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IMPACT OF WATER MANAGEMENT ON GROWTH AND YIELD OF EARLY AHU RICE VARIETY THROUGH ON-FARM TRIAL IN MORIGAON DISTRICT OF ASSAM

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ABSTRACT

An On-Farm trail was conducted in eight different villages in Morigaon district of Assam having almost similar soil conditions during the autumn season of 2017 and 2018. The Early ahu rice is an important crop component in lowland flood-affected areas of Assam where water management is increasingly important for rice productivity. The paper aims to measure the growth and yield of early ahu rice through improved water management practice at the farmers' fields. The water management at 3 DADPW (days after the disappearance of water) at 5 cm depth which was compared with farmers' practice of continuous flooding. It was found that the water was saved than the normal practice yield of rice have also been enhanced compared to the normal practice of continuous flooding. The growth attributing characters like plant height, number of effective tiller hill^{-1}, number of panicles hill^{-1}, spike length and number of grains penicle^{-1} were found more in case of water management treatment compared to continuous flooding in both the years. The average grain yield of rice was higher (45q ha^{-1} and 43.2 q ha^{-1}, in 2017 and 2018, respectively) in water management treatment compared to continuous flooding (36.9 q ha^{-1}and 37q ha^{-1}, in 2017 and 2018, respectively) in both the years. The economics of the study also revealed the higher average gross returns in irrigation at 3DADPW (Rs 48173 and Rs 43200, in 2017 1nd 2018, respectively) compared to continuous flooding (Rs 36000 and Rs 39609 in 2017 and 2018, respectively) during the course of endeavour. Obviously the B: C ratio (1.79 and 1.61) in water management treatment was also higher compared to continuous flooding (1.10 and 1.21) in both the years due to water saving and higher yield of the crop. Irrigation Water Use Efficiency (IWUE) was also improved at irrigation at 3DAP (73.10 kg ha-cm^{-1} and 73.00 kg ha-cm^{-1} in 2017 and 2018, respectively) compared to farmer's practice of continuous flooding (40.88 kg ha-cm^{-1} and 42.25 kg ha-cm^{-1} in 2017 and 2018, respectively). Thus, the practice may be beneficial for the farmers.

(Keywords: Early ahu, water management, DADPW, continuous flooding)

INTRODUCTION

Rice (*Oryza sativa* L.) is a major staple food for much of the world's population and the largest consumer of water in the agricultural sector. More than 90 per cent of Assam's population being rice eaters; it is the only staple food crop in Assam of which autumn rice holds significance because of the food security of about 62.6 per cent of marginal farmers. Rainfed rice is being grown under more complex and unpredictable environment than most other crops (Jayanthi *et al*., 2007) and Borkotoki *et al*., 2016). Flood is a recurring problem in Morigaon district of Assam (Rasid *et al*., 2019). Due to flood, the farmers could not go for sali season rice in most of the areas. Rice cultivation is specifically water-intensive, requiring approximately 2500 l of water kg^{-1} of rice produced (Bouman, 2009) the traditional water management viz., continuous flooding system makes the production of rice to be critically judged if it is environmentally sustainable or not (Dey, 2017). On today's context, water economy is one of the prime objectives of modern agriculture. Climate change is mainly getting attention for the enhanced mean temperature, elevated carbon dioxide levels so far but it is also worth noticing the erratic rainfall patterns over the rice-growing areas. It is estimated that by 2025, 15 million of Asia's 130 million hectares of irrigated rice area may experience "physical water scarcity" and approximately 22 million hectares of irrigated dry-season rice may suffer "economic water scarcity (Tuong, & Bouman 2003). Water is a critical component of all crops and due to water scarcity, there is a shift towards low water required crops (Rockström *et al.*, 2007; Borkotoki *et al.*, 2015). Under irrigated system water management reckons challenge as water is becoming scarce and precious over time. In Assam rice is grown throughout the year in three

