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Response of Rice (*Oryza sativa* L.) to Irrigation Regimes and Precise Nitrogen Management Practices

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ABSTRACT: During the *kharif* season of 2021, a field experiment was carried out at the college farm of PJTSAU Rajendranagar, Hyderabad to examine how rice responded to irrigation regimes and precise nitrogen management techniques (LCC, green seeker, nutrient expert, and recommended dose of fertilizer) on sandy clay soil. The experiment was laid out in a strip plot design, with four nitrogen treatments as subplots and three irrigation regimes as main plots. According to the findings, flooded transplanted rice outperformed AWD by sensor-based semi-automatic irrigation and AWD by manual irrigation in terms of panicles m^{-2} (307.8m^{-2}), test weight (23.8 g), and grain yield (6302.5 kg ha^{-1}). It is inferred that when comparing precise nitrogen management techniques, top dressing of N as per LCC recorded the highest panicles m^{-2} (304.5 m^{-2}), test weight (24.1 g), and grain production (6124.8 kg ha^{-1}) than green seeker, nutrient expert and RDF.

Keywords: Rice, AWD, Sensor, LCC, Nutrient expert, Green seeker.

INTRODUCTION

Water use is becoming one of the more worrisome environmental issues in many parts of the world as the planetary population continues to expand and resources become more constrained. The amount of water used to keep the fields in optimum condition can occasionally be wasted by ineffective irrigation practices used on farms, especially when it comes to rice. It is a fallacy that rice can only be produced in submerged environments. Farmers in India and many other countries across the world regularly pond their rice crop for over 80% of the time they are in cultivation. Previously rice was cultivated in submerged conditions to control weeds but over time it has become mandatory. A switch from a continuously submerged system to an alternate wetting and drying system is therefore necessary. Continuous flooding can be avoided by AWD, which also conserves water. There is an added benefit if AWD can be automated using IoT (Internet of Things). Thus, the primary goal is to optimize the use of water in agricultural irrigation systems by applying artificial intelligence techniques and thereby reducing the quantity of water lost with conventional irrigation systems. Modern farmers are using cutting-edge technology to track crop productivity, gather data on crop growth, and collect weather data. IoT can connect all of them, and automated irrigation was once the place to start. By using IoT farmers can regulate the irrigation water as per crop needs. As a result, irrigation efficiency and water productivity are improved while ensuring logical water distribution.

Because so much nitrogen is lost from the soil through leaching and denitrification, rice has an extremely low nitrogen utilization efficiency of less than 30 to 40 %. The efficiency of added fertilizer N in rice is influenced by N sources, application techniques, N rates, and management techniques (Wang *et al*., 2011). For researchers and producers, effective management of fertilizers, particularly N, remains a significant concern. Therefore, implementing intelligent management strategies at the right moment according to the crop's needs is absolutely essential. Utilizing precise nitrogen management strategies, such as LCC, green seeker, and nutrient expert-based nitrogen management, can optimize and recommend nitrogen and meet crop nutrient needs while causing minimal environmental damage. Keeping the views above the experiment was planned to study the response of rice (*Oryza sativa* L) to irrigation regimes and precise nitrogen management.

MATERIALS AND METHODS

During the *kharif* season of 2021, the field experiment was held at the Water Technology Centre, College

Farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana. The experimental site was located at 17°32' N Latitude, 78°40' E Longitude, and an altitude of 542.6 m above mean sea level. The experiment field had a sandy clay texture, a pH of 7.6, and an EC of 0.86 dS m^{-1}. It was low in organic carbon (0.45%) and available nitrogen (242 kg ha^{-1}) but high in available phosphorous (34.5 kg ha^{-1}) and potassium (197.6 kg ha^{-1}). KNM-118 paddy variety was transplanted 30 days after sowing with 2-3 seedlings per hill with a spacing of 15cm × 15cm. The experiment was laid out in strip-plot design with three irrigation methods as main plot treatments *viz*., I_1- Alternate wetting and drying by the sensor-based semi-automatic - Irrigation up to 5 cm depth throughout the crop growth when the water level drops 5 cm below ground level, I_2- Alternate wetting and drying by manual - Irrigation up to 5 cm depth throughout the crop growth when the water level drops 5 cm below ground level, I_3-Flooded transplanted rice- 2-5 cm of water depth as per crop growth stage (control) and four nitrogen treatments as subplot treatments viz., N_1- Basal 1/3rd of N as soil application + top dressing of nitrogen as per LCC values, N_2 - Basal 1/3rd of N as soil application + top dressing of nitrogen as per green seeker values, N_3 - Nutrient expert-based nitrogen management, N_4- Recommended dose of fertilizer (120-60-40 kg NPK ha^{-1}). Each plot was separated by providing buffer channels for proper maintenance of the treatments. The amount of water applied to the field is measured with the help of a water meter.

