International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 10, 2017, pp.-3993-3996.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

CULTIVATION OF WATER SAVING RICE INDUCED SUBMERGENCE TOLERANCE IN FLOOD PLAIN OF THE RIVER MAHANADI IN EASTERN COASTAL ALLUVIUM

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Received: February 09, 2017; Revised: February 12, 2017; Accepted: February 13, 2017; Published: February 28, 2017

Abstract- Wet season rice sown early by 20 June could out-yield subsequent delayed sowings by 69.18% (5 July) and 290.86% (20 July) under complete submergence. Straw yield also followed the similar trend. Harvest index of early sown rice was significantly superior over the corresponding indices of rice sown by latter two dates. Grain and straw yields were higher in *cv.* Pratikshya than Hybrid Ajay under post-flood agro-ecological situation. Among all treatment combinations, the highest grain yield could be harvested in Pratikshya sown early (20 June) under modified System of Rice Intensification (SRI) whereas Ajay sown late (20 July) under SRI had yielded the lowest grain.

Keywords- Sowing time, Submergence, Flood, Systems of Cultivation, Rice Genotypes.

Citation: Dwibedi Sanat Kumar and Dash Abhiram (2017) Cultivation of Water Saving Rice Induced Submergence Tolerance in Flood Plain of the River Mahanadi in Eastern Coastal Alluvium. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 10, pp.-3993-3996.

Academic Editor / Reviewer: Dr Eleonora Nistor

Introduction

A set of water-saving rice cultivation management practices popularly known as System of Rice Intensification (SRI) has been introduced from Madagascar to many countries including India. It changes in management practices by planting of very young seedlings singly in a square pattern, maintaining non-flooded soil rhizosphere up to panicle initiation through alternate wetting and drying, mechanical weeding, and much stress to organic nutrient and plant protection measures [1]. The benefits of SRI and Modified SRI (MSRI) in terms of water saving, nutrient uptake and productivity compared to the continuous flooded Best Management Practices (BMP) with respect to the production efficiency of water and nutrient in flood, drought and cyclone affected coastal agro-ecological situations under assured irrigation system during wet season are well established [2 and 3]. In this paper the research results of the comparative performance of rice crop genotypes under complete submergence in the flood plain of the river Mahanadi in the coastal alluvium nearby the Bay of Bengal.

Materials and Methods

Experimental site

The present experiment was conducted during *kharif* 2008 at Ranitola village of Tirtol block of Jagatsinghpur district in east and south east coastal plain zone of Odisha, India (86^0 23' E longitude, 20^0 19' N latitude) at 25.6 km air distance from the Bay of Bengal at east and 14.0 m above the mean sea level in warm and moist climate [4] in moderately acidic (5.8 to 6.0) clay loam alluvium with medium availability of N, P_2O_5 [5] and K_2O and high organic carbon (0.81% to 0.89%) and electrical conductivity (0.97 to 0.99 dS m^{-1}). The mean annual rainfall at the site was observed to be 1,333.9 mm and nearly 62.0% of rainfall was being received between June and October (827.0 mm). The monsoon usually sets in around mid June and recedes by first week of October. July and August are wettest months.

Experimental design and treatments

The experiment was originally planned to find out the effects of three dates of sowing and three systems of cultivation of two genotypes of rice for the doctoral programme of the author. The three dates of sowing (main plots) were 20 June, 5 and 20 July; three systems of cultivation (sub plots) of rice were Best Management Practice (BMP), System of Rice Intensification (SRI) and Modified SRI (MSRI); and two medium duration rice genotypes (sub sub plots) i.e. high yielding variety (HYV) 'Pratikshya' (ORS 201-5, IET-15191) and hybrid 'Ajay' (CRHR-7, IET 18166). The experiment was carried out in a split-split plot design with 18 treatment combinations replicated thrice. However, after planting of the two rice genotypes as mentioned above, the crop field was completely submerged under turbid water for about 8 days from 19 September 2008 onwards [Photo-1.c. to 1.f.] due to heavy down pour at the upper catchment area of the mighty river Mahanadi. The agronomic practices thus followed for the management of the crop according to different treatments are explained as follows.

