ISSN: 2347-4688, Vol. 8, No.(1) 2020, pg. 39-45

Current Agriculture Research Journal

www.agriculturejournal.org

Evaluation of Excess Water Tolerant Rice Varieties *Swarna Sub-1* and *CR-1009 Sub -1* under Head to Head Project in East and South- Eastern Coastal Plain Zone of Odisha

S. R. DASH[1]*, B.K. ROUTRAY[2], S. K. MOHANTY[3] and N. BEHERA[1]

[1]Krishi Vigyan Kendra, Malkangiri, OUAT, Odisha, Bhubaneswar.
[2]Krishi Vigyan Kendra, Jagatsinghpur, OUAT, Odisha, Bhubaneswar.
[3]Krishi Vigyan Kendra, Puri, OUAT, Odisha, Bhubaneswar.

Abstract

Flash flood or submergence is a common phenomenon in rice growing rainfed lowland areas that seriously affects crop establishment leading to severe yield losses. A few submergence–tolerant rice varieties have been developed by introgression SUB-1 gene into mega rice varieties of South Asia. Performance of this variety can be further enhanced through adoption of appropriate management practices. Farners Participatorty trials were conducted using Swarna- sub-1 and CR 1009 sub-1 during kharif, 2017 in three adopted villages at Erasama, Kujanga and Raghunathapur blocks of Jagatsinghpur district. Results of this experiment revealed that at recommended doses of N:P:K @ 80-40-40 Kgha^{-1}, transplanting of 30 days aged seedlings and additional N-dose of 20kg/ha at 7 days after receding of flood water resulted in better post submergence recovery and maximum yield. Maximum number of tillers m^{-2} was recorded in CR 1009 sub-1 followed by Pooja and Swana Sub-1. Rice variety Swarna Sub–I rerecorded an yield of 55.23 q ha^{-1} which was 14.5% higher as compared to farmers variety Swrana 48.2 q ha^{-1}. The Swarna Sub-1 and CR 1009 sub-1 survived in the flood and gave higher yield under submergence condition in the coastal flood prone area.

Article History

Received: 4 December 2019
Accepted: 24 March 2020

Keywords

Nursery Management;
Post Flood Management;
Survival;
Submergence;
Stress Tolerance Rice.

Introduction

Rice (*Oryza sativa* L.) is one of the most imporatnat crop in the world and is the foremost staple foods in Asia, providing 35-60% of the diettary calories consumed by nearly three billion pepole.[9] Rice is the staple food fror more than half of the World's population, especially those living in developing countries. In rain fed low lands, rice production

CONTACT S. R. Dash samirdash2007@rediffmail.com Krishi Vigyan Kendra, Malkangiri, OUAT, Odisha, Bhubaneswar.

Doi: 10.12944/CARJ.8.1.07

is severely affected because the crop at different growth satges often suffers from various abiotic stresses like submeregence, drought, flood and salinity. In recent years these problems have got aggravated due to erratic rainfall distributioun and rise in sea levels under the influence of global climate change. Submergence has been identified as the third most important constraint for higher productivityof rice particularly in Eastren India.[5] About 29% of India's total rice area16.1 million hectare (M ha) is rainfed low land, which contributes 19% to national rice production. Rice is the major crop in most flood- prone areas of South and South-East Asia. Flash flood or submergence is a common phenomenon in lowland areas, subject to monsoon rains, seriously affecting crop establishment as well as survival and leading to severe yield losses. It imposes a complex abiotic stress in flood-prone ecosystem, because it's substantially reduces crop stand, especially if it occurs during early vegetative stage and prolongs for more than a week. Rice is grown in varied ecologies from uplands to deepwater areas of about 44 M ha of cultivated rice in India, about 16.1 M ha is rain fed lowland, of which 4.4 M ha are highly submergence-prone intermediate rainfed lowlands[10] In addition, and submergence might also occur in shallow rain fed lowlands and irrigated lowlands. In Odisha about 40 lakh ha area covered under rice crop which occupies about 24 % of gross cropped area of the country and basically the coastal plains are major dominant in rice production of the state but are more prone to flash and heavy flood.

