertilizer. Other highlighting plant characteristics of this line that farmers preferred were non lodging, less shattering and high weed competitive ability.

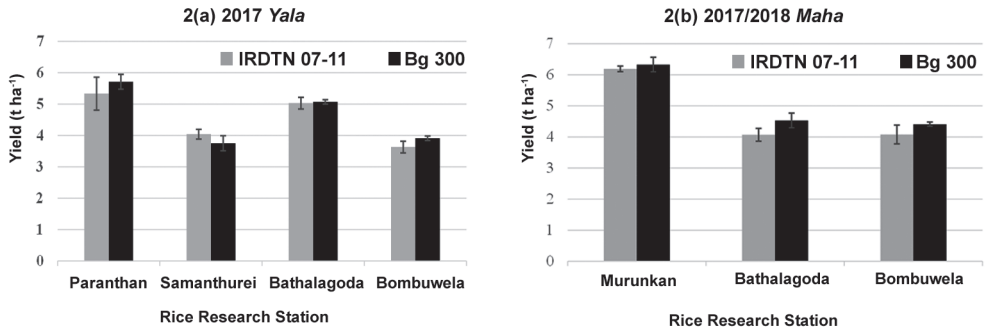

Figure 2. Grain yield (t/ha) of IRDTN 07-11 in comparison to Bg 300 in yield trials conducted under irrigated condition in research stations in 2017 *Yala* and 2017/18 *Maha*

Table 5. Farmer perception (%)on plant characteristics of IRDTN 07-11 and Bg 300 in the LSVAT conducted in farmers' fields over 2017 *Yala* and 2017/18 *Maha* seasons

	2017 *Yala*		207/18 *Maha*		Average	
	IRDTN 07-11	Bg 300	IRDTN 07-11	Bg 300	IRDTN 07-11	Bg 300
Appearance of seed (Good)	89	89	100	92	95	91
Appearance of young plant (Good)	89	89	78	85	84	87
Yellowing at vegetative phase (No)	84	73	92	78	88	76
Uniformity after flowering (Yes)	84	89	85	92	85	91
Lodging (No)	88	21	93	71		46
Shattering (No)	94	89	92	78	93	84
Competitiveness with weeds (Yes)	89	68	92	21	91	45

Evaluation of shoot and root characteristics

According to the comparison of shoot and root characters of IRDTN 07-11 with Bg 300 (Table 6), the number of effective tillers of IRDTN 07-11 was same as Bg 300. Thousand grain weight was higher in IRDTN 07-11 than that of Bg 300 and as a result, bushel weight of IRDTN 07-11 was higher than that of Bg 300.

Gowda *et al*. (2011) identified that drought tolerance of rice was related with coarse, long and dense root system. Root biomass and rooting depth determine the ability of plants to withstand in water deficit (Kato *et al*., 2007; Henry *et al*., 2012; Kano *et al*., 2011). It was also observed that there was big difference in dry weight of shoots among rice cultivars and this is highly bound with water uptake (Kano *et al.*, 2011; Manikavelu *et al*., 2006). Accordingly, the higher root dry weight, root surface area and root volume of IRDTN 07-11 than that of Bg 300 may be reasons for the moisture stress tolerance in IRDTN 07-11 (Table 6). However, these characteristics should be further investigated.

Table 6. Comparison of shoot and root characteristics of IRDTN 07-11 with Bg 300

Characteristics	IRDTN 07-11	Bg 300
Plant height (cm)	113.5	105.2
No. of effective tillers/ plant	9	9
Thousand grain weight (g)	28.4	24.5
Shoot dry weight/per plant (g)	26.2	21.1
Root dry weight/per plant (g)	2.3	1.7
Root volume/ per plant (cm^3)	113.9	82.4
Root surface area/ per plant (cm^2)	2245.3	1793.6
Average root diameter of plant (mm)	2.19	2.09

Evaluation of IRDTN 07-11 for major pests and diseases

As the IRDTN 07 -11 is moderately resistant to brown plant hopper, so that the line is expected to withstand brown plant hopper incidences in farmers' fields. Moderately resistant/ Moderately susceptible levels exhibited by this line to leaf blast and moderately susceptible/ susceptible levels for bacterial leaf blight diseases under controlled screening conditions will be adequate to show field resistance to those diseases.

Grain quality and sensory evaluation

The IRDTN 07-11 is white, intermediate bold rice line which has thousand grain weight of 28.4g. Line IRDTN 07-11 had 62.2% of raw rice head grain percentage and 71.3% of parboiled rice head grain percentage showing that it has acceptable head grain percentage.

The grain chalkiness of this line is level WB3. Intermediate amylose content of this line proves non stickiness and the low gelatinization temperature of this line indicates shorter cooking time (Cruz and Khush, 2000). Farmers involved in LSVAT trials preferred cooked rice of IRDTN 07-11 because of its volume expansion ability, appearance, taste of cooked rice and its suitability for rice based products (Table 7).

Table 7. Sensory response of farmers (%) on cooked rice of IRDTN 07-11 in LSVAT in 2017 *Yala* and 2017/18 *Maha* seasons

Sensory parameter	2017 *Yala*	2017/18 *Maha*	Average
Cooked rice Aroma (Good)	63	92	78
Volume Expansion (Good)	94	92	93
Appearance of cooked rice (Good)	89	85	87
Taste of cooked rice (Good)	100	78	89
Stickiness of cooked rice (Not sticky)	57	92	75
Drying of rice after cooking (No)	63	85	74
Suitability for rice based food products (Yes)	100	64	82

Conclusions

The white intermediate bold, 95- 100 days rice line, IRDTN 07-11 was identified as the best adaptable moisture stress tolerant line for rainfed condition compared to the other varieties/ lines tested. The average yield of IRDTN 07-11 in rainfed farmer fields was 2.32 ± 0.24 t ha^{-1} and in irrigated farmer fields was 4.13 ± 0.40 t ha^{-1}. The maximum yield under the rainfed farmer fields was 3.97 t ha^{-1} and the maximum yield recorded under the irrigated farmer fields was 8.06 t ha^{-1}. The highest yield recorded under the research managed irrigated condition was 6.19 t ha^{-1} at the Rice Research Station, Murunkan. Considering higher yield potential under rainfed and irrigated conditions, tolerance to pest & diseases, suitability for the normal consumption, the moisture stress tolerant line, IRDTN 07-11 was released as Bg 314 for drought prone rainfed areas of Dry and Intermediate zones of Sri Lanka in the Varietal Releasing Committee in 2020. This moisture stress tolerant variety has a high potential to overcome crop losses due to drought in rainfed areas of the Dry and Intermediate zones while effectively utilizing rainfed drought prone rice lands and increasing farmers' income in those lands.

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