Photo-1.a Satellite-view of the experiment site nearby the river Mahanadi in Tirtol block of Jagatsinghpur district, Odisha, India

Photo-1.b Mr Nityananda Routray, former *Sarpanch* conoweeding in his SRI/MSRI plots before flood

Photo-1.c Flood water overflowing the embankment of the river Mahanadi on 19 September 2008

Photo-1.d The experimental field completely submerged under turbid flood water

Photo-1.e Post-flood comparative view of *cv.* Pratikshya grown under SRI (his left) and BMP (his right) sown by 20 June

Photo-1.f Mr. N. Routray standing in his rice field-plot sown by 20 July under BMP almost completely damaged by flood

Photo-1 Chronological action photos of the experimental field affected by flood water during *kharif* 2008

Agronomic management practices

Seedlings from the raised nursery beds uprooted at 25 days were planted in the main field under BMP @ two seedlings hill^{-1} at 25.0 cm x 12.5 cm spacing in lines. Under SRI and MSRI, seedlings from the raised bamboo beds uprooted at 10 days by scooping the seedlings in bulk at 2 to 3 cm below the nursery bed surface along with the moist mother soil were planted in the main field at 25.0 cm x 25.0 cm spacing @ single seedling hill^{-1} and 25.0 cm x 12.5 cm spacing @ two seedlings hill^{-1}, respectively.

In BMP sub plots, FYM @ 5.0 t ha^{-1} along with total P and 1/3rd of the total recommended dose (100:50:50 kg ha^{-1} of N:P_2O_5:K_2O) of the nitrogenous (N) and potassic (K) fertilizers were applied before final puddling and rest of the N and K fertilizers were applied in two equal halves at 1/3rd at maximum tillering i.e. at 40 days after sowing (DAS) and 1/3rd at panicle initiation stage (70 DAS). However, in SRI and MSRI, FYM @ 15.0 t ha^{-1} along with total P and 1/4th of the total (50:50:50 kg ha^{-1} of N:P_2O_5:K_2O) N and K fertilizers were applied before final puddling. Rest of the N and K fertilizers were applied in three equal splits i.e. 1/4th each at 25, 40 and 70 DAS.

In BMP, three hand weedings at 40, 55 and 70 DAS incorporated the weeds *in situ*. Whereas, in SRI and MSRI four weedings (20, 30, 40 and 50 DAS) were carried out by using conoweeder. In SRI, the weeder was operated in criss-cross manner but in MSRI it was run in east west direction only [Photo-1.b.]

Since after planting, water was allowed to stand in BMP plots by irrigating at alternate days maintaining 5 to 8 cm depth during the entire crop period till 15 days before harvest. While in SRI and MSRI, water was not allowed to stand in the plots rather special care was taken to avoid submergence of 10 days' old tiny seedlings just after planting. However, the soil was kept moist above the field capacity by irrigating the sub sub-plots as per requirement till panicle initiation was attained. After panicle initiation stage, the plots were allowed to hold standing water of 5.0 cm height up to two weeks before harvest.

Prophylactic sprays of neem oil @ 5.0 ml L^{-1} of water, Trichocards with 1,00,000 viable eggs of *Trichogramma japonicum* ha^{-1} and sex pheromone traps @ 20 traps ha^{-1} were used at 15 days intervals (40, 55 and 70 DAS) as prophylactic measure.

Statistical analyses

All the data obtained on grain and straw yield of rice crop was statistically analyzed using F-test [6] for split split-plot design. Least significant difference (LSD) values at p=0.05 were used to determine the significant differences between treatment means.

Results and Discussion

Grain yield

The grain yield of rice was influenced significantly due to difference in sowing dates [Table-1] and [Fig-1]. Early sowing (20 June) was the most promising in recording significantly the highest grain yield of 1.411 t ha^{-1} that provided an additional yield of 0.577 t ha^{-1} (40.89% more) over 5 July sowing. Sowing by 5 July

had the advantage of producing significantly higher grain yield (0.834 t ha^{-1}) than that of the delayed sowing by 15 days causing saving of 0.473 t ha^{-1} yield. Thus there was reduction of grain yield to the tune of 0.0315 t ha^{-1} d^{-1} due to delay in sowing time beyond 5 July. The lowest yield of 0.606 t ha^{-1} was in BMP and on the contrary, the highest yield of 1.05 t ha^{-1} was in MSRI. SRI produced grains at par with latter one but 56.6% (0.343 t ha^{-1}) more than BMP. Grain yield production was significantly influenced by genotypes. The HYV Pratikshya produced 0.973 t ha^{-1} (27.36%) more grains than Hybrid Ajay.

