Int.J.Curr.Microbiol.App.Sci (2017) *6*(2): 909-921

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 2 (2017) pp. 909-921**
Journal homepage: http://www.ijcmas.com

Original Research Article http://dx.doi.org/10.20546/ijcmas.2017.602.102

Dynamics of Nitrogen Uptake under Alternate Wetting and Drying Method of Water Management in Low Land Rice (*Oryza sativa*)

Kishor Mote[1*], V. Praveen Rao[2], K. Avil Kumar[2], V. Ramulu[2] and M. Uma Devi[2]

[1]Central Coffee Research Institute, Chikmagaluru-577117, Karnataka, India
[2]Water Technology Centre, Professor Jaysankar Telangana State Agriculture University, Hyderabad-500030, India
[3]Department of Crop Physiology, Professor Jaysankar Telangana State Agriculture University, Hyderabad-500030, India
Corresponding author:

A B S T R A C T

A field study was conducted entitled with “Standardization of Alternate Wetting and Drying (AWD) method of water management in low land rice (*Oryza sativa* (L.) for up scaling in command outlets”. The treatments consisted of continuous submergence throughout the crop growing season besides AWD irrigation regimes with two pond water depths of 3 and 5 cm and drop in pond water levels in field water tube below ground level to 5, 10 and 15 cm depth. The eight treatments were laid out in randomized block design with three replications. Continuous Submergence (CS) registered higher nitrogen uptake 20.78, 45.52, 64.05 and 85.36 kg ha^{-1} at 30, 60, 90 DAT and at harvest, respectively which resulted it recorded significantly higher SPAD chlorophyll meter (SCMR) readings (42.74, 42.78) and Leaf Color Chart (LCC) ratings (3.83, 3.94) over rest of the irrigation regimes except that it was on par with Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm Below ground level (BGL) in field water tube (39.40, 39.59), (3.59, 3.51), Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube (41.21, 41.78), (3.73, 3.74) and Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube (40.04, 40.83), (3.69, 3.52).

Keywords

SCMR readings, LCC ratings, Nitrogen uptake, Alternate wetting and drying, Lowland rice, Field water tube.

Article Info

Accepted:
20 January 2017
Available Online:
10 February 2017

Introduction

Rice *(Oryza sativa L.)* is one of the world’s major food crops and as well as for India. The area under rice in India is 45 million ha with production of 106.19 million tonnes (Department of Agriculture, India, 2014). A tremendous amount of water is used for the rice irrigation under the conventional water management in lowland rice termed as ‘‘continuous deep flooding irrigation’’ consuming about 70 to 80 per cent of the total irrigated fresh water resources in the major part of the rice growing regions in Asia including India (Bouman and Tuong, 2001; Bouman *et al.*, 2007). However, irrigation water in India is becoming increasingly scarce and costly (Rijsberman, 2006). Rapid population growth, urbanization and multiple competing demands for water (i.e., drinking, industrial uses) have contributed to irrigation water scarcity (Pingali *et al.*, 1997; Tabbal *et al.*, 2002). Tuong and Bouman (2003) estimate that, by 2025, about 2 million ha of Asia's irrigated dry-season rice and 13 million ha of its irrigated wet-season rice will experience physical water scarcity. The occurrence of water scarcity prompted researchers to find ways to optimize water use under water saving systems in irrigated rice fields in the tropics where high yield is critical to ensure food security (Rosegrant and Ringler, 1998).

Growing rice under AWD could consequently lead to a greater loss of applied fertilizer N and soil N compared with that under continous flooding conditions; the latter itself has been characterized as having low N-use efficiency (Peng *et al.*, 2006). Belder *et al.*, (2005) reported that N recovery of rice under AWD (about 20%) was significantly lower than that under continuous flooding (about 40%). Increasing N-use efficiency in AWD will help farmers reduce the amount of fertilizer inputs, increase their income, and facilitate their adoption of AWD to cope with water scarcity.

Materials and Methods

The experiment was laid out in a randomized block design with eight irrigation regimes comprising of two submergence levels above the ground (3 and 5 -cm) and three falling levels below ground surface (5, 10 and 15 -cm drop of water in field water tube) and farmers practice of continous standing water which were randomly allotted in three replications. The experimental soil was sandy clay in texture, moderately alkaline in reaction, non-saline, low in organic carbon content, low in available nitrogen (N), medium in available phosphorous (P_2O_5) and potassium (K_2O).

