Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5434

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (4):** 629-634 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Prospects of Alternate Wetting and Drying (AWD) Methodology of Irrigation through System Intensification on Productivity of Summer Transplanted Rice (*Oryza sativa* L.)

Dibyendu Mondal*, Anannya Ghosh, Diana Shamurailatpam, Soumen Bera, Pintoo Bandopadhyay and Ratikanta Ghosh

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, West Bengal, India

*Corresponding Author E-mail: dibyendumondal.agri@yahoo.com

Received: 13.08.2017 | Revised: 21.08.2017 | Accepted: 22.08.2017

ABSTRACT

The System of Rice Intensification (SRI) shows promise for substantially raising rice productivity besides offering savings of major inputs viz. water, seed, labour and increasing soil health status. Field experiment was conducted at the Viswavidyalaya farm, Mohanpur during summer 2014-15 and 2015-16 on water management in transplanted puddle rice cv. IET 4786 to find out the advantages of SRI over TTR (Traditional transplanted rice) in respect to water saving and rice productivity. Four treatments viz. T_1- FCP (Farmers' common practices: 3-5 cm of standing water throughout the crop cycle), T_2- Only 2-3 cm WS (2-3 cm of standing water throughout the crop cycle), T_3- HC (Irrigation at soil hair crake stage) and T_4- AWD (Irrigation at soil hair crake stage during vegetative phase + 2-3 cm of standing water at active tillering, panicle initiation and flowering stage only) were used in randomised block design replicated six times. The results revealed that average yield increase in 2015-16 than 2014-15 was 2.56 %. Irrigation through AWD methodology resulted 32.78 % water savings in comparison to FCP. The other two treatments, irrigation at hair crack stages and only 2-3 cm WS showed 53.90 and 21.23 % water saving over farmers' common practice respectively. For producing one kg of rice the water requirement in AWD, HC and only 2-3 cm WS was 1217, 1037 and 1580 litre respectively, which was lower than of FCP (1891 litre). Therefore it could be concluded that in SRI irrigating through AWD methodology showed 33 % water saving and an average of 7.62 % productivity increase in comparison to FCP in traditional transplanted rice cultivation.

Key words: *System of rice intensification; alternate wetting and drying (AWD); water saving %; rice productivity.*

INTRODUCTION

The System of Rice Intensification (SRI) shows promising results for substantially raising rice productivity by using farmers' improved thinking and practice with resources what farmers already have, besides offer to the increase in soil and plant health, saving natural resources and lowering GHG emission[1,2].

Cite this article: Mondal, D., Ghosh, A., Shamurailatpam, D., Bera, S., Bandopadhyay, P. and Ghosh, R., Prospects of Alternate Wetting and Drying (AWD) Methodology of Irrigation through System Intensification on Productivity of Summer Transplanted Rice (*Oryza sativa* L.), *Int. J. Pure App. Biosci.* **5(4):** 629-634 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5434