Table-1 *Effect of treatments on grain and straw yield, grain-straw ratio and harvest index of rice during kharif 2008*

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Grain straw ratio	Harvest index (%)
Dates of sowing of rice				
20 June	1.411a	2.136a	0.654a	39.403b
5 July	0.834b	1.406b	0.609ab	37.151a*
20 July	0.361c	0.604c	0.584b	36.538a
S.Em (±)	0.031	0.023	0.017	0.679
C.D. (0.05)	0.100	0.074	0.054	2.214
C.V. (%)	21.26	9.87	16.23	10.80
Systems of cultivation of rice				
BMP	0.606b	1.203a*	0.498b	33.012b
SRI	0.949a*	1.345a	0.695a*	40.936a*
MSRI	1.050a	1.598b	0.653a	39.144a
S.Em (±)	0.053	0.064	0.021	0.916
C.D. (0.05)	0.154	0.185	0.061	2.674
C.V. (%)	36.51	27.57	20.48	14.58
Genotypes of rice				
Pratikshya	0.973a	1.590a	0.606	37.282b
Ajay	0.764b	1.174b	0.625	38.113a
S.Em (±)	0.030	0.048	0.007	0.272
C.D. (0.05)	0.087	0.139	NS	0.781
CV%	25.73	25.72	7.81	5.30

* Means followed by common letters did not differ significantly up to 5% level.

Table-2 *Three way table sowing effect of treatments on grain yield (t ha^{-1}) of rice during kharif 2008 influenced under complete submergence for a week.*

Treatments		Dates of sowing of rice											
		20 June				5 July				20 July			
		Systems of cultivation of rice				Systems of cultivation of rice				Systems of cultivation of rice			
		BMP	SRI	MSRI	Mean	BMP	SRI	MSRI	Mean	BMP	SRI	MSRI	Mean
Genotype	Pratikshya	1.256	1.728	1.824	1.603	0.625	1.004	1.122	0.917	0.225	0.473	0.505	0.401
	Ajay	0.826	1.340	1.490	1.219	0.501	0.800	0.949	0.750	0.206	0.350	0.410	0.322
	Mean	1.041	1.534	1.657		0.563	0.902	1.036		0.216	0.411	0.457	
S.Em (±) for genotypes at same combination of dates of sowing and systems = 0.027													
CD at 0.05 for genotypes at same combination of dates of sowing and systems = 0.078													
S.Em (±) for systems at same combination of dates of sowing and genotypes = 0.112													
C.D. (0.05) for systems at same combination of dates of sowing and genotypes = 0.325													
S.Em (±) for dates of sowing at same combination of systems and genotypes = 0.103													
C.D. (0.05) for dates of sowing at same combination of systems and genotypes = 0.303													

However, deep analysis of the three way table [Table-2] for grain yield revealed significant superiority of early sown HYV Pratikshya grown under MSRI (1.824 t ha^{-1}) over all other treatment combinations except under SRI (1.728 t ha^{-1}). Such superiority in grain yield could be due to positive and significant correlation between the yield attributing characters in Pratikshya in spite of complete submergence under flood water. The crop sown by 20 June had attained about 90 days at the time of submergence on 19 September and it had surpassed the maximum vegetative stage, panicle initiation, flowering and fertilization. Whereas, the crop sown at 15 days latter might not have completed the initial developmental phases and thus there was severe reduction in the grain yield. The drastic reduction in the grain yield in the crop sown by last date was mostly due to strand mortality resulting in reduced plant population and subsequent regeneration at a slower pace.