Treatment Details	
I_1	Continuous submergence of 3 cm up to PI and thereafter 5 cm up to PM
I_2	AWD – Flooding to a water depth of 3 cm when water level drops to 5 cm BGL from 15 DAT to PM
I_3	AWD – Flooding to a water depth of 3 cm when water level drops to 10 cm BGL from 15 DAT to PM
I_4	AWD – Flooding to a water depth of 3 cm when water level drops to 15 cm BGL from 15 DAT to PM
I_5	AWD – Flooding to a water depth of 5 cm when water level drops to 5 cm BGL from 15 DAT to PM
I_6	AWD – Flooding to a water depth of 5 cm when water level drops to 10 cm BGL from 15 DAT to PM
I_7	AWD – Flooding to a water depth of 5 cm when water level drops to 15 cm BGL from 15 DAT to PM
I_8	AWD – Flooding to a water depth of 3 cm from 15 DAT to PI and thereafter 5 cm up to PM when water level drops to 15 cm

The SCMR readings were recorded from 15 DAT to flowering at every 15 days interval for all the treatments. The youngest fully expanded leaf of a plant was used for the SCMR value measurement. The LCC ratings were measured under the body shade in the morning time. The LCC ratings were taken up to 50 per cent flowering. The plant samples collected for dry matter estimation at 30, 60, 90 DAT and at harvest from the respective treatments were oven dried and finely ground in Willey mill and used for chemical analysis to estimate N content in the straw at 30, 60 and 90 DAT and in straw and grain at harvest. Nitrogen content of shoot and grain at harvest was estimated by Modified Micro Kjeldhal's Method as outlined by Jackson (1967) and expressed in percentage. The data on various parameters studied during the course of investigation were statistically analyzed as suggested by Gomez and Gomez (1984). Crop yield (dependent variable) was assumed as a function of various growth traits and the following straight line model was established by least square technique (Gomez and Gomez, 1984) as follows:

$$Y = a + bx$$

Where,

Y = Grain yield of rice (g m^{-2})
a = Y–axis intercept
b = Regression coefficient
x = Independent variable i.e., Growth and yield components

Likewise, to characterize the crop weather relationship all growth and yield components and grain yield were related to weather elements adopting the above linear model.

Results and Discussion

SCMR readings

The SCMR readings were not significantly influenced by different irrigation treatments at 15 and 30 DAT, but were significant at 45 and 60 DAT. Both at 45 and 60 DAT significantly higher SCMR readings were registered by the crop in I_1 (Continuous Submergence depth of 3-cm from transplanting to PI and 5 cm from PI to PM) over other AWD irrigation regimes (Table 1) except that it was statistically on par with I_2 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_3 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube), I_5 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube) and I_6 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube) at 45 DAT in 2013 and I_2 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_4 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube), I_5 and I_6 at 45 DAT in 2014 and at 60 DAT both in 2013 and 2014. The higher SCMR readings could be traced increased uptake of N in wet irrigation regimes over stressed regimes, which could be due to reduced leaching losses (Aulakh and Singh, 1997). On the other hand intermittent aerobic conditions in AWD irrigation regimes increased the average soil N supply or induced increased root development, or both in turn the SCMR, thus compensating for reduced growth during drought phases (Haefele *et al.,* 2010). Further, the SCMR values between I_7 and I_8 at 45 DAT in 2013 and that between I_3 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube), I_7 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube) and I_8 (Flooding to a water depth of 3-cm from 15 DAT to PI and 5-cm from PI to PM as and when pond water level drops to 15-cm BGL in field water tube) at 45 DAT in 2013 and 60 DAT in 2013 and 2014 were statistically on par.

The SPAD meter is a simple portable diagnostic tool used for monitoring crop N status *in situ* in the field. The relationship between leaf N content and SCMR value indicated that when a variety will show higher SCMR reading, it has certainly higher amount of nitrogen (Islam *et al.,* 2009). To achieve the maximum yield target, the N concentration of the upper most fully expanded leaf must be maintained at or above 1.4 g N m^{-2} (leaf area basis) (Islam *et al.,* 2009). Leaf N status at this critical level gives a SPAD value of 35 regardless of genotypes (Dobermann and Fairhurst, 2000). The SPAD meter- based N management appeared to be more efficient and would save 20 – 30 kg N ha^{-1} than the conventional N management practices to produce similar grain yield (Miah and Ahmed, 2002). Cabangon *et al.,* (2011) opined that a combination of AWD and SCMR based N management by maintaining a critical value of 38 can contribute to savings in irrigation water and fertilizer N while maintaining high yield as in continuous submergence conditions with fixed time and rate of nitrogen application (180 kg ha^{-1}). It can be noticed that in the present study the AWD treatments I_5 and I_6 registered SCMR readings more than 38 and were on par with continuous submergence treatment (I_1). A good correlation between leaf N content and the SCMR reading was reported by Cabangon *et al.,* (2011) suggesting that the SCMR reading can be used to estimate leaf N of rice grown under AWD in a way similar to that under continuous submergence.A good correlation was observed between N uptake and SPAD readings with a determination coefficient of R^2 = 75.7% (Fig. 1). These results suggest that SPAD-based management can be used for timing of N topdressing for a given variety at a specific crop growth stage or during the entire growing period under AWD irrigation regime. The result was similar to previous findings for rice under continuous submergence conditions (Cabangon *et al.,* 2011). The findings implied that SPAD can be used to assess N uptake of rice under AWD conditions as it is used in continuous submergence rice (Cabangon *et al.,* 2011).