Rice occupies an area of about 44 m ha in the country with an average production of 90 m t and productivity of 2.2 t ha^{-1}. India's population will be about 1,546 million by the end of 2030 according to the projections made by the Population Foundation of India and it is estimated that the demand for rice will be 121.2 m t [3]. The productivity of rice has to be increased to the level of 3.3 t ha^{-1} from present level (2.2 t ha^{-1}) to achieve the estimated target[4]. With the richest reservoir of rice bio-diversity West Bengal is known as the rice bowl of the country[5]. In West Bengal during 2007-08 rice occupied almost 53% of the total agricultural crop areas of the state and it contributed the same i.e., 53% towards the total production of all agricultural crops. Cultivation of rice is a very water intensive activity in the agricultural sector as it requires about 3,000–5,000 litres of water for producing one kg rice depending on the different rice cultivation methods such as traditional transplanted rice (TTR), direct-seeded rice (DSR) and alternate wetting and drying (AWD) etc. It is estimated that by 2025, 15-20 m ha of irrigated rice will suffer some degree of water scarcity[6]. As the sector itself is under pressure to reduce water consumption due to the increasing water scarcity, a shifting trend towards less-water demanding crops against rice is noticed in most of the parts in India and this warrants alternate methods of rice cultivation that aims at minimal use of water without affecting its productivity. Evidences are there that the rice cultivation through system of rice intensification (SRI) methodology can increase its yield by 2 to 3 fold comparing to the current yield standard[7]. By facing the gradual decrease in land holdings (in 2030, estimated world area will be 0.17 ha and in India 0.32 ha $person^{-1}$), water crisis (15-20 m ha land will have no irrigation), decrease in soil health and ill effects in the environment (irrigated rice is one of the major sources of methane which is produced by soil organisms mainly methanogens that live under anaerobic conditions), causing adverse impacts on climate change (increase in temperature of about 1.8- 4.0°C and an increasing number of extreme weather events), it needs more challenge in India as productivity of most crops is below than the world average. System of Rice Intensification (SRI) proved better for sustainable productivity in rice throughout the world but it needs research proof in different agro-ecosystems to find out the proper reasons and concepts (12-15 days seedling can give more tillers[8]; balance nutrition helps to convert amino acid to more protein and thereby reducing the surplus sugar and finally insect pest or pathogen attack[9]; alternate wetting and drying helps to save water without productivity loss[10]; botanical pesticides coming up as an alternate of hand weeding[11]; reduces the GHG like N_2O, CH_4 etc.[12] by more mineralization of nitrogen) and ultimately increase the rice productivity in a sustainable way. In light of the above mentioned point regarding water management, it is highly needed to find out the actual amount of water saving in SRI over TTR and the yield performances of the rice in these methodologies in the Gangetic inceptisol.

MATERIALS AND METHODS

The experiment was conducted at the Viswavidyalaya farm, Mohanpur, Nadia, West Bengal during summer 2014-15 and 2015-16 on water management in transplanted puddle rice cv. IET 4786 with four treatments i.e., T_1- FCP (Farmers' common practices: 3-5 cm of standing water throughout the crop cycle), T_2- Only 2-3 cm WS (2-3 cm of standing water throughout the crop cycle), T_3- HC (Irrigation at soil hair crake stages only) and T_4- AWD (Irrigation at soil hair crake stage during vegetative phase + 2-3 cm of standing water at active tillering, panicle initiation and flowering stages only) were studies in randomized block design replicated six times. Data were analyzed using analysis of variance (ANOVA) to evaluate the differences among treatments while the means were separated using the least significant difference (LSD) test at the 5% level of significance. Organic manure through neem cake @ 4 t ha^{-1} was applied in each plot as basal along with full P_2O_5 and 25% K_2O in the form of SSP and MOP, respectively. No Nitrogen was applied as basal instead 25 % N in the form of Urea was applied at 10 DAT. Rest of nitrogen (75%) and potash (75%) was applied in the form of Urea and MOP in 3 equal splits (active tillering, panicle initiation and flowering). The rice seedlings were transplanted with a spacing of 20 cm (P-P) and 25 cm (R-R) taking care against the root damages of the seedlings. The crop was planted following integrated plant protection measures by using annual planning of weed management and ecosafe pest management during the critical pest infestation period by using safer pesticides. The irrigation water was applied through lined channel using "V" notch as per the treatments. The effects on water saving along with the major plant growth and yield parameters including the biological yield were recorded.