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distinct seasons viz., winter, autumn and summer, with winter (*kharif*) rice as the main crop. Of the state's total rice area of 2.5 million ha, summer (boro/early ahu) rice covers about 0.42 million ha (16.9%) contributing to 23.44 per cent of total rice production with a reasonably higher yield (2940 kg ha^{-1}) than winter rice (2120 kg ha^{-1}) (Gogoi *et al*.,2018). Water availability has been reducing over years and it is expected that by 2030. India will also be in the list of water deficit country with the anticipated $capita^{-1}$ availability of the critical limit of 100 m^3 $year^{-1}$. It is also expected that by 2025, about 10% of irrigated rice will face water scarcity (Bouman *et al.,* 2007, Borkotoki *et al.,*2015). In the context of the global energy crisis and water scarcity, the rice production system is changing with the strategy to produce more rice with a lesser amount of water. (Husain *et al*.,2009) Throughout the rice-growing countries, farmers are habituated to maintain continuous standing water in rice land, which is associated with increased energy consumption and eventually higher cost of production (Husain *et al*.,2009). The application of irrigation water based on visual observation of water table in the rice land is the new concept where irrigation is applied in rice land to bring ponding conditions after a certain period has elapsed after the ponded water has receded from the field. (Sakthivadivel *et al.,* 2001, Bouman *et al*., 2007). The period of non-flooded condition may vary depending on soil texture, but normally that could be 3-4 days. Irrigation is applied with a depth of about 5-cm (Husain *et al*., 2009).

MATERIALS AND METHODS

The study was carried in eight locations namely Kunwargaon, Monoha, Jhargaon, Rupahiborinigam, Bagariguri, Rupohibori, Bhakat gaon and Borkunwargaon villages of Morigaon district situated in central Brahmaputra zone (92^0 E to 95.5^0 E longitude and 26.15^0N to 26.5^0N latitude) during 2017 and 2018 of Assam. Under Krishi Vigyan Kendra (KVK), Morigaon with 2-hectare area with similar soil conditions (Table1) to see the effect of alternate wetting and drying over continuous flooding in ahu paddy (summer rice) through On-Farm Trials (OFTs) in Farmers' fields. For conducting OFTs, farmers were selected based on land situation suitable for ahu rice with irrigation facilities. The required inputs were supplied, and regular visits to the trial fields by the KVK scientists ensured proper guidance to the farmers. Farmers were advised to use recommended fertilizers rate of 40:20:20 of N: P: K kg ha^{-1} with the split application of urea, first half as basal and another half at 30 DAT. The seed treatment with Carbendazim 50%WP @ 2.5g $kg^{-1}$of seed was practised before sowing in the nursery bed. The seedlings were uprooted at 12 DAS and root-dip treatment was done with Chlorpyriphos 20 EC 1 ml l^{-1} before transplanting. The variety was Dishang with 90-100 days duration. The characteristic of this variety was that it can be grown pre-flood and post-flood situations as well as early ahu. This variety when planted during February 15 could be harvested just before the onset of monsoon and escaped the flood in low-lying areas. In both the years the seeds were sown on 15^{th} February in seedbed and 12 days old seedlings were transplanted on 27^{th} February in the main field. The objective of the OFT was to enhance the growth and yield of ahu rice and to save water and input cost and increase framers income though water management at 3 DADPW (days after the disappearance of water) at 5 cm depth which was compared with existing farmers' practice of continuous flooding.

Treatment combinations

T_1: 5 cm irrigation at 3 days after the disappearance of water (3DADW)
T_2: Farmers' practice Continuous Flooding (CF)
&
Replication: 8
Total plot : 2 x 8 = 16
Design: RBD
Data regarding average soil fertile status of the location are presented in Table 1

Table 1. Soil fertility status of the study area

pH	N	P_2O_5	K_2O	DTPA extractable Fe
	................kg ha^{-1}	....		...mg kg^{-1}...
5.27 (5.27-5.54)	145.56 (142.32-167.54)	12.2 (11.6 - 22.32)	68.36 (61.21-111.34)	23.21 (14.51-28.21)
Strongly Acid	Low	Low	Low	high

RESULTS AND DISCUSSION

The findings of the On-Farm Trails conducted in eight different locations of Morigaon district to see the effect of water management at 3 days after the disappearance of water at 5 cm depth in comparison to farmers practice during 2017 and 2018 are presented below. A perusal of data of Table 2 and Table 3 reveals that in both the years' variety Dishang performed better in 3DADW treatment compared to farmers' practice of continuous flooding. Alternate wetting and drying helped in root aeration and helped in oxidation iron present in acid soils of Morigaon district of Assam from Ferrous (Fe^{2+}) to Ferric (Fe^{3+}) state and thus, reduced the probability of the toxicity of the metal to paddy crops was an added benefit. In our study in treatment T_2 (Farmers' practice Continuous Flooding) we oversee mild to moderate iron toxicity in 6 out of 8 locations. Although no such severe iron toxicity was observed in these 6 locations, we observed Fe induced Potassium deficiency in those locations and that might have affected the yield performance of T_2 treatment (Farmers' practice Continuous Flooding) in comparison to T_1 treatment (5 cm irrigation at 3 days after the disappearance of water ie. 3DADW). In improved water management practice no such iron toxicity and potassium deficiency were observed. In this concern, it is worthwhile to mention that the additional split application of murate of potash had been made in K deficit locations under T_2 treatment (continuous flooding) to overcome the deficiency.