As large part of N in the plant is allocated to the leaves throughout the life of the plant and photosynthetic capacity per unit leaf area is considered to be an important factor related to crop productivity. Since leaf N concentration/N uptake is closely related to the leaf chlorophyll content, the measure of chlorophyll content can estimate the crop N status and thereby determine the need for additional N fertilizer. The chlorophyll (SPAD) meter provides an instantaneous, non-destructive indication of leaf chlorophyll or N concentration in the field. Figure 1 is a scatter diagram for N uptake versus SPAD readings of the present experiment. A good correlation was observed between N uptake and SPAD readings with a determination coefficient of R^2 = 75.7%. These results suggest that SPAD-based management can be used for timing of N topdressing for a given variety at a specific crop growth stage or during the entire growing period under AWD irrigation regime. The result was similar to previous findings for rice under continuous submergence conditions (Cabangon *et al.,* 2011). The findings implied that SPAD can be used to assess N uptake of rice under AWD conditions as it is used in continuous submergence rice (Cabangon *et al.,* 2011).

Leaf colour chart (LCC) ratings

The LCC ratings were not significantly influenced by different irrigation treatments at 15 and 30 DAT, but were significant at 45 and 60 DAT. Both at 45 and 60 DAT significantly higher LCC ratings were registered by the crop in I_1 (Continuous Submergence depth of 3-cm from transplanting to PI and 5 cm from PI to PM) over other AWD irrigation regimes (Table 2) except that it was statistically on par with I_2

(Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_3 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube), I_5 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_6 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube) and I_7 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube) at 45 DAT and I_2 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_3 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube) only in 2013, I_5 and I_6 at 45 DAT. Higher LCC rating in I_2 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube) could be traced to favourable soil water balance, reduced leaching and better uptake of N.

However, the LCC ratings registered in I_2, I_3, I_6 and I_7 at 45 DAT in 2013; I_4 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube), I_7 and I_8 at 45 DAT in 2014; I_4 and I_8 at 60 DAT in 2013 and that between I_4, I_7 and I_8 at 60 DAT in 2014 were statistically not significant. Significantly lowest LCC rating were recorded by the crop in I_4 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube) AWD irrigation regime in both the years. Nutrient uptake by plants is decreased under water stress conditions due to reduced transpiration (Yambao and O'Toole, 1984) and impaired active transport and membrane permeability (Hsiao, 1973) resulting in reduced absorbing power. Nutrient uptake from the soil solution is also closely linked to soil water status.

Thus a decline in soil moisture as indicated by soil moisture content and plant water balance parameters RWC and LWP in I_4, I_7 and I_8 might have been associated with decrease in diffusion rate of nutrients from soil matrix to the absorbing root surface (Viets, 1972) in turn affecting the LCC ratings.

A positive and significant correlation (P = 0.01) was observed between N-Uptake and LCC rating with a Determination Coefficient of R^2 = 0.87 (Fig. 2). These results suggest that LCC-based management can be used for timing of N topdressing for a given variety at a specific crop growth stage or during the entire growing period under AWD irrigation regime. While SCMR readings provide objective information on the chlorophyll content of the leaf, the LCC rating is subjectively judged by visually differentiating the leaf colour. Figure 3 shows a good and highly significant (R^2 = 0.89, P=0.01) correlation between LCC rating and SCMR readings. The result was similar to previous findings for rice under continuous submergence conditions (Cabangon *et al.*, 2011). The findings implied that LCC can also be used to assess N uptake of rice under AWD.

However, given the high cost of the SPAD meter, the LCC rating is potentially an inexpensive alternative tool to the SPAD meter (Furuya, 1987) and the LCC could be used instead of the SCMR readings for estimating leaf N or crop N status and for determining the timing of N top dressing.

Table.1 SCMR readings of rice as influenced by different AWD irrigation regimes during kharif 2013 and 2014

Code	Description of Treatment	15 DAT		30 DAT		45 DAT		60 DAT	
		2013	2014	2013	2014	2013	2014	2013	2014
I_1	Continuous submergence of 3 cm up to PI and thereafter 5 cm up to PM	31.40	37.77	38.48	37.17	39.73	40.39	42.74	42.78
I_2	AWD – Flooding to a water depth of 3 cm when water level drops to 5 cm BGL from 15 DAT to PM	35.74	40.22	36.89	35.83	38.74	38.84	39.40	39.59
I_3	AWD – Flooding to a water depth of 3 cm when water level drops to 10 cm BGL from 15 DAT to PM	36.91	40.37	35.96	35.72	37.92	37.50	37.92	38.40
I_4	AWD – Flooding to a water depth of 3 cm when water level drops to 15 cm BGL from 15 DAT to PM	39.28	37.78	33.44	34.32	35.18	35.55	33.41	33.52
I_5	AWD – Flooding to a water depth of 5 cm when water level drops to 5 cm BGL from 15 DAT to PM	35.31	39.19	38.46	36.72	39.55	40.09	41.21	41.78
I_6	AWD – Flooding to a water depth of 5 cm when water level drops to 10 cm BGL from 15 DAT to PM	33.95	39.97	38.03	37.10	39.33	39.17	40.04	40.83
I_7	AWD – Flooding to a water depth of 5 cm when water level drops to 15 cm BGL from 15 DAT to PM	36.73	40.36	36.60	36.87	36.06	36.43	35.63	36.23
I_8	AWD – Flooding to a water depth of 3 cm from 15 DAT to PI and thereafter 5 cm up to PM when water level drops to 15 cm	38.12	40.72	35.20	35.68	35.71	35.61	35.22	35.55
SEm ±		**1.51**	**1.43**	**1.46**	**1.12**	**1.09**	**1.14**	**1.86**	**1.66**
CD at P = 5%		**NS**	**NS**	**NS**	**NS**	**3.32**	**3.47**	**5.65**	**5.04**
General Mean		**35.93**	**39.54**	**36.63**	**36.17**	**37.77**	**37.94**	**38.19**	**38.58**