The world currently faces a major food security challenge to which crop genetic improvements can make significant contribution. According to the FAO, world food production needs to increase by 70% by the year 2050 in order to meet growing demand. Since rice is one of the world's three main staple foods, a productivity gain in rice is essential to achieve this goal, especially for Asia where there is no room for land expansion. Major gain in productivity was achieved in the 1970's with Green Revolution technologies targeted at the better-endowed areas under irrigation. But the challenging issue is that maximum yields achieved in the better-endowed areas have stagnated at around 11 t ha^{-1}, with little prospects for significant improvements and Green Revolution has remained elusive for rainfed areas, particularly those affected by flash flooding and drought.[11]

The introduction of the SUB-1 locus into Swarna (MTU-7029) India's most popular rice variety resulting Swarna-Sub1 (IR05F102) which maintains all the properties of Swarna and acquiring submergence tolerance.[12] An MAS (Marker Assisted Selection) approach was used to introgression the SUB-1 locus into Swarna, It has been shown to withstand floods of up to 17 days.[4] of the country's 44 M ha area of rice, rain fed lowlands where flash flooding is common and Sub1 varieties found beneficial accounting for approximately 12 M ha, or 30 % of the cultivated rice area. Swarna-Sub1 rice is genetically identical to Swarna except for the presence of a gene increasing flood tolerance. Another variety CR 1009 sub-1 is an improved version of CR 1009 with Sub-1 gene conferring submergence tolerance at seedling level for 15 days immediately after transplantation and the work was undertaken at International Rice Research Institute (IRRI), Philippines. This variety has given a mean grain yield of 5759 kg ha^{-1}, in 155 days with moderate resistance to brown spot, blast, brown plant hopper (BPH) and white backed plant hopper (WBPH). The CR 1009 sub-1 possesses short bold rice with high milling percentage and head rice recovery. Rice contains high amylose with intermediate gelatinization temperature and soft gel consistency, which is suitable for idly making and this variety is recommended as an alternate to CR 1009.

The district, Jagatsinghpur is one of the natural calamities prone areas particularly in the months of September to November resulting in varying degrees of damage of wet season's rice and other field crops. The district lies in the agro-climatic zone of east and south east coastal plain zone of Odisha extending from 20-21^0 North latitude to 84-87^0 East longitude. The district Jagatsinghpucr is a cyclone prone area of the coastal region and flood and cyclone occurance is the main threat to the rice growers in kharif season. The Average Normal Rainfall of this district is 1521.16 mm and more than 75% of the precipitation is received over five months i.e. June-October. It is a cyclone prone district of the coastal region, flood and cyclone occurance is the main threat to the rice growers in kharif season.

In such unpredictable, adverse situation (particularly on stagnant water condition), the growing of submergence tolerant rice varieties is the objective of producing higher yield and income, particularly for small and marginal farmer. Paddy is a major crop in the district and is cultivated in 90, 172 ha out of which 6745 ha is high land paddy, 37572 ha is medium land and 45,855 ha, is low land paddy (Fig.1).

Rice is the major crop grown in kharif season but due to occurrence submergence, flood and cyclone, farmers are getting less production in rice. (Fig. 2).

