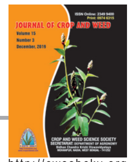
Journal of Crop and Weed, 17(1): 110-114 (2021)

ISSN- O : 2349 9400 ; P : 0974 6315



http://cwssbckv.org
www.cropandweed.com

Productivity of rice as influenced by irrigation regimes and nitrogen management practices under mechanized transplanting

*G. VIJAYSHEKAR, M. M. REDDY AND R. M. KUMAR

Agricultural Officer, Kamareddy District, Telangana, India.
Professor (Agronomy) & Head, University Computer Centre, PJTSAU, Rajendranagar, Hyderabad, India
Principal Scientist & Head, Department of Agronomy, ICAR-Indian Institute of Rice Research
Rajendranagar, Hyderabad, India

Received : 25.11.2020 ; Revised : 28.12.2020 ; Accepted : 05.01.2021

DOI : https://doi.org/10.22271/09746315.2021.v17.i1.1412

ABSTRACT

A field experiment was carried out during kharif 2014 on clay loam soil at Indian Institute of Rice Research, Hyderabad with an objective to study the response of rice to irrigation regimes and nitrogen levels under mechanized transplanting. The experiment was laid out in a split plot design with three replications. Three irrigation regimes were taken as main plots and four nitrogen levels in subplots. Irrigation regimes include I_1: Submergence (3±2 cm) throughout the crop period, I_2: Saturation up to panicle initiation stage followed by maintaining (3±2 cm) standing water till maturity, I_3: Alternate wetting and drying irrigation through PVC water pipe at (5 cm) fall from ground level and nitrogen levels viz., N_1: 75 % RDN (90 kg ha^{-1}), N_2: 100 % RDN (120 kg ha^{-1}), N_3: 125 % RDN (150 kg ha^{-1}) and N_4: 150 % RDN (180 kg ha^{-1}). Results revealed that saturation up to panicle initiation stage followed by maintaining (3±2 cm) standing water till maturity proved significantly superior in terms of yield attributes, grain and straw yield (7386 and 9638 kg ha^{-1} , respectively), water productivity (0.55 kg m^{-3}) and PFP N (nitrogen use efficiency) (55.8kg grain kg^{-1} N applied)over submergence (3±2 cm) throughout the crop period .150 % RDN recorded significantly higher yield attributes, grain and straw yield (8366 and 10611 kg ha^{-1} , respectively) and water productivity (0.57 kg m^{-3}) compared to 125 % RDN.Combination of maintenance of saturation up to panicle initiation stage followed by submergence till maturity and 150 kg N ha^{-1} was found to be the best for higher yield, water productivity and PFP N in rice under mechanized transplanting.

Keywords: Alternate wetting and drying, mechanised transplanting, water productivity, effective rainfall, partial factor productivity of nitrogen

Rice occupies an area of 44.1 M ha with a production of 116.47 M tonnes and productivity of 2638 kg ha^{-1}in India (Indiastat, 2020). It is a major food crop of Telangana State contributing 1.93 M ha area with a production of 6.66 M tones (Socio Economic Outlook-Telangana, 2020).

Traditional rice cultivation involves submerged condition with around 5 cm depth standing water throughout the crop period. It requires around 3000 litres of water for producing one kg of grain which is about twice or even more than that for wheat or maize (Joshi *et al*., 2009). However, the increasing scarcity of fresh water for agriculture and competing demand from the non-agricultural sector threaten the sustainability of rice ecosystem. Hence, the major challenges are to produce more rice, increase water productivity and reduce water input in the fields.

Rice is traditionally a transplanted crop in India. The transplanting itself is a cumbersome practice,which requires more labour. In recent years, because of scarce labour coupled with higher wages during the peak period of farm operations invariably lead to delay in transplanting. This is aggravated by untimely release of water from canals and delayed monsoon rains which force to identify alternate methods of rice cultivation without reduction in yield. Among them, transplanting using mechanical transplanter and SRI method of cultivation gained significance among farmers because of easy adoptability, less cost and on par yield with that of conventional transplanting method (Mitra *et al*., 2013). Mechanical transplanting of rice with transplanter is an alternative to complete the transplanting in time with less labour thereby achieving maximum productivity of crop. In addition, mechanization in rice releases the work force to other sectors. Among different agronomic measures, nutrient management deserves special attention in hybrid rice cultivation. Rice is a bulk consumer of nitrogen, but nitrogen use efficiency is very low in low land rice. Nitrogen applied is lost from soil through leaching and denitrification. Excessive N supply or inadequate N does not provide an appropriate environment for hybrid rice to exploit its potential. Thus, there is a need to find out optimum N level for higher productivity in hybrid rice. Keeping these points in view, the experiment was conducted to evaluate the irrigation regimes and nitrogen levels on production potential of hybrid rice under mechanized transplanting.

Email: vijayshekaragri099@gmail.com

MATERIALS AND METHODS

A field experiment was conducted during *kharif,* 2014 on clay loam soil at Indian Institute of Rice Research, Hyderabad situated at an altitude of 542.3 m above MSL, 17°19′ N latitude and 78°23′ E longitude with an objective to study the response of rice to irrigation regimes and nitrogen levels under mechanized transplanting. The experiment was laid out in a split plot design with three replications. Three irrigation regimes were taken as main plots and four nitrogen levels in subplots. Irrigation regimes include I_1: Submergence (3±2 cm) throughout the crop period, I_2: Saturation up to panicle initiation (PI) stage followed by maintaining (3±2 cm) standing water till maturity, I_3: Alternate wetting and drying irrigation (AWDI) through PVC water pipe at (5 cm) fall from ground level and nitrogen levels *viz.,* N_1: 75 % RDN (90 kg ha^{-1}), N_2: 100 % RDN (120 kg ha^{-1}), N_3: 125 % RDN (150 kg ha^{-1}) and N_4: 150 % RDN (180 kg ha^{-1}). The hybrid 'DRRH-3' with the duration of 120-130 days was used for the study. The texture of the experimental soil was clayey loam with the available soil moisture holding capacity of 20.8 mm in 0-15 cm and 18.8 mm in15-30 cm soil depth. Mat type of nursery was prepared by laying plastic sheets. The sprouted seeds were broadcasted uniformly and sparsely on each frame @15 kg ha^{-1} and then covered with a thin layer of vermicompost (0.5 cm). After a week of sowing water was applied through the water channel until transplanting. During transplanting (18 days old seedlings), the mats were lifted from the plastic sheets and placed directly on the trays of the transplanter. Yangi – china paddy transplanter (Self-propelled - Riding type) was used for planting the rice seedlings at a spacing of 22.5 x 10 cm on 25.07.2014. A uniform dose of 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied basally in the form of SSP and KCl, respectively. Nitrogen was applied in the form of urea as per the treatments. It was applied in three equal splits *viz*., as basal, maximum tillering and panicle initiation stages. Farmers practice was followed till 10 DAT for proper establishment. Each plot was irrigated separately. The irrigation water was measured with water meter. Depth of irrigation water (mm) applied was computed by dividing the volume of water applied with the area of plot.After 10 DAT, the irrigation schedules were adopted as per the treatments. In conventional method, 3cm depth of irrigation from 15 DAT to panicle initiation stage and 5 cm depth from panicle initiation to physiological maturity was maintained. In saturation method, the soil was kept as close to saturation as possible, thereby reducing the hydraulic head of the ponded water, it means that a shallow irrigation was given to attain about 2.5 cm depth of ponded water through water meter. Whenever, water falls below 