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High yielding deep water rice culture MTU 1184 tolerance for major pests and diseases

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Abstract
In recent years climate change is increasing the incidence of both types of floods and yield loss due to floods ranges from 10 to 100 % depending on the cultivated variety, flood duration, depth and floodwater conditions. In recent years due to heavy and intense rainfall and cyclonic storms, paddy crop is experiencing damage due to flooding. If the flood water stagnation remains for more than a week the varieties are unable to sustain and there by the yield levels are drastically reduced. Hence, there is a need to develop submergence tolerant variety to minimize the yield losses. Acharya NG Ranga Agricultural University (ANGRAU), Regional Agricultural Research Station, Maruteru has developed a flood tolerant culture MTU 20601-1-1-1-1 through conventional Plant Breeding using PLA 1100 and BM 71 as parents from 2008 to 2011. The flood tolerant rice culture was extensively evaluated for yield in semi deep water ecosystem at RARS, Maruteru over the years of Kharif, 2012 to Kharif,2016 in Station yield trials The entry recorded superior grain yield(4370Kg/ha) against check PLA 1100(3811Kg/ha) and yield advantage over check was 14.67 The entry was tested in AICRIP trials from 2014 to 2017 at RARS, Maruteru and the results revealed that the entry registered 4650Kg/ha and found to be significantly superior over the national check, Sabitha(3703Kg/ha) and the per cent increase over check was 25.60. The entry recorded a mean grain yield 4282 Kg/ha and found to be significantly superior over the national check, Sabitha (2790Kg/ha) & yield advantage was 1492 Kg/ha and per cent increase over national check was 53.48 and zonal check Poornendu (1444Kg/ha & 50.88 respectively) in eight locations of six states of south eastern region. Multi location testing of the entry from 2015 to 2017 revealed that the entry has out yielded (5370Kg/ha) and found superior over the best check PLA 1100(4290Kg/ha) and the per cent increase over check was 25.18. Minikit testing in 890 locations for a period of three years from 2016 to 2018 revealed that the average mean yield of the entry over three years was 6039Kg/ha against local popular check PLA 1100(5700Kg/ha) and per cent increase over check was 6.0 when tested in Andhra Pradesh.

Keywords: New deep-water rice culture MTU 1184- Stagnant flooding- ecosystem- South Eastern Zone

Introduction

Rice is the Staple food Rice crop is being cultivated in varied ecologies to feed increasing population. Deep Water rice ecosystem, Coastal rice ecosystems, covering more than 16 % of rice areas worldwide (20×10^6 ha) are adversely affected by annual flooding. Paddy fields in these flood-prone lowlands are subjected to either flash floods (few days to two weeks) or long-term flooding i.e., semi deep water (30-50 cm). In recent years climate change is increasing the incidence of both types of floods and yield loss due to floods ranges from 10 to 100 % depending on the cultivated variety, flood duration, depth and floodwater conditions. Rice, a semi-aquatic crop, is cultivated across different climatic conditions but remains vulnerable to both biotic and abiotic stresses (Santhosh *et al*., 2023). Further flood is a recurrent phenomenon in coastal areas of Andhra Pradesh, Assam, Orissa, West Bengal, Kerala, Karnataka and South Gujarat. The problem is accentuated due to poor drainage and topography of the land which impedes fast drainage from crop lands (Yamuna and Ashwini,2016) [9] In general, the submergence exists up to 15 days which coincides the vegetative stage of the crop at 30 days after transplanting and recedes later. If the flood water stagnation remains for more than a week the varieties are unable to sustain and there by the yield levels are drastically reduced. Though deep-water rice is cultivated in small areas with low yield, attention should be given to develop high yielding deep water rice to maintain stable rice production (Ahmed *et al*,2016) [1]. Apart from improving drainage and other preventive measures, farmers can adopt flood tolerant varieties that can withstand inundation for an extended period and reduce the risk from flood damage (Shalahuddin *et al*,2019) [8]. Deep water ecosystem has been classified into two types based on stature and depth of water, traditional tall and floating cultivars. Continuous high rainfall in a short span leading to water logging causes inundation of paddy fields and lodging of the crop at grain filling and maturity stages causes huge losses to the farmer. The challenge is farther aggravated by the fact that numerous bettered rice kinds warrant adaptability to flooding (Santhosh and Maitra 2021) With over 3.5 billion people worldwide counting on rice for food and livelihood, addressing this issue is critical (Midya *et al*., 2021; Maitra *et al*., 2024) [3, 4] Traditional tall cultivars are tall with long leaves and grown at water depths between 50and 100 cm while floating rice is grown in 100cm or deeper situations (Sairam *et al*., 2023; Sarthak Pattanayak *et al*,2025) [6, 7] Apparently each of these types requires specific adaptive traits, which requires the development of unique varieties(Lafitte *et al*,2006).