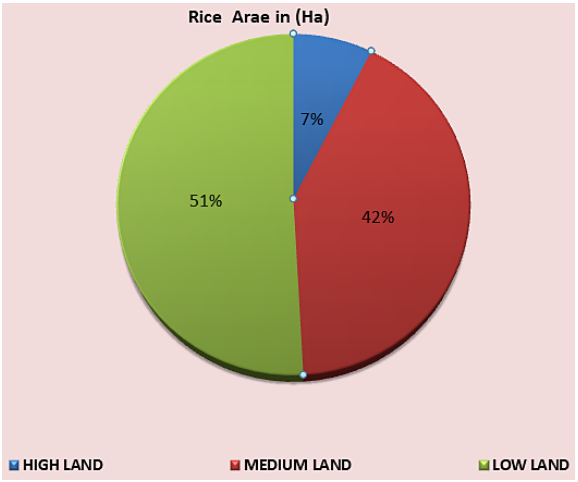

Fig.1: Area(in ha) under Rice cultivation in Jagatsinghpur district

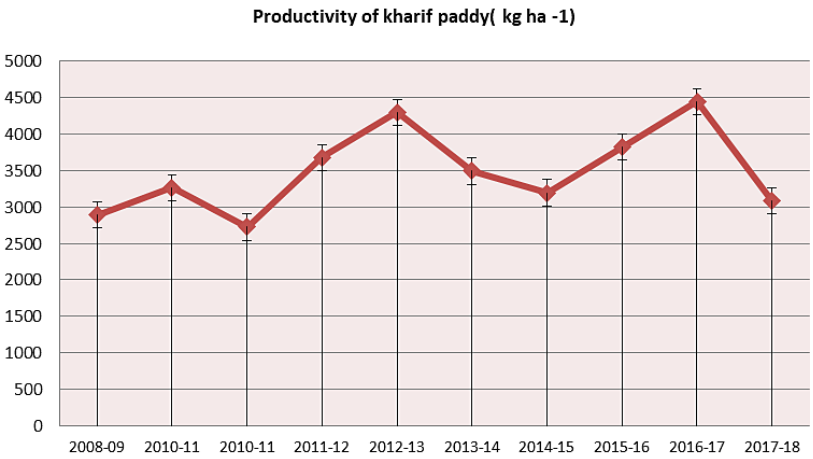

Fig. 2: Paddy Productivity trend analysis of district Jagatsinghpur

Swarna, Pooja CR -1018. Sarala and Ranidhan are the major preferred varieties of this district grown by majority of the farmers in low land and shallow low land rice eco-system. Every year flood comes to various intensities in the area and damage the rice crop to different.[6] The fields become gappy, which results in production losses. Farmers are growing Swarna, Sarala Pooja and CR 1009 in the shallow low land situation but susceptibility of Swarna to sheath blight and sheath rot, coarse grain of CR-1009 and incidence of false smut in Pooja are the matter of concern and crop loss occurs due

to water submergence situation. There is an ample scope for varietal substitution in rice suitable to the low land rice ecosystem and to combat the threats of climate change.[2]

The present investigation was under taken with the objectives for assessing the performance of rice variety Swarna sub-1 against Swarna and CR 1009 sub-1 against Pooja in coastal plain zone of Jagtsinghpur district with respect to its yield potential and other yield attributing parameters of these varieties

Materials and Methods

The field experiments were carried out during Kharif season in the year 2017 under the Head to Head trials in collaboration with IRRI, Phillipines programme in the district covering three villages like Darijanga of Erasama block, Chardia of Kujanga block and Gamhapur of Raghunathapur block. These villages were selected purposefully as most of the areas are prone to submergence in kharif from September to October month.

The nursery was raised in the month of July and the healthy rice seedlings of 25-30 days old were transplanted in August. Crop management practices for this trials was followed as per recommendation i.e. certified seeds were used @50kg ha^{-1} , the seeds were treated with Captan @3 gm kg^{-1} of seed, Seedling treatment was done with Chloropyriphos@1ml/1lt of water, for weed management farmers used weedicides Pretilachlor @ 1.51ha^{-1}, some farmers done manual weeding by using mandwa weeder. Soil samples were collected prior to the start of experimentation and analyzed using standard protocols .Farmers used recommended dose of fertilizer N: P: K @ 80- 40-40 kg ha^{-1} with 5t FYM ha^{-1}.

The farmers involved in field experiments were facilitated by KVK scientists in performing proper field operations like timely sowing of nursery transplanting, spraying and harvesting. During this period extension activities like field days, farmers' trainings, diagnostic visits, etc. were undertaken which benefitted the farmers. Data on crop yield were recorded by per square meter observation method randomly from 3 to 4 places with in experimental plot. The yield data were collected from both the demonstrations and farmers' fields and analyzed using simple statistical tools.

Results and Discussions

Soil Nutrient Status of the Trial Plots

A total of 96 trials were conducted in farmers field in kharif-2017. Seeds of different varieties were supplied by IRRI, Phllipines and other critical inputs were provided by the farmers themselves. Soil status of the cluster villages is given in the table-2.

Table 2: The soil nutrient status of the experimental plots

Soil test Parameters	Erasama	Kujanga	Raghunatahpur
pH	6.56	6.25	6.1
EC (dS m^{-1})	0.68	0.81	0.72
Available N (Kg ha^{-1})	342.00	31o.00	345.00
Available P_2O_5 (Kg ha^{-1})	49.00	38.00	41.00
Available K_2O (Kg ha^{-1})	360.00	325.00	256.00
Organic carbon (%)	0.67	0.65	0.75