In irrigation methods, AWD by manual irrigation the water level in the field is observed using a field water tube and when the water level reaches 5cm below ground level, the field was irrigated until 5cm above the ground and in AWD by sensor-based irrigation, water was applied to the field based on the indication from the sensor.For this study, we used the Smart Paddy Internet of Things technology, which applies to rice fields with fully automated and autonomous behaviour. Sensor can be automated in such a way that when the water level falls below 5cm below ground level, the motor turns on, and when the water level rises above 5cm above ground level, the motor turns off, preventing over-application of water.The farmer can control flows, volumes, and water levels in the fields using a special website, mobile app, or SMS service by manually operating when necessary or by configuring the irrigation program in accordance with the water requirements of various water-saving strategies.

In nitrogen management treatments nitrogen fertilizer was applied based on the LCC(Leaf colour chart is an easy-to-use tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N and urea was applied when leaf matches LCC-3), and Green seeker (Green seeker handheld sensor is an easy-to-use optical sensor that instantly measures plant height and vigor in terms of NDVI readings and urea was applied when NDVI value is less than 0.7) in N_1 and N_2 respectively, whereas in N_3 nitrogen fertilizer was applied in accordance with Nutrient expert software and in N_4 as per recommended dosage(120-60-40 Kg NPK ha^{-1}).

RESULTS AND DISCUSSION

A. Yield Attributes

Number of Panicles (m^{-2}). The number of panicles m^{-2} was higher in I_3 (308 m^{-2}) than in I_1 (266 m^{-2}) and I_2 (273 m^{-2}) (Table 1). The lower number of panicles m^{-2} observed during the later water regime may be due to the fact that plants under moisture stress could not extract more nutrients from the deeper soil layer due to moisture deficit conditions. This ultimately resulted in poor growth, fewer tillers, and subsequently fewer panicles. Kumar *et al*. (2014); Sandhu *et al*. (2012) reported similar findings.

The number of panicles m^{-2} was much higher in the N_1 (304 m^{-2}) than in the N_3(261 m^{-2}) and N_2 (271 m^{-2}) and were on par with the N_4 (293 m^{-2}) (Table 1). The lowest number of panicles m^{-2}in N_3may be the result of insufficient nitrogen for crops to grow and develop more effectively (Sandya Rani, 2012). The findings concur with those of Sun *et al*. (2012); Ali Abdalla and Abou-Khalifa (2012).

Panicle Length(cm). Panicle length was higher in I_3 (22.8 cm) than in I_1 (21.0 cm) and I_2 (21.3 cm) (Table 1). The lower panicle length in I_1 and I_2could be due to thedue to lower water level might have caused moisture stress to rice plants.These findings are in consistent with those of Azarpour *et al*. (2011); Rahaman and Sinha (2013).

The panicle length was much higher in the N_1 (22.8 cm) than in the N_3 (20.4 cm) and N_2 (21.5 cm) and on par with the N_4 (22.2 cm) (Table 1). It is viable that the increased availability and uptake of N, which is a substrate for the synthesis of organic compounds that comprise protoplasm and chlorophyll, caused an increase in cell division and enlargement at higher nitrogen doses (Avijit *et al*., 2011). The findings of this study are similar to those of Malik *et al*. (2014); Ali Abdalla and Abou-Khalifa (2012); Debnath and Bandyopadhyay (2008).

Test Weight (g). In contrast to I_1 (21.6 g) and I_2 (23.8 g), I_3 had a higher test weight (21.9 g) (Table 1). Whereas I_1 and I_2 were on par with each other. According to the findings of several researchers, test weight can increase when crops receive enough water without being stressed during the flowering and grain development stages (Pandey *et al*., 2010; Rahaman and Sinha, 2013; Srinivasulu, 2017).