Materials and Methods

Many advanced breeding lines were developed by Acharya NG Ranga Agricultural University, Regional Agricultural Research Station (RARS), Maruteru, one flood tolerantRice culture MTU 1184 is an outcome of single cross between PLA 1100 and BM 71 with an objective to develop a semi deep water submergence tolerant rice culture Pedigree of MTU 1184 is MTU 20601-1-1-1-1. Crossing was done in 2008 and developed through hybridization followed by pedigree selection. The local popular variety PLA 1100 was used as check for this study. The new culture MTU 1184 with 150 days duration is tolerant to flash floods for 15 days at tillering stage and suitable for stagnant flooding (50-60cm) with good elongation ability possessing two weeks dormancy and good grain quality characteristics. It is a medium slender brown glume semi tall plant type of 140-150 cm depending on water depth.

Field trials were performed under semi deep-water ecosystem in Randomized Block Design with three replications in three consecutive seasons from 2012 to 2014 in a 50-60 cm deep water. The entry was tested in fiash floods with a stagnant flooding of 60-65cm for a period of 15-20 days from 2015-2017. All India Coordinated trials were conducted from 2014 to 2017 in seven states of Orissa (Bhuvaneswar, Cuttock), WestBengal (Chinsurah), UttarPradesh (Ghaghraghat), Assam (Gerula), Bihar (Pusa), Karnataka (Sirsi), and Andhra Pradesh (Maruteru). Based on the superior performance of the entry in Multi location testing when compared to best check PLA 1100 from Kharif,2015 to Kharif,2017, the culture was tested in mini kit testing from Kharif,2016 to Kharif,2018 and per cent increase over check was estimated. Land was well prepared in semi dry condition. Sowing was done in second week of June and transplanting was done in second week of july in each year. All recommended package of practices was followed as per schedule. When flood water or stagnant water depth was more than 50cm urea application was avoided.

Evaluation of Agronomic traits

The data on Plant height, days to 50% flowering, days to maturity, number of panicles/m2, grain yield, grain type and test weight were recorded in accordance with standard Evaluation system. Growth duration was counted from date of sowing to grain maturity. Grain yield was estimated from eight to ten square meter sample plot for each replication.

Screening for submergence and other important adaptability traits

The seed material was raised in raised bed nurseries and 30days old seedlings were submerged in submergence ponds for 15 days. Then the water was drained out plants were kept for recovery. The plants were scored for submergence tolerance and survival per cent was recorded as per standard evaluation system for rice. The genotype was scored for adaptability parameters of elongation ability, kneeing ability, grain shattering and phenotypic acceptability based on SES system.