RESULTS AND DISCUSSION

Results revealed that among the major yield attributes (Table 2), maximum number of panicles plant^{-1} (28.8 plant^{-1}) and number of grains panicle^{-1} (183.6 panicle^{-1}) was recorded from SRI alternate wetting and drying (AWD) plots. In SRI AWD (water is used as 2-3 cm at active tillering, panicle initiation and flowering stages + HC), both grain and straw (biological) yield was observed maximum in comparison to all other treatments. This may be due to higher growth and yield attributes obtained in that treatment (Table 2). The grain yield data also revealed that SRI alternate wetting and drying (AWD) methodology recorded 5.63% more grain yield (Table 3) in the final year 2015 in comparison to initial year 2014 and the corresponding figures for the other two treatments were 7.06 and 4.00 % in irrigation at soil hair crake stages (HC) and only 2-3 cm water submergence (WS) respectively (Table 3). Mean grain yield data also proved the superiority of SRI AWD methodology as it recorded 7.62% more yield (Table 3) over FCP. The actual water saving percentage (Table 1) was calculated by applying irrigation through the established "V Notch" at different crop growth stages. Irrigation at soil hair crake stage during vegetative phase + 2-3 cm of standing water at active tillering, panicle initiation and flowering stages only (SRI AWD) resulted 32.78 % water saving in comparison to the farmers' common practice (3-5 cm water submergence). Similar result was also observed by Shantappa *et al.*[7] and they reported that 34% water can be saved through SRI AWD methodology without reduction in yield. The other treatments, irrigating at hair crack stage (HC) and continuous 2-3 cm water submergence showed 53.90 % and 21.23 % of water saving over the farmers' practice respectively. For producing one kg of rice the water requirement in SRI alternate wetting and drying (AWD) treatment was 1217.14 litre. The corresponding figures for irrigation at soil hair crake stage (HC) and only 2-3 cm water submergence (WS) were 1036.68 and 1580.17 litre of water respectively. However for producing one kg of rice maximum water (1948.74 litre) was used in farmers' common practice.

Maximum water saving was observed under irrigation at soil hair crack stage, followed by AWD methodology due to the restriction of seepage and deep percolation losses by maintaining water level up to saturation attributing to lesser water use in the said two treatments. Application of irrigation water, after formation of hairline cracks and 2-3 cm at active tillering, panicle initiation and flowering stages showed considerable water saving besides providing a better root-growing and microbial environment in SRI AWD treatment which resulted to a higher plant growth and development traits and ultimately a sustainable higher biological yield. These findings were in line with the findings of Duttarganvi *et al.*[3]. Whereas in farmers' common practice (maintaining 3-5 cm submergence throughout the crop growth period) due to lack of oxygen in the root zone, rice plants were unable to produce sufficient tillers, panicles and percent filled grains and lastly the biological yield. Similar situation was raised in the treatment where only 2-3 cm of water submergence was used throughout the crop growth period. Only in the treatment where irrigation was given at hair crack stages, the crop was unable to improve its' major growth and development traits due to lack of sufficient water in the important critical crop vegetative and reproductive stages. Similar findings were recorded by Ghosh *et al.*[13] and in the research works conducted under the ADHOC project on SRI at BCKV[14].

Table 1: Water use, rice grain yield litre^{-1} of water use as affected by different irrigation levels (mean data of two years)

Perticulars	T_1	T_2	T_3	T_4
Irrigation water (litre ha^{-1})	1,02,30,000	80,58,000	47,16,000	68,76,000
Rainfall received by crop (litre ha^{-1})	887.0 litre ha^{-1}			
Total water used (litre ha^{-1})	1,02,30,887	80,58,887	47,16,887	68, 76,887
Water saving (%) over FCP	-	21.23	53.90	32.78
Total grain yield (kg ha^{-1})	5250	5100	4550	5650
Total water used (litre) Kg^{-1} of rice production	1948.74	1580.17	1036.68	1217.14

[T_1- Farmers' common practice: 3-5 cm of standing water throughout the crop cycle, T_2- Only 2-3 cm water submergence throughout the crop cycle, T_3- Irrigation at soil hair crake stages and T_4- AWD (Irrigation at soil hair crake stage during vegetative phase + 2-3 cm of standing water at active tillering, panicle initiation and flowering stage only)]