PI – Panicle Initiation; **PM** – Physiological Maturity; **DAT** – Days After Transplanting; **BGL** – Below Ground Level **AWD –** Alternate Wetting and Drying **SCMR-** SPAD chlorophyll Meter Readings

Table.2 LCC ratings of rice as influenced by different AWD irrigation regimes during kharif 2013 and 2014

Code	Description of Treatment	15 DAT		30 DAT		45 DAT		60 DAT	
		2013	2014	2013	2014	2013	2014	2013	2014
I_1	Continuous submergence of 3 cm up to PI and thereafter 5 cm up to PM	2.92	3.10	3.65	3.50	3.52	3.69	3.83	3.94
I_2	AWD – Flooding to a water depth of 3 cm when water level drops to 5 cm BGL from 15 DAT to PM	2.66	3.07	3.25	2.98	3.35	3.51	3.59	3.51
I_3	AWD – Flooding to a water depth of 3 cm when water level drops to 10 cm BGL from 15 DAT to PM	2.61	3.03	3.27	3.21	3.29	3.36	3.40	3.14
I_4	AWD – Flooding to a water depth of 3 cm when water level drops to 15 cm BGL from 15 DAT to PM	2.74	2.84	3.10	2.37	2.43	2.7	2.54	2.36
I_5	AWD – Flooding to a water depth of 5 cm when water level drops to 5 cm BGL from 15 DAT to PM	2.74	3.02	3.36	3.35	3.50	3.58	3.73	3.74
I_6	AWD – Flooding to a water depth of 5 cm when water level drops to 10 cm BGL from 15 DAT to PM	2.81	2.82	3.28	3.29	3.47	3.54	3.69	3.52
I_7	AWD – Flooding to a water depth of 5 cm when water level drops to 15 cm BGL from 15 DAT to PM	2.80	2.48	3.19	2.84	3.03	3.27	3.16	2.76
I_8	AWD – Flooding to a water depth of 3 cm from 15 DAT to PI and thereafter 5 cm up to PM when water level drops to 15 cm	2.63	2.59	3.11	2.80	2.98	3.06	2.63	2.48
SEm ±		**0.15**	**0.18**	**0.14**	**0.63**	**0.16**	**0.19**	**0.16**	**0.15**
CD at P = 5%		**NS**	**NS**	**NS**	**NS**	**0.49**	**0.56**	**0.49**	**0.46**
General Mean		**2.73**	**2.86**	**3.27**	**3.04**	**3.19**	**3.34**	**3.32**	**3.18**

PI – Panicle Initiation; **PM** – Physiological Maturity; **DAT** – Days After Transplanting; **BGL** – Below Ground Level **AWD –** Alternate Wetting and Drying **LCC-** Leaf Color Chart

Table.3 Nitrogen uptake (kg ha^{-1}) of rice at 30, 60 and 90 DAT as influenced by different AWD irrigation regimes during kharif 2013, 2014 and pooled means

Code	Description of Treatment	30 DAT			60 DAT			90 DAT		
		2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
I_1	Continuous submergence of 3 cm up to PI and thereafter 5 cm up to PM	22.45	24.37	23.41	49.00	51.34	50.17	72.77	75.50	74.14
I_2	AWD – Flooding to a water depth of 3 cm when water level drops to 5 cm BGL from 15 DAT to PM	20.84	22.88	21.86	47.07	49.05	48.06	63.77	67.32	65.54
I_3	AWD – Flooding to a water depth of 3 cm when water level drops to 10 cm BGL from 15 DAT to PM	19.96	21.17	20.57	46.49	48.57	47.53	61.30	65.78	63.54
I_4	AWD – Flooding to a water depth of 3 cm when water level drops to 15 cm BGL from 15 DAT to PM	19.26	21.54	20.40	35.20	39.16	37.18	52.25	53.53	52.89
I_5	AWD – Flooding to a water depth of 5 cm when water level drops to 5 cm BGL from 15 DAT to PM	20.95	23.05	22.00	48.03	50.52	49.28	68.64	72.90	70.77
I_6	AWD – Flooding to a water depth of 5 cm when water level drops to 10 cm BGL from 15 DAT to PM	20.14	21.90	21.02	47.39	49.50	48.45	65.18	70.26	67.72
I_7	AWD – Flooding to a water depth of 5 cm when water level drops to 15 cm BGL from 15 DAT to PM	19.38	21.09	20.23	45.93	45.86	45.90	60.60	62.63	61.61
I_8	AWD – Flooding to a water depth of 3 cm from 15 DAT to PI and thereafter 5 cm up to PM when water level drops to 15 cm	15.34	18.21	16.78	36.04	39.26	37.65	55.99	56.54	56.26
SEm ±		**1.77**	**1.42**	**1.45**	**1.67**	**2.12**	**1.70**	**3.06**	**2.48**	**2.70**
CD at P = 5%		**NS**	**NS**	**NS**	**5.08**	**6.44**	**5.15**	**9.27**	**7.51**	**8.19**
General Mean		**19.79**	**21.77**	**20.78**	**44.39**	**46.65**	**45.52**	**62.56**	**65.55**	**64.05**