Results and Discussion

The flood tolerant rice culture was extensively evaluated for yield in semi deep-water ecosystem at RARS, Maruteru over the years of Kharif, 2012 to Kharif,2016 in Station yield trials the culture recorded superior grain yield(4370Kg/ha) against check PLA 1100(3811Kg/ha) and yield advantage over check was 14.67 (Table1)

Table 1: Performance of MTU 1184 in Station trials at RARS, Maruteru

Name of the Trial	Code/IET No	Year of testing	Entry	Check (PLA 1100)	Percentage increase over check	Remarks
			Grain yield (kg/ha)	Grain yield (kg/ha)		
OYTSDW	ADW 59	Kharif2012	5330	4988	6.86	Yield under Water depth 20-50 cm
PYT SDW	BDW 55	Kharif 2013	4105	3878	5.85	
AYT SDW	CDW 69	Kharif2014	3968	3680	7.83	
AYT submergence	CSB 16	Kharif 2016	4077	2697	51.16	Flash floods+ Stagnant flooding 60-65 cm
Mean under stress			4370	3811	14.67	

The culture was tested in AICRIP trials from 2014 to 2017 at RARS, Maruteru and the results revealed that the culture registered 4650Kg/ha and found to be significantly superior over the national check, Sabitha(3703Kg/ha) and the per cent increase over check was 25.62(Table 2)

Table 2: Performance of MTU 1184 (IET 24486) in AICRIP trials at RARS, Maruteru

AICRIP trials						
Name of the Trial	Code/ IET No	Year of testing	Entry MTU 1184	Check (PLA 1100)	Percentage Increase over check	Remarks
			Grain yield (kg/ha)	Grain yield (kg/ha)		
AVT 1 SDW	IET No 24486	Kharif 2016	5994	4185	43.22	4820 kg/ha over all mean across the locations under semi deep-water situation with 22% increase over best check
AVT2 SDW	24486	Kahrif 2017	4881	4295	13.64	Performed well in AP
Mean yield under stress			4650	3703	25.62	Under floods

The entry was tested in AICRIP trials from 2014 to 2017 over all mean performance of the variety in eight locations of six states of Orissa (Bhuvaneswar, Cuttock), Bihar (Pusa) Uttar Pradesh (Ghaghraghat), Assam (Gerua, North Lakhimpur) Karnataka (Sirsi) and Andhra Pradesh (Maruteru) was presented in Table (3). The culture recorded a mean grain yield 4282 Kg/ha and found to be significantly superior over the national check, Sabitha (2790Kg/ha) & yield advantage was 1492 Kg/ha and per cent increase over national check was 53.48 and zonal check Poornendu (1444Kg/ha & 50.88 respectively)

Table 3: Over all Mean Performance of MTU 1184(IET 24486) for Grain Yield (Kg/ha) in AICRIP Trials from 2014-2017

S no	Year of study	Mean performance in Eight locations MTU 1184 (IET 24486)	Sabitha (National Check)	Purnendu (Zonal check)	Yield Advantage over NC	Yield Advantage over ZC	Per cent increase over National check	Percent increase over Zonal check
1	2014	3818	2852	2871	967	947	33.89	32.99
2	2015	4114	2323	2557	1791	1557	77.09	60.89
3	2016	4820	3120	3150	1699	1670	54.46	53.00
4	2017	4376	2863	2771	1513	1605	52.85	57.93
	Over all Mean	4282	2790	2838	1492	1444	53.48	50.88

Multi location testing of the culture from 2015 to 2017 revealed that the variety has out yielded (5370Kg/ha) and found superior over the best check PLA 1100(4290Kg/ha) and the per cent increase over check was 25.18(Table4)

Table 4: Performance of MTU 1184 under Multi location Yield Trials (MLTs)

Name of the Trial	Code/IET No	Year of testing	Entry	Check	Percentage increase over check	Remarks
			Grain yield (kg/ha)	Grain yield (kg/ha)		
MLT- (I year)	L516	Kharif 2015	5376	4531	18.64	Normal condition
MLT (II year)	S32	Kharif 2017	5364	4048	32.51	Normal condition
Mean			5370	4290	25.18	

The culture was given for minikit testing in 890 locations for a period of three years from 2016(245 locations),2017(350 locations) and 2018(295 locations) and the average mean yield of the entry over three years was 6039Kg/ha against local popular check PLA 1100(5700Kg/ha) and per cent increase over check was 6.0 when tested in Andhra Pradesh (Table 5).