Table 2: Growth and yield parameters and biological yield of summer transplanted rice as affected by different irrigation levels (pooled over two years)

Treatments		Plant height (cm)	No. of Panicle plant^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	Yield (t ha^{-1})	
						Grain	Straw
T_1	Farmers Common Practice (FCP) 3-5 cm water submergence	94.79	23.40	25.16	169.40	5.25	6.81
T_2	Only 2-3 cm water submergence	94.91	25.60	25.11	172.10	5.10	6.49
T_3	Irrigation only at hair crack stage	95.58	21.80	25.40	165.20	4.55	6.39
T_4	AWD (2-3 cm WS at AT, PI & F + HC)	95.95	28.80	25.64	183.60	5.65	6.97
LSD (P=0.05)		1.21	2.00	NS	12.02	0.73	0.42

*NS- Non Significant

Table 3: Average yield increase in treatment and year wise of summer transplanted rice

Treatments		Grain yield (t ha^{-1})		Average	Percent grain yield increase over year	Percent grain yield increase over FCP
		2014	2015			
T_1	Farmers Common Practice (FCP) 3-5 cm water submergence	5.08	5.41	5.25	6.49	-
T_2	Only 2-3 cm water submergence	5.00	5.20	5.10	4.00	(-)2.86
T_3	Irrigation only at hair crack stage	4.39	4.70	4.55	7.06	(-)13.33
T_4	AWD (2-3 cm WS at AT, PI & F + HC)	5.50	5.81	5.65	5.63	7.62
Average		5.07	5.20	5.14	-	

% Yield increase	In respect to 2014 2.56%

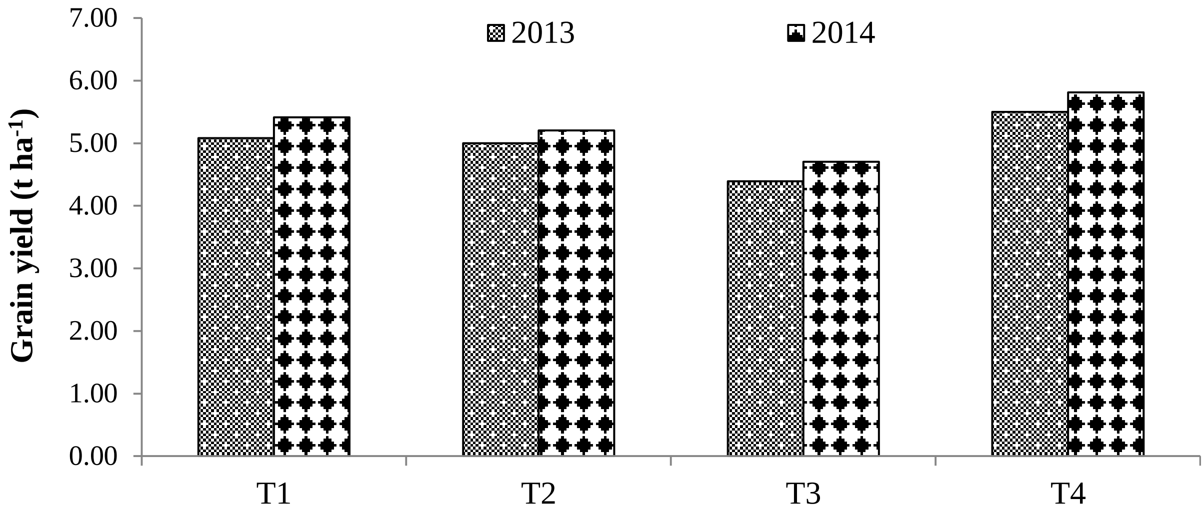

Fig. 1: Grain yield (t ha^{-1}) of summer transplanted rice

CONCLUSION

In SRI alternate wetting and drying methodology (water applied as 2-3 cm water submergence at active tillering, panicle initiation and flowering stages + soil hair crack stages) saved the cost of most precious water input in addition to increasing productivity in transplanted rice. Therefore it could be concluded that in SRI, irrigating through alternate wetting and drying (AWD) methodology showed 33 % water saving and an average of 7.62% productivity increase in comparison to farmers' common practice (FCP) in traditional transplanted rice cultivation.