Poor yield performance under BMP irrespective of dates of sowing and genotypes could possibly be due to the inability of the rice plants to survive under complete submergence and also its failure to regenerate further under changing post-flood agro-ecological situations. Higher percentage of tiller mortality either reduced tillers hill^{-1} or entire hill was degenerated that ultimately resulted in drastic negative effect on the grain yield.

However, the lowest grain yield was recorded with sowing of Hybrid Ajay under BMP by 20 July (0.206 t ha^{-1}) which however was statistically similar with *cv.* Pratikshya only under same treatment combination.

Straw yield

Straw yield [Table-1] and [Fig-1] was significantly influenced due to various sowing dates. Early sowing (20 June) produced significantly the highest straw yield among there sowing dates whereas 20 July sowing could produce the lowest straw yield. Among the systems, MSRI recorded significantly the highest straw yield. This was succeeded by SRI and BMP with descending order without significant difference. Genotypes had significant difference in straw yield. *Cv.*

Pratikshya produced straw yield of 0.416 t ha^{-1} (35.43%) more than Ajay.

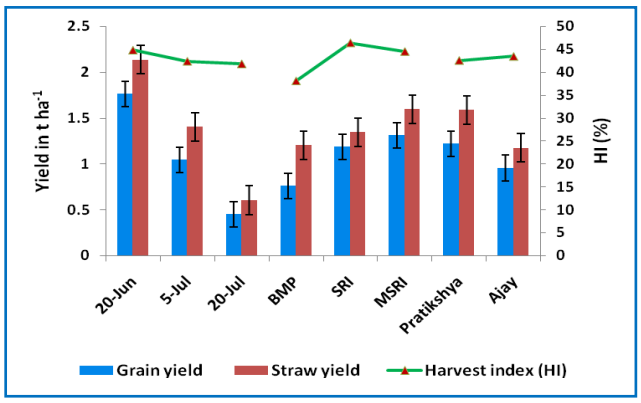

Fig-1 Effect of treatments on grain yield, straw yield and harvest index of rice

Harvest Index

Among three dates of sowing, harvest index (HI) was the highest in 20 June sown crop [Table-1] and [Fig-1]. In MSRI and SRI, the indices were statistically at par but significantly higher than BMP. In spite complete submergence resulting in significantly lower grain yield Hybrid Ajay could show significantly higher HI than *cv.* Pratikshya. This could be ascribed to genetic potential of this hybrid over its onsite competitor.

Conclusion

From the above experiment of submergence by natural flood water for a week it is quite evident that earlier sowing under MSRI system of cultivation of rice genotype *cv.* Pratikshya could out yield other treatments. Pratikshya could sustain submergence better than Hybrid Ajay under different treatment combinations. Hence, it may be considered as an initial approach for inviting further refinements and validation in the flood prone coastal alluvium soil of India in future.

Acknowledgements

The technical and informative supports of National Rice Research Institute (NRRI), Cuttack and Krishi Vigyan Kendra (KVK), Jagatsinghpur for conducting such nature-supported research in coastal flood plain are highly acknowledged. Never the less the dedicated, selfless, inquisitive and innovative endeavour of Mr. Nityananda Routray, former *Sarpanch* devoting his own farmland for taking up such problem-based research is quite praiseworthy. This research was originally planned for the doctoral dissertation of the first author with self financial support.

Conflict of Interest: None declared

References

[1] Uphoff Norman (2003) *International Journal of Agricultural Sustainability,* 1(13), 38-50.
[2] Dwibedi S. K., De G. C. and Dhua S. R. (2016) *Journal of Crop and Weed,* 12(1), 107-111.
[3] Dwibedi S. K., De G. C. and Dhua S. R. (2017) *Environment & Ecology,* 35(1), 35-39.
[4] Lenka D. (1976) Classification of rainfall zones and drought prone areas, (*In*) water management of crops in Orissa. Directorate of Agriculture, Government of Orissa. pp. 4-5.
[5] Bray R. H. and Kurtz L. T. (1945) *Soil Science,* 59, 39-45.
[6] Gomez K. A. and Gomez A.A. (1984) Statistical Procedures for Agricultural Research. New York, NY: A Wiley-Inter-science Publication/John Wiley and Sons Inc.