Grain Yield and Economics

The Swarna Sub-1 with local variety Swarana and CR 1009 sub-1 with farmers variety Pooja were compared under farmers field (medium to shallow low and i.e. water depth up to 30 cm. During the crop season of 2017, there was a flood in last week August and devastated the rice crop in the study area. Because of heavy rainfall with its uneven distribution, the crop between the age of 2 to 3 months experienced natural submergence twice in September (40 - 50 cm depth of water for 6 days) and (30 - 40 cm depth of water for 4 days), water was not released from the field and it kept continues up to 15 days. The date of sowing of the crop in the

nursery was second week of July and the date of harvest of the crop field was last week of December to first week of January. The data presented in table 2 indicated that Swarna Sub-1 and CR 1009 sub-1 well survived in the flood and the yield was recorded as 55. 23 and 54.8 q ha $^{-1}$, respectively. These findings tally with the other study[7]

Table 2: Yield and yield attributes of rice under experimental plots

Sl no	Parameters	SWARNA (local check) (Improved variety)	SWARNA SUB-1)	POOJA (local check) (Improved variety)	CR-1009 SUB -1
1	Ear bearing tillers (EBT) (no /m2)	324	365	388	400
2	Plant height(cm)	90-102	95-103	101-108	98-107
3	Incidence of pest and disease				
	I)Nursery stage	No	No	No	No
	II)Active tillering stage	Sheath blight	Sheath blight	Stem borer and leaf folder	Leaf spot, Stem borer and leaf folder
	III)Panicle initiation stage	Stem borer and leaf folder	Stem borer and leaf folder	False smut	Stem borer
4	Days to maturity	140	143	150	155
5	No of panicles per meter square at harvest	323	364	385	397
6	Fertile Grains per panicle	145	168	170	182
7	Fertility %age				
	I)No of filled grains	85.4	89.2	94.3	90.8
	ii)No of unfilled grains	14.6	10.8	5.7	9.2
8	Crop Cutting results (5m x5m) in Kg.	12	13.8	13.5	13.9
9	Yield (q / ha)	48.2	55.23	53.4	54.8
10	Lodging and survivability mergence for 14-15 days of crop under sub at vegetative stage	Swarna 80–90% exhibited lodging.	Swarna SUB no lodging -1 exhibited but under submergence condition it survives.	Pooja 70–80% exhibited lodging.	CR 1009 SUB -1 exhibited no lodging and survived under sub mergence c ondition up to 14-15 days

On an overall Swarna Sub-1 and CR 1009 sub-1 were identified to be the best as compare to local farmers preferred rice varieties. Maximum number of tillers m^{-2} was recorded in CR 1009 sub-1 followed by Pooja and Swana Sub-1. Similar findings have been reported by another study.[8] The fertile grains per panicle was also recorded the highest in CR 1009- sub-1 followed by Pooja and Swarna Su–1. Swarna sub-1 and CR 1009 Sub-1 exhibited no logging and survived under sub mergence condition up to 14-15 days.

As per the field observations, incidence of false smut in Pooja was the main constraints perceived by the farmers (Table 2).

The economic impact study (Table 3) indicated that Swarna sub^{-1} showed Gross return, of Rs. Rs 85600

ha^{-1}, net return of Rs 45600 ha^{-1}, with B : C ratio of 2.14. while farmers variety Swarna gave the gross return of Rs 74710 ha^{-1}, net return of Rs 36210 ha^{-1} and had benefit cost ratio of 1.94. Similarly in case of CR 1009 sub^{-1}, the B:C was 2.13 as compared to Pooja 2.11. The results revealed that the farmers could be able to get an additional net return of Rs 9000 ha^{-1}, in case of Swarna sub^{-1} of Rs 1000 ha^{-1}. The results of the present study are in line with the findings of another investigation.[7] In addition, Swarna sub^{-1} was very similar to Swarna, which is already popular among rice farmers in India, so switching to Swarna sub^{-1}, does not require significant changes in behavior for improving smallholder farmers' resilience to climate change. The findings are in conformity with the findings of other study1.