Table 5: Compiled performance of three years in minikits

S. No	Year	No. of locations	Average minikit yield (Kg/ha)	Check average yield (Kg/ha)	Average % increase
1	2016	245	6241	5883	6.10
2	2017	350	6154	5814	5.86
3	2018	295	5721	5404	5.86
Average		890	6039	5700	6.00

Reaction of MTU 1184 was tested in AICRIP trials from 2014 to 2017 against major diseases along with disease score was given in Table 6(a) to 6(d). The entry MTU 1184 was tolerant to leaf blast and Bacterial leaf blight which are prominent diseases of rice in Andhra Pradesh and eastern region of India

Table 6(a): Reaction of MTU 1184(IET 24486) to major rice diseases (Kharif 2014)

IET No	Blast	Neck Blast	BLB	Sheath blight	Brown spot	Sheath rot	RTD	Leaf scald	Glume discoloration
MTU 1184 (IET 24486)	4.6	3.6	4.6	6.6	5.8	4.9	6.3	5	7
Sabita (NC)	4.7	6.5	5.7	5.6	5.3	3.9	6.3	3	5
Purnendu (ZC)	5.1	5.0	4.4	5.1	4.6	4.6	6.3	7	7

T**able 6(b):** Reaction of MTU 1184(IET 24486) to major rice diseases (Kharif 2015)

IET No	Blast	BLB	Sheath blight	Brown spot	Sheath rot	RTD	Leaf scald	Glume discoloration	Neck blast
MTU 1184 (IET 24486)	4.8	4.6	5.4	5.3	4.7	3.3	7	5	5.5
Sabita (NC)	5.4	5.6	5.4	5.2	5.1	3.3	5	4.0	5.5
Purnendu (ZC)	5.6	5.6	5.2	5.3	5.6	5.0	5	4.0	6.0

Table 6(c): Reaction of MTU 1184(IET 24486) to major rice diseases (Kharif 2016)

IET No	Blast	Neck Blast	BLB	Sheath blight	Brown spot	Sheath rot	RTD	Leaf scald	Glume discoloration
MTU 1184 (IET 24486)	5.2	4.5	5.6	6.2	5.8	5.7	4.3	9	5
Sabita (NC)	5.4	4.3	6.7	5.5	6.3	6.6	5.0	7	9.0
Purnendu (ZC)	6.0	5.7	5.8	5.7	5.9	4.0	7.0	5	9.0

Table 6(d): Reaction of MTU 1184(IET 24486) to major rice diseases (Kharif 2017)

IET No	Blast	Neck Blast	BLB	Sheath blight	Brown spot	Sheath rot	RTD	Leaf scald	Glume discoloration
MTU1184 (IET 24486)	5.4	3.3	5.4	5.6	6.1	5.6	6.0	9	6.0
Sabita (NC)	6.3	5.5	6.4	5.9	6.8	6.7	5.0	7.0	5.0
Purnendu (ZC)	6.4	5.3	6.3	6.1	6.8	5.4	6.0	7.0	6.0

Reaction of MTU 1184 to major pests along with score was given in Table 7(a) to 7(d). The culture was moderately tolerant to BPH in AICRIP trials when tested during 2014 to 2017 which is a prominent pest of coastal region of India

Table 7(a): Reaction of MTU 1184(IET 24486) to major rice pests, Kharif 2014

	SBDH	SBDH	SBDH	SBDH	SBDH	SBDH	SBDH	LF	LF	LF	LF	LF	WM
	SBP	ADT	RGL	LDN	GGV	SBP	GGT	ADT	LDN	MNC	PDC	RGL	JDP
	50DT	96DT	-	96DT	120DT	Pre-harvest	107DT	48DT	74DT	82DT	30DT	30DT	50DT
	%DH	%WE	%WE	%WE	%WE	%WE	DS	%DL	%DL	%DL	%DL	%DL	%DL
MTU 1184 (IET 24486)	12.8	2.6	3.7	1.8	2.9	4.3	1	2.7	13.6	19.8	3.6	5.5	11
Sabita (NC)	9.9	0.9	1.9	8.8	12.7	1.8	NT	1.4	25.4	11.7	6.2	2.7	13.4
Purnendu (ZC)	8.4	1.7	1.7	1.8	0.0	1.4	5.0	1.6	18.2	24.2	2.9	3.4	12.1