REFERENCE

1. Uphoff, N., Agroecological implications of the System of Rice Intensification. *Environment, Development and Sustainability*, 1: 297-313 (1999).
2. Ghosh, R.K., Sharma, L., Barman, S. and Dolai, A.K., System of Intensification: The alternate approach for increasing production of Field Crops, *Journal of Crop and Weed* **5(2):** 63-67 (2009).
3. Duttarganvi, S., Mahender, R., Desai, B.K., Pujari, B.T., Tirupataiah, K., Koppalkar, B.G., Umesh, M.R., Naik, M.K. and Reddy, K.Y., Influence of establishment methods, irrigation water levels and weed management practices on growth and yield of rice (*Oryza sativa*), *Indian Journal of Agronomy*. **61 (2):** 174-178 (2016).
4. Anjani, K., Dasgupta, P. and Kumar, R., Emerging opportunities and challenges in rice production, *Popular Kheti*. **2(2):** 6-11 (2014).
5. Chatterjee, S.D., Adhikari, B., Ghosh, A., Ahmed, J., Neogi, S.B. and Pandey, N., The rice bio-diversity in West Bengal. Department of Agriculture, Govt. of West Bengal. Pp 50 (2008).
6. Tuong, T.P., and Bouman, B.A.M., Rice production in water-scarce environments. *Water productivity in agriculture: Limits and opportunities for improvement*, **1:** 13-42 (2003).
7. Shantappa, D., Reddy, Y.K., Pujari, B.T. and Kumar, M.R., Performance of SRI and NTP rice (*Oryza sativa* L.) cultivation under different water levels, *Progressive Research*. **8(9):** 788–790 (2014).
8. Laulanié, H., 1993a. Technicalpresentation on the System of Rice Intensification (SRI) based on Katayama's Tillering

Model. Available : (http://ciifad.cornell.edu/SRI/Laulanie.pdf)

9. Chaboussou, F., *Health Crops: A New Agricultural Revolution.* Jon Anderson, Charnley, UK (2004).
10. Ceesay, M., Reid, W.S., Fernandes, E.C.M., and Uphoff, N., The effects of repeated wetting and drying on lowland rice yield with the System of Rice Intensification, *International Journal of Agricultural Sustainability*. **4:** 5-14 (2006).
11. Ghosh, R.K., Jana, P.K., Nongmaithem, D., Pal, D., Bera, S., Mallick S., Barman, S.K. and Kole, R.K., *In Abstract:* Prospects of Botanical Herbicides in System of Crop Intensification in the Gangetic Inceptisols of India. Proceeding of 6th IWSSC at Hangzhou, China on June 17 – 22, (2012), Pp 116-117.
12. Neue, H.U., Methane emissions from rice fields: Wetland rice fields may make a major contribution to global warming, *Bio Science*. **43:** 466-473 (1993).
13. Ghosh, R.K., Sentharagai, S., Shamurailatpam, D., Ckakrabarty, D. and Patra, P.K., SRI- An option for farmers to change traditional rice growing practices for more economic, social, environment and Productivity benefits. National symposium on “System of Intensification Research Issues, Priorities and Prospects” at Bhubaneswar, Odisha, during 12-14 August (2014): Pp 28-35.
14. BCKV. Final report of ADHOC project on SRI during 2011-14, entitled “Improvement of productivity of land through diversity and activity of soil organisms in various agro ecosystem of the System of Rice Intensification (SRI) in West Bengal” sponsored by Sir Dorabji Tata Trust, Mumbai (2014).