Table 3: Economics of the rice varieties Swarna Sub-1and CR 1009 sub-1 in comparison to farmer's practice

Variety	Seed yield ($kgha^{-1}$)	Gross cost ($Rs.ha^{-1}$)	Gross returns ($Rs.ha^{-1}$)	Net returns ($Rs.ha^{-1}$)	Benefit cost ratio
Swarna Sub-1	55.23	40000	85600	45600	2.14
Swarna	48.2	38500	74710	36210	1.94
CR 1009 Sub -1	54.8	40200	84940	44740	2.13
Pooja	53.4	38500	82270	43770	2.11

Conclusion

On the basis of present findings it can be concluded that the stress tolerant rice varieties Swarna sub-1performed well under submergence condition in coastal district of Odisha. Adoption of this variety will substantially increase rice production in the country thereby benefiting thousands of the poor farmers inhabiting such rainfed lowlands areas. Rice variety Swarna sub-11 had recorded positive effect on rice yields (relative to non-tolerant varieties) when fields were submerged for as long as 7–14 days and thereby improving the livelihood of the poor farmers of rainfed lowland region prone to flash flooding and submergence condition.

Acknowledgements

We are grateful to International Rice research Institute, Philippines and Odisha University of Agriculture and Technology for their co operation and timely providing the critical inputs and need based technical support for carrying out this experiment in farmers field .

Funding

Odisha University of Agriculture and Technology, Bhubaneswar and International Rice Research Institute, Philippines.

Conflict of Interest

The authors do not have any conflict of interest.

References

1. Arora, A. Bansal, S, and Patrick, S. Ward Do farmers value rice varieties tolerant to droughts andfloods?Evidence from a discrete choice experiment in Odisha, India, *Water resource Economics,* 2019: 25: 27-41
2. Mackill, D.J., Ismail, A.M., Singh, U.S., Labios, R.V and Paris, T.R.: Development and rapid adoption of submergence tolerant (Sub1) rice varieties. *Advances in Agronomy:* (2012) 115:303–356
3. Emerick, K., Janvry, De A, Sadoulet. E. and Dar, M.,: Technological Innovations, Downside

Risk, and the Modernization of Agriculture; Flood-tolerant rice reduces yield variability and raises expected yield, differentially benefiting socially disadvantaged groups, *American Economic Review*, : 2016. : 106 (6), 1537-1561.

4. Varshney R. K.and Tuberosa, R., Eds., Genomics-Assisted Crop Improvement: An overview: *Abiotic Stress, Yield and Quality*, 1st Edition, John Wiley and Sons, New York, 2013: 1-12
5. Hossain, M.and Laborte, A. : Differential growth in rice production in eastern India;agroecological and socioeconomic constraints. In Physiology of Stress Tolerance Rice, NDUAT and IRRI, Los Banos, The Philippines, 1996: 221-239.
6. Sarkar, R. K., Reddy, J. N., Sharma,S. G. and Ismail A. M.. "Physiological Basis of Submergence Tolerance in Rice and Implications for Crop Improvement," *Current Science,* 2006: (91): 899-906.
7. Pandey, S. K. ,Tiwari, D. K., Singh, S. and Singh. P.: Promotion of Long Duration Rice Variety Swarna sub-1 through Frontline Demonstrations in Chandauli District of Uttar Pradesh. *Int. J. Curr. Microbiol. App. Sci.* 2018: 7(05): 2870-2874.
8. Sarkar, R. K., Panda, D. , Reddy, J. N., Patnaik S. S. C., Mackil, l D. .J and Ismail, A. M. : Performance of submergence tolerant rice (*Oryza sativa*) genotypes carrying the Sub 1 quantitative trait locus under stressed and non-stressed natural field conditions, *Indian Journal of Agricultural Sciences*. 2009: 79 (11): 876–83.
9. Fageria, N. K., N. A. Slaton, and V. C. Baligar.. Nutrient management for improving lowland rice productivity and sustainability. *Advances in Agronomy*, 2003: (16):80:63–152.
10. Haefele,S.M. and Hijmans,R..J., Soil quality in rice-based rainfed lowlands of Asia: characterization and distribution Proceedings of the 26th *International Rice Research Conference*: Science, technology, and trade for peace and prosperity, 2007.
11. Das, K.K., Panda D., Sarkar R.K., Reddy J.N., Ismail A.M. : Submergence tolerance in relation to variable floodwater conditions in rice, *Environmental and Experimental Botany,* 2009: 66:3: 425-434.
12. Septiningsih, E. M. , Bertrand C. Y., Collard, B.C. Y., Heuer, S., Serres B, J., Ismail, A. M. and. Mackill D. J.: "Applying Genomics Tools for Breeding Submergence Tolerance in Rice," 2013, *Translational Genomics for Crop Breeding*, Volume II: Abiotic Stress, Yield and Quality. John Wiley & Sons, Inc.: 9-30.