A perusal of Table 4 reveals the economics of the experiment. It was found that in both the years highest B:C ratio was observed in irrigation at 3DADW (T_1) *ie.* 1.79 and 1.61, respectively in 2017 and 2018 compared to continuous flooding (T_2). There were 8.1 and 6.2 q ha^{-1} yield advantage of treatment T_1 (5 cm irrigation at 3 days after the disappearance of water *ie.* 3DADW) over treatment T_2 ((Farmers' practice Continuous Flooding) in 2017 1st 2018, respectively.

Table 2. Yield and yield attributes of paddy variety Dishang during 2017

Treatments	Plant height (cm)	No. of effective tillers	No. of panicle $tiller^{-1}$	Spike length (cm)	No. of grains $panicle^{-1}$	Seed yield (q ha^{-1})	IWUE kg ha cm^{-1}	Improved IWUE kg ha cm^{-2}
T_1	95.000	18.000	10.000	15.500	249.000	45.000	73.10	32.22
T_2	93.000	13.000	8.000	12.000	200.000	36.900	40.88	
C.D. (0.05)	0.752	0.544	1.633	0.442	7.242	1.460	2.508	
SE(m)	0.213	0.154	0.463	0.125	2.053	0.414	0.737	
SE(d)	0.302	0.218	0.655	0.177	2.903	0.585	1.043	

Table 3. Yield and yield attributes variety Dishang during 2018

Treatments	Plant height (cm)	No. of effective tillers	No. of panicle $tiller^{-1}$	Spike length (cm)	No. of grains $panicle^{-1}$	Seed yield (q ha^{-1})	IWUE kg ha cm^{-1}	Improved IWUE kg ha cm^{-2}
T_1	94.000	20.500	12.000	15.400	252.000	43.200	73.00	30.75
T_2	93.500	13.400	7.800	13.000	199.000	37.000	42.25	
C.D. (0.05)	N/A	1.682	1.886	1.179	5.106	1.027	2.466	
SE(m)	0.318	0.477	0.535	0.334	1.447	0.291	0.725	
SE(d)	0.450	0.674	0.756	0.473	2.047	0.412	1.025	

Table 4. Economics of the rice crop during 2017 and 2018.

Technology	Yield (q ha^{-1})		Cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		B:C	
	2017	2018	2017	2018	2017	2018	2017	2018
T1	45	43.2	26888	26890	48173	43200	1.79	1.60
T2	36.9	37	32500	32700	36000	39609	1.10	1.21

Moreover Rs. 5612.00 and Rs. 5810.00 were the additional cost of cultivation in treatment T_2 due to the application of more irrigation to maintain the continuous flooding situation. Thus irrigation 3DADW not only increased the yield of rice but also saved several thousand of water.

Many studies have already revealed that continuous submergence is not essential for obtaining high yield of rice. Tabbal *et al.* (1992) , Singh *et al.* (1996) and Guerra *et al.* (1998) reported that maintaining a very thin layer, at saturated soil conditions or alternate wetting and drying can reduce water applied to rice field by about 40-70% compared to continuous shallow submergence, without significant yield loss. Belder *et al.,* (2002) reported that water-saving in alternate wetting and drying was 13-16% compared with the continuously submerged regime, while water regime did not significantly influence yield. Conversely, in our study we got significantly higher yield with irrigation at 3DADW in comparison to continuous flooding besides having better IWUE. Availability of water for agricultural use has been reducing due to growing water scarcity and competing water demands. Therefore, this kind of efforts is needed to be popularised among the farmers to utilize the available limited water resources efficiently and effectively to increase water productivity (Borkotoki *et al.*, 2015) and profitability.

Horizontal expansion of agricultural land is virtually impossible. Conversely, the population rate of our country is escalating beyond control. Under such circumstances, Indian agriculture has to face very redoubtable mission of accomplishing sound growth rate in coming years (Borkotoki *et al*., 2019). Therefore, on the present day, thrust area of agriculture should be aimed at the sustainability of the rice production even in the varied climatic condition. Water sustainability is one of the major issues. As we all know that rice is a major crop and it is highly water inefficient, it is very much essential to enhance water productivity so as the protect this precious natural resource as well as to increase the farmers income.

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