PI – Panicle Initiation; **PM** – Physiological Maturity; **DAT** – Days After Transplanting; **BGL** – Below Ground Level **AWD** – Alternate Wetting and Drying

Table.3a Nitrogen uptake (kg ha^{-1}) of rice at harvest as influenced by different AWD irrigation regimes during kharif 2013, 2014 and pooled means

Code	Description of Treatment	Grain			Straw			Total		
		2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
I_1	Continuous submergence of 3 cm up to PI and thereafter 5 cm up to PM	59.27	61.84	60.56	43.55	47.01	45.28	102.83	108.85	105.84
I_2	AWD – Flooding to a water depth of 3 cm when water level drops to 5 cm BGL from 15 DAT to PM	45.11	48.94	47.03	35.98	39.87	37.93	81.09	88.81	84.95
I_3	AWD – Flooding to a water depth of 3 cm when water level drops to 10 cm BGL from 15 DAT to PM	40.75	46.71	43.73	32.84	37.49	35.17	73.59	84.20	78.89
I_4	AWD – Flooding to a water depth of 3 cm when water level drops to 15 cm BGL from 15 DAT to PM	32.91	35.01	33.96	27.41	30.12	28.77	60.32	65.13	62.72
I_5	AWD – Flooding to a water depth of 5 cm when water level drops to 5 cm BGL from 15 DAT to PM	54.42	58.82	56.62	39.95	44.92	42.44	94.37	103.75	99.06
I_6	AWD – Flooding to a water depth of 5 cm when water level drops to 10 cm BGL from 15 DAT to PM	52.05	56.64	54.35	37.42	42.62	40.02	89.47	99.26	94.36
I_7	AWD – Flooding to a water depth of 5 cm when water level drops to 15 cm BGL from 15 DAT to PM	46.83	52.18	49.51	30.94	35.02	32.98	77.78	87.20	82.49
I_8	AWD – Flooding to a water depth of 3 cm from 15 DAT to PI and thereafter 5 cm up to PM when water level drops to 15 cm	42.09	44.94	43.52	30.15	32.04	31.10	72.23	76.98	74.60
SEm ±		**2.54**	**2.21**	**2.22**	**2.94**	**1.84**	**2.00**	**4.53**	**3.31**	**3.83**
CD at P = 5%		**7.69**	**6.71**	**6.74**	**6.30**	**5.59**	**6.06**	**13.73**	**10.04**	**11.62**
General Mean		**46.67**	**50.63**	**48.66**	**34.78**	**38.63**	**36.71**	**81.46**	**89.27**	**85.36**

PI – Panicle Initiation; **PM** – Physiological Maturity; **DAT** – Days After Transplanting; **BGL** – Below Ground Level **AWD** – Alternate Wetting and Drying