Table 7(b): Reaction of MTU 1184 (IET 24486) to major rice pests, Kharif 2015

	BPH	BPH	WBPH	PH	PH	GMB1	GMB1	GMB4	GMB?	SBDH	SBDH	SBDH	SBDH	LF	LF	LF
	IIRR	LDN	IIRR	GNV*	MTU	IIRR	CHP	RGL	JDP	PUS	GGT	PUS	CHP	GNV	MNC	PUS
	GH	GH	GH	97DT	75DT	GH	50DT	50DT	50DT	71DT	116DT	103DT	Pre-harvest	78DT	50DT	71DT
	DS	DS	DS	DS	DS	%DP	%SS	%DP	%DP	%DH	DS	%WE	% WE	%DL	%DL	%DL
MTU1184 (IET 24486)	9	9	7.6	3	5	IPD	6.3	90	64.6	22.6	NF	9.7	10.9	7.1	8.8	9.3
Sabita (NC)	7.4	9.0	8.4	3.0	7.0	IPD	9.2	0.0	64.5	28.6	NF	9.5	4.5	9.8	1.3	7.4
Purnendu (ZC)	7.7	9.0	8.6	5.0	7.0	IPD	1.2	0.0	62.4	23.8	NF	11.3	8.9	9.3	0.0	12.3

Table 7(c): Reaction of MTU 1184(IET 24486) to major rice pests, Kharif 2016

	BPH	BPH	BPH	BPH	BPH	BPH	BPH	BPH	WBPH	WBPH	WBPH	PH	PH
	IIRR	CBT	MND	PNT	LDN	MND	PNT	GNV	IIRR	GNV	CBT	MTU	GNV
	GH	GH	GH	GH	GH	59DT	60DT	59DT	GH	59DT	GH	100DT	77DT
	DS	DS	DS	DS	DS	DS	No./10h		DS	No./10h	DS	DS	DS
MTU1184 (IET 24486)	5.7	8	9	9	9	9	34	127	8.5	216	6.8	7	3
Sabita (NC)	8.3	6.4	9.0		5.7		31	67	5.8	104	7.4	9.0	1.0
Purnendu (ZC)	5.8	4.1	9.0		8.3		31	43	2.2	78	8.7	7.0	1.0

Table 7(d): Reaction of MTU 1184(IET 24486) to major rice pests, Kharif 2016

	SBWE	SBWE	SBWE	SBWE	SBWE	SBWE	SBWE	LF	LF	LF	LF	WM	WM	RT^
	MNC	LDN	MSD	PNT	RPR	NWG	GGT	LDN	PNT	JDP	NWG	JDP	RNR	JDP
	60DT	Pr.H	90DT	119DT	91DT	78DT	131DT	66DT	88DT	50DT	66DT	50DT	56DT	70DT
	%WE	%WE	%WE	%WE	%WE	%WE	DS	%DL	%DL	%DL	%DL	%DL	%DL	DS
MTU1184 (IET 24486)	18.4	1.9	0	28.1	0	21.4	LF	4.9	3.6	7.3	17.3	10.2	1.6	2.4

Table 7 (e): Reaction of ofMTU 1184(IET 24486to major rice pests, Kharif 2016

	GMB1	GMB1	GMB4	GMB4	GMB4M	GMB5	GMB?
	IIRR	CHP	SKL	RGL	WGL	MNC	JDP
	GH	50DT	50DT	50DT	59-72DT	30DT	50DT
	%DP	%DP	%DP	%DP	%DP	%SS	%DP
MTU 1184 (IET 24486	50	80	25	100	50	9.8	50