Test weight (g) was substantially greater in N_1 (24.1 g) than in N_2 (22.1 g), N_3 (20.6 g), and was on par with the N_4 (23.0 g) (Table 1). The increased test weight could result from higher nitrogen application levels than lower nitrogen application levels transferring more carbohydrates to grain. Bhavana *et al*. (2020) reported findings that were comparable to these findings.

Grain Yield (kg ha^{-1}). In comparison to I_1 (5532 kg ha^{-1}) and I_2 (5582 kg ha^{-1}), I_3 had a higher grain production of 6302 kg ha^{-1}(Table 1). While I_1 and I_2 were on par with each other. The improved performance of the crop plants was aided by a favourable soil water balance under saturation, which may have contributed to the higher seed yield observed in the flooded transplanted rice. This favourable vegetative growth and development under an adequate and sufficient moisture regime were maintained throughout the crop growth. As a result, crop plants that received regular flooding irrigation when ponded water disappeared from the surface of the ground produced more tillers. Similar findings had been made by several other researchers Pandey *et al*. (2010); Kumar *et al*. (2013); Srinivasulu *et al*. (2017).

Table 1: Influence of irrigation regimes and precise nitrogen management on yield and yield attributes in rice, 2021.

Treatments	No. of panicles m^{-2}	Panicle length (cm)	Test weight (g)	Grain yield (kg ha^{-1})	Harvest index
Mainplot– (Irrigation regimes)					
I_1: AWD by sensor-based semi-automatic	266	21.0	21.6	5532	47.5
I_2: AWD by manual	273	21.3	21.9	5582	47.9
I_3: Flooded transplanted rice	308	22.8	23.8	6302	46.9
SEm±	8	0.3	0.4	145	0.7
C.D(P=0.05)	32	1.3	1.8	571	NS
Subplot– (Nitrogen levels)					
N1 : Top dressing of N as per LCC	304	22.8	24.1	6125	48.5
N_2 : Top dressing of N as per green seeker	271	21.5	22.1	5792	49.1
N_3 : Nutrient expert based	261	20.4	20.6	5390	45.5
N_4: RDF (120-60-40)	293	22.2	23.0	5915	46.7
SEm±	9	0.5	0.4	100	0.7
C.D(P=0.05)	31	1.6	1.5	348	2.4
Interaction:					
I at same or different level of N					
SEm±	12	0.7	0.8	162	1.5
C.D(P=0.05)	NS	NS	NS	609	NS
N at same or different level of I					
SEm±	12	0.7	0.7	120	1.4
C.D(P=0.05)	NS	NS	NS	403	NS

The grain yield in N_1 (6125 kg ha^{-1}) was significantly greater than that in N_3 (5390 kg ha^{-1}) and was comparable to that in N_2 (5792 kg ha^{-1}) and N_4 (5915 kg ha^{-1}) (Table 1). The enhancement of yield characteristics, which in turn increased the yield, was presumably caused by an adequate N supply during the reproductive growth phase (Duttarganvi *et al*., 2014). Kenchaiah *et al.* (2000) also found higher grain yield under LCC-based N management than the blanket recommendation. Similar findings were reported by Manjappa *et al*. (2006); Houshmandfar and Kimaro (2011); Sui *et al*. (2013); Bhavana *et al*. (2020).

Harvest Index. A higher harvest index was recorded in I_2 (47.9) than in I_3 (46.9) and was on par with I_1 (47.5) (Table 1). A significantly higher harvest index was observed in N_2 (49.1) than in N_3 (45.5) and was on par with N_1 (48.5) and N_4 (46.7) (Table 1). Timely release of nitrogen in a sustained manner to absorb and translocate sufficient quantities of photosynthates to the sink, resulted in the production of elevated yield structure and yield in top dressing of N as per LCC. This study findings concur with those of Moharana *et al*. (2017); Tauseeef Ahmad (2014).

Water Saving. Amount of water saved in AWD by sensor-based semi-automatic irrigation and AWD by manual irrigation is 25.2% and 23.3 % higher than flooded transplanted rice.