Fig.1 Regression of rice N uptake on SPAD readings

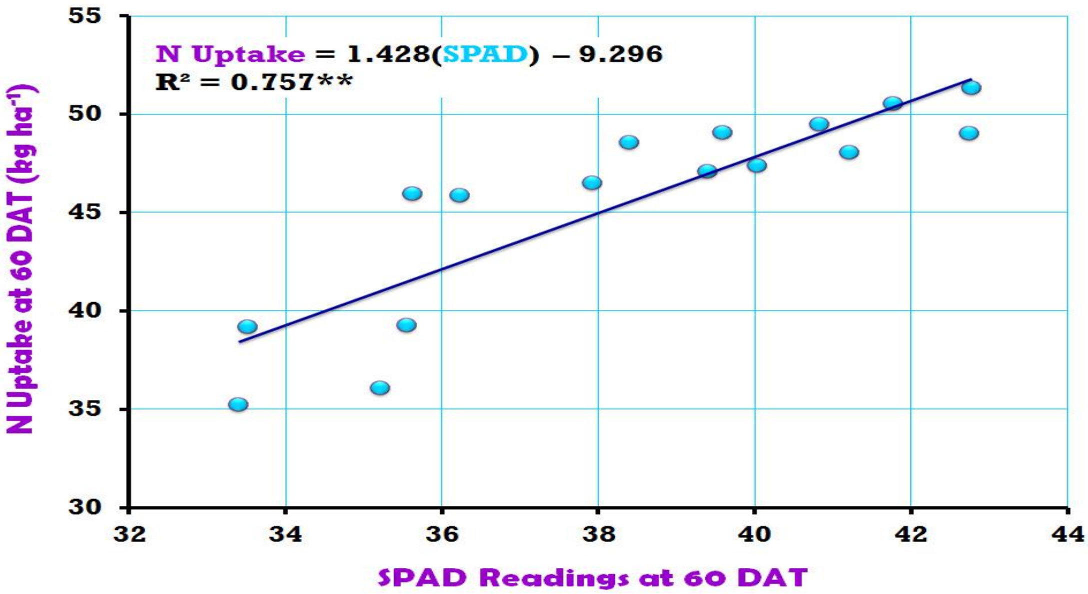


Fig.2 Regression of nutrient uptake by rice on LCC rating

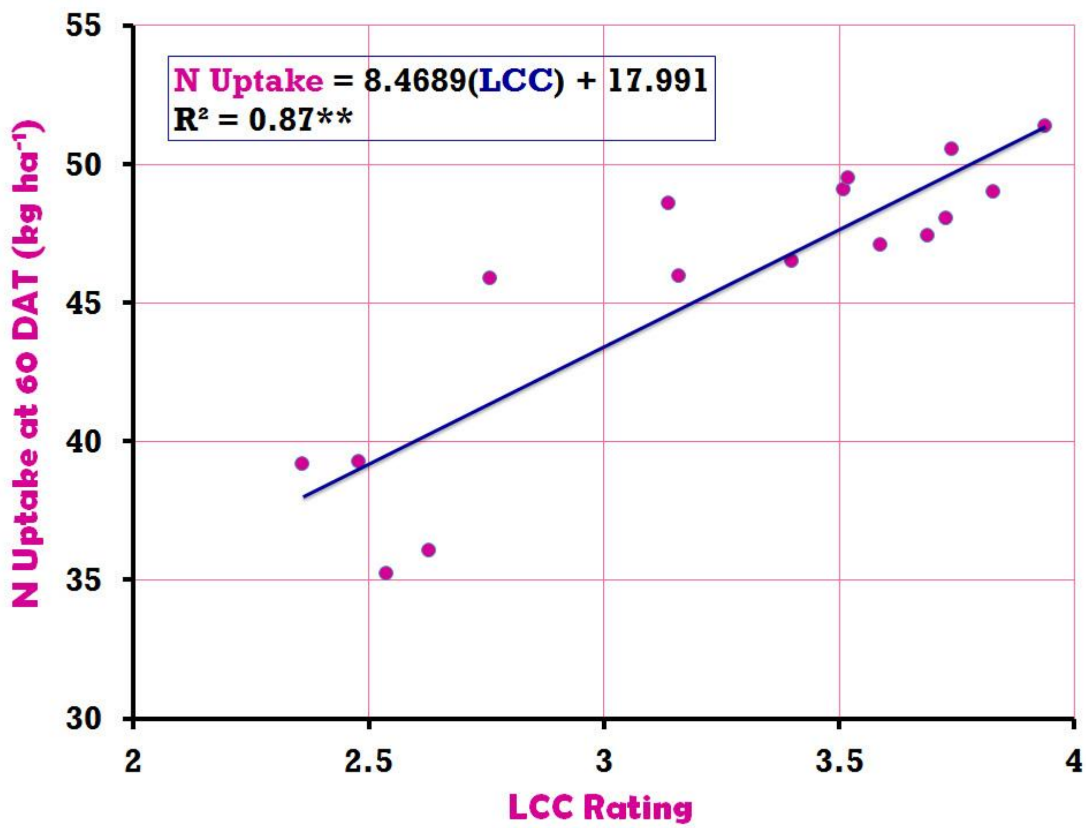
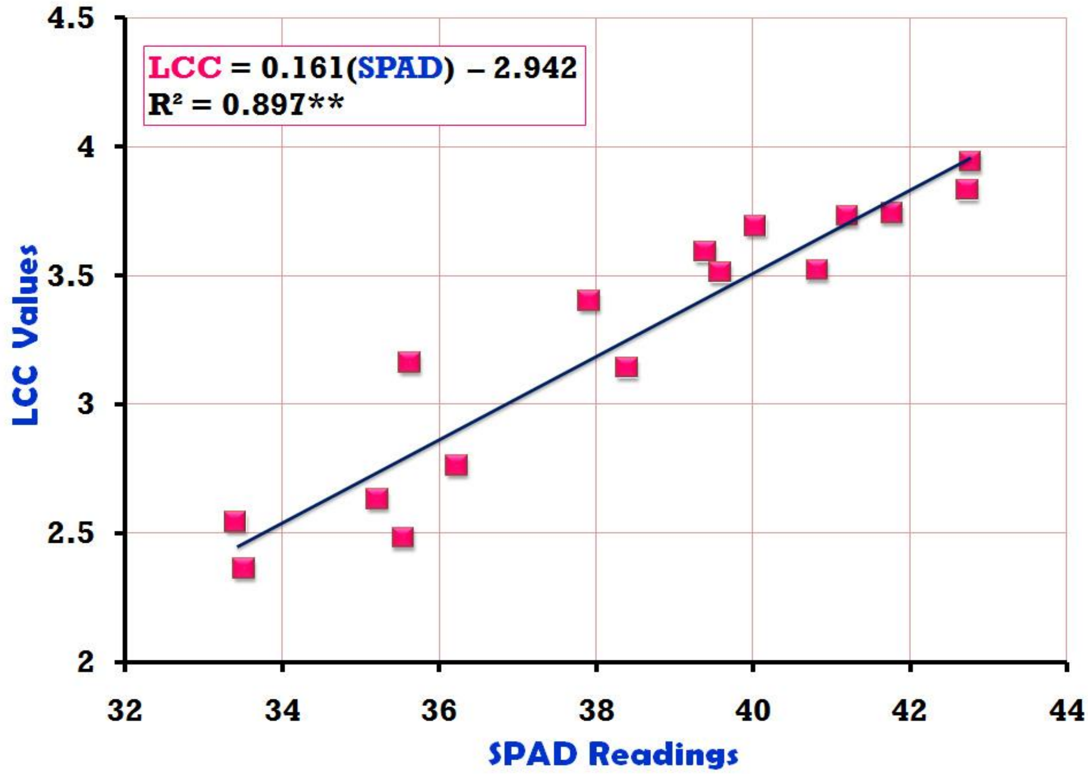