Table 7(f): Reaction of MTU 1184(IET 24486) to major rice pests, *Kharif*, 2017

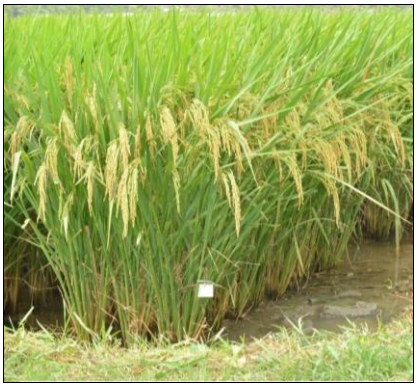
	BPH	BPH	BPH	BPH	WBPH	WBPH	BPH + WBPH	BPH + WBPH	BPH + WBPH	BPH + WBPH	PH
	IIRR	LDN	CBT	KUL	IIRR	CBT	MTU	GNV	GNV	PNT	WGL
	GH	GH	GH	86DT	GH	GH	90DT	90DT	90DT	60DT	58-64DT
	DS	DS	DS	No./10h	DS	DS	DS	DS	No./10h	No./10h	DS
MTU 1184(IET 24486)	9	8.4	8.6	116	9.0	7.5	270	3	128	9	30
Sabita (NC)	8.30	5.40	8.40	136.00	9.00	9.00	1.00	3.00	256.00	138.00	5.00
Purnendu (ZC)	5.80	7.00	7.10	177.00	9.00	6.70	1.00	3.00	219.00	184.00	3.00

	GMB1	GMB1	GMB4	GMB	GMB4M	SBDH	SBDH	SBDH	Sbwe	SBWE	SBWE	SBWE
	IIRR	CHP	SKL	TTB	WGL	PNT	PSA	RGL	RNR	PNT	NWG	PSA
	GH	Mean of 30 & 50DT	50DT	50DT	36-43DT & 56Dt	60DT	36DT	50DT	105DT	115DT	88DT	86DT
	%DP	%DP	%DP	%SS	% DP	%DH	%DH	%DH	%WE	%WE	%WE	%WE
IET 24486	100.00	15.00	100.00	2.11	75.00	28.24	13.75	8.64	5.93	0.00	23.08	NT
Sabita (NC)	100.00	5.00	100.00	1.96	80.00	30.17	7.69	12.50	11.11	0.00	18.18	NT
Purnendu (ZC)	100.00	10.00	100.00	5.26	70.00	22.37	3.03	12.60	11.21	0.00	22.22	13.13

	LF	LF	LF	LF	LF	RT	WM
	LDN	NWG	NWG	PNT	WGL	JDP	JDP
	60DT	40DT	60DT	82DT	58-64DT	70DT	50DT
	%DL	%DL	DS	%DL	% DL	DS	%DL
IET 24486	6.35	24.39	5.00	9.52	2.59	1.80	18.90
Sabita (NC)	9.80	14.71	3.00	7.09	2.87	3.40	15.31
Purnendu (ZC)	9.16	16.36	3.00	8.15	2.12	3.80	10.47

MTU 1184(MTU 20601-1-1-1-1)

Field view at grain filling



Field view at Maturity

Paddy, brown rice and rice kernel after cooking

Plate 1: Field view of MTU 1184 and paddy, brown rice and rice

Conclusion

The performance of the culture in Station Yield trials, AICRIP trials, multi location trials and minikit testing over 890 locations showed that the significant superiority of the variety performance not only in Andhra Pradesh but also in six states of coastal regions of India. It has good adaptability parameters of tillering ability, kneeing ability, elongation ability in deep water conditions, low grain shattering and good phenotypic acceptability. It has dark green foliage possessing long panicles with medium slender brown glume with semi tall plant type of 140-150 cm depending upon water depth. It has good grain quality having translucency with grain length 5.28mm, L/B 2.5, milling 78% and head rice recovery 67% In future, the new flood tolerant rice culture can be utilized for breeding programmes for improvement of tallness with strong stem, submergence tolerance and moderate level of stem elongation ability and kneeing ability.

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