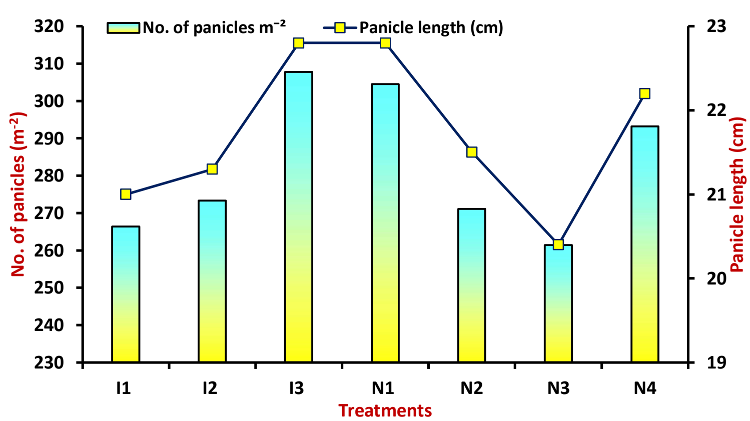

Fig. 1. Influence of irrigation regimes and nitrogen management practices on no. of panicles m^{-2}, panicle length (cm).

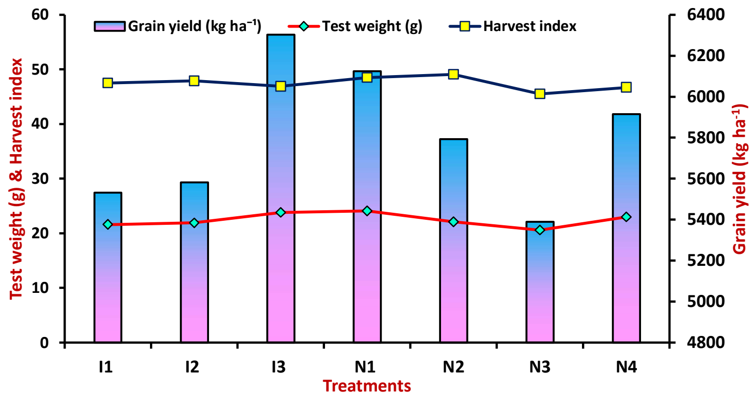

Fig. 2. Influence of irrigation regimes and nitrogen management practices on grain yield, test weight, and harvest index.

Fig. 3. Green seeker handheld sensor.

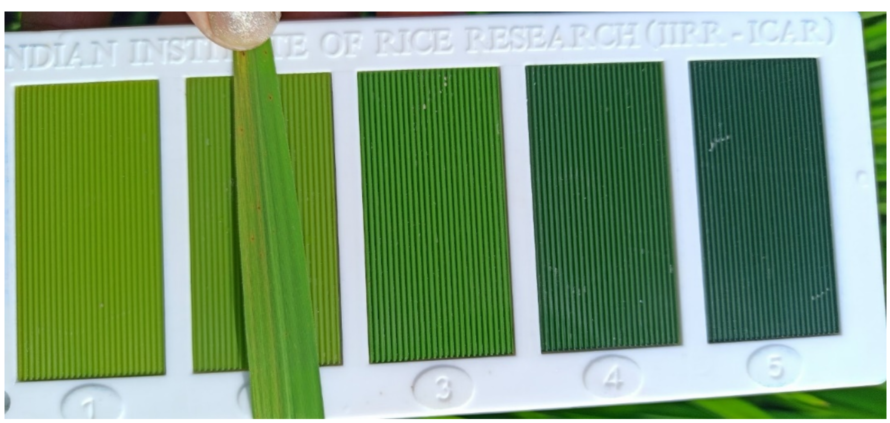

Fig. 4. Leaf colour chart.

CONCLUSION

According to the findings, flooded transplanted rice recorded significantly higher yield attributes and grain yield, than AWD by sensor-based semi-automatic and AWD by manual irrigation. However, AWD is safe to apply in rice because it saves a lot of water (23.3 to 25.2 %) while just slightly reducing grain yield. Top dressing of nitrogen according to LCC resulted in higher yield attributes and grain yield, than other precise nitrogen management practices. However, application of N according to green seeker has the highest harvest index (49.1), indicating that with less N, the yield obtained is high, so using green seeker to apply nitrogen gives better results in terms of grain yield.

FUTURE SCOPE

This research will assist farmers in understanding the appropriate irrigation and nitrogen control practises. Furthermore, advances in AWD and precise nitrogen management practises have a stronger impact on water conservation and nitrogen usage.

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Conflict of Interest. None.

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