Fig.3 Regression of rice LCC on SPAD readings



Nitrogen uptake

Irrigation at Continuous Submergence depth of 3-cm from transplanting to PI and 5 cm from PI to PM (I_1) registered significantly higher N uptake on pooled basis (50.17, 74.14 and 105.84 kg ha^{-1} at 60, 90 DAT and at harvest, respectively) over AWD irrigation regimes (Table 3 and 3a) except that it was statistically on par with I_2 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_5 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_6 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube) and I_7 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube) at 60 DAT and with I_5 and I_6 at 90 DAT and at harvest in grain, straw and total uptake and significantly superior over other AWD irrigation regimes viz., I_3 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 10-cm BGL in field water tube), I_4 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 15-cm BGL in field water tube) and I_8 (Flooding to a water depth of 3-cm from 15 DAT to PI and 5-cm from PI to PM as and when pond water level drops to 15-cm BGL in field water tube) at 60 DAT and I_2, I_3, I_4, I_7 and I_8 at 90 DAT and at harvest in grain, straw and total uptake.

Under conditions of water stress, roots are unable to take up many nutrients from the soil due to a lack of root activity as well as slow ion diffusion and water movement rates (Dubey and Pessarakli, 2001). Moreover, the mineralization process depends on micro-organisms and enzyme activity, which may be affected by water stress. Water molecules are adsorbed on the surfaces of particles, forming hydration shells that influence the physiochemical reactions. Water in liquid form allows the diffusion and mass flow of solutes and is therefore essential to the translocation and distribution of nutrients and metabolites throughout the entire plant (Mengel and Kirkby, 2001). Water and minerals are taken up from the root medium and predominantly translocated to the upper parts of the plant through the xylem (Mengel and Kirkby, 2001). Transpiration plays an important role in this process and the water flow rate throughout the root (short-distance transport) and xylem vessels (long-distance transport) is determined by the root pressure and transpiration rate. An increase in the transpiration rate enhances both the uptake and translocation of mineral elements in the xylem (Mengel and Kirkby, 2001). Under water stress, there is a reduction in nutrient uptake by the roots partially due to the reduction in soil moisture, which causes a decreased rate of nutrient diffusion from the soil matrix to the absorbing root surface (Hu *et al.*, 2007) and translocation to the leaves. A number of studies have shown decrease in some mineral accumulation and other physiological effects under water stress. Water deficit also causes stomatal closure, which reduces transpiration (Silva *et al.*, 2004,). Thus, nutrient transport from the roots to the shoot is also limited by the decrease in transpiration rate, imbalance in active transport and membrane permeability, resulting in a reduced absorption power in the roots (Farooq *et al.*, 2009). Therefore, water stress causes low nutrient availability in the soil and lower nutrient transport in plants (Hu *et al.*, 2007).

In conclusion, maintenance of Continuous Submergence depth of 3-cm from transplanting to PI and 5-cm from PI to PM (I_1) registered significantly superior performance in terms of SCMR, LCC and Nitrogen uptake at all the crop growth stages over rest of the irrigation regimes except that it was on par with I_2 (Flooding to a water depth of 3-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube), I_5 (Flooding to a water depth of 5-cm between 15 DAT to PM as and when pond water level drops to 5-cm BGL in field water tube) and I_6 (Flooding to a water depth of 5-cm between 15 DAT to PM.

References

Belder, P., Spiertz, J.H.J., Bouman, B.A.M. and Tuong, T.P. 2005. Nitrogen economy and water productivity of lowland rice under water saving irrigation. *Field Crops Res*., 93: 169–185.

Bouman, B.A.M. and Tuong, T.P. 2001. Field water management to save water and increase its productivity in irrigated lowland rice. *Agric. Water Manage,* 49: 11-30.

Bouman, B.A.M., Humphrey, E., Tuong, T.P. and Barker, R. 2007. Rice and water. *Adv in Agron.*, 92(4): 187-237.

Cabangon, R.J., Castillo, E.G. and Tuong, T.P. 2011. Chlorophyll meter-based nitrogen management of rice grown under alternate wetting and drying irrigation. *Field Crops Res*., 121: 136–146.

Department of Agriculture, India. 2014.

Dobermann, A. and Fairhurst, T. 2000. Rice: Nutrient Disorders & Nutrient Management. IRRI, Philippines, PPI, U.S.A., and PPIC, Canada.

Dubey, R.S., Pessarakli, M. 2001. Physiological mechanisms of nitrogen absorption and assimilation in plants under stressful conditions. In: Passarakli M (Ed). Handbook of Plant and Crop Physiology (2nd Edn), Marcel Dekker Inc, New York, pp 636-655.

Farooq, M., Wahid, A., Kobayashi, N., Fujita, D., Basra, S.M.A. 2009. Plant drought stress: Effects, mechanisms and management. *Agron for Sustainable Development*, 29: 185-212.

Furuya, S. 1987. Growth diagnosis of rice plants by means of leaf color. *Japanese Agric. Res. Quarterly*, 20: 147-153.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research. A Wiley inter science publication, John. Wiley and Sons, New York. p: 680.

Haefele, S.M., Joel, D.L.C.S., Serafin, T.A. and To, P.T. 2010. Effect of abiotic stresses on the nondestructive estimation of rice leaf nitrogen concentration. *Int. J. Agron.* ID 863605, 11 pages.

Hsiao, T.C. 1973. Plant responses to water stress. *Annual Review on Plant Physiol.*, 24: 519-570.

Hu, Y., Burucs, Z., Tucher, S.V., Schmidhalter, U. 2007. Short-term effects of drought and salinity on mineral nutrient distribution along growing leaves of maize seedlings. *Environ. Experi. Bot*., 60: 268-275.

Islam, M.S.H., Bhuiya, M.S.U., Rahman, S., Hussain, M. 2009. Evaluation of SPAD and LCC based nitrogen management in rice (*Orayza sativa* L.). *Bangladesh J. Agric. Res.*, 34(4): 661-672.

Jackson, M.L. 1967. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi. pp: 1-49.

Mengel, K., Kirkby, E.A. 2001. Principles of Plant Nutrition, (4th Edn), International Potash Institute, Switzerland, 687 pp.

Miah, M.A.M. and Ahmed, Z.U. 2002. Comparative efficiency of the chlorophyll meter technique, urea supper granule and prilled urea for hybrid rice in Bangladesh. In: "Hybrid Rice in Bangladesh: Progress and Future Strategies". pp. 43-50. Bangladesh Rice Res. Inst., Publication No. 138.

Peng, S., Buresh, R.J., Huang, J., Yang, J., Zou, Y., Zhong, X., Wang, G. and Zhang, F. 2006. Strategies for overcoming low agronomic nitrogen use efficiency in irrigated rice systems in China. *Field Crops Res.*, 96: 37–47.

Pingali, P.L., Hossain, M. and Gerpacio, R.V. 1997. Asian Rice Bowls: the Returning Crisis? CAB International, Wallingford, UK, in association with IRRI, Los Baños, Philippines, 341 pp.

Rijsberman, F.R. 2006. Water scarcity: fact or fiction? *Agric Water Manage.*, 80: 5– 22.

Rosegrant, M.W., Ringler, C. 1998. Impact on food security and rural development of transferring water out of agriculture. *Water Policy*, 1(6): 567–586.

Silva, E.C., Nogueira, R.J.M.C., Azevedo Neto, A.D,. Brito Cabral, E.L. 2004. Aspectos ecofisiológicos de dez espécies em uma área de caatinga no município de Cabaceiras, Paraíba, Brasil. Iheringia 59: 201-205.

Tabbal, D.F., Bouman, B.A.M., Bhuiyan, S.I, Sibayan, E.B. and Sattar, M.A. 2002. On-farm strategies for reducing water input in irrigated rice. *Agric Water Manage.*, 56(2): 93-112.

Tuong, T.P. and Bouman, B.A.M. 2003. Rice production in water-scarce environments. In: Proceedings of the Water Productivity Workshop, International Water Management Institute, Colombo, Sri Lanka, November 12–14.

Viets, F. 1972. Water deficits and nutrient availability. *In* Water Deficits and plant Growth. Ed.T T Kozlowski. (3): 217-239.

Yambao, E.B. and O' Toole, J.C. 1984. Effects of nitrogen nutrition and root medium water potential on growth, nitrogen uptake and osmotic adjustment of rice. *Physiol. Plant*, 60: 507-515.

How to cite this article:

Kishor Mote, V. Praveen Rao, K. Avil Kumar, V. Ramulu and Uma Devi, M. 2017. Dynamics of Nitrogen Uptake under Alternate Wetting and Drying Method of Water Management in Low Land Rice (*Oryza sativa*). *Int.J.Curr.Microbiol.App.Sci.* 6(2): 909-921.
doi: http://dx.doi.org/10.20546/ijcmas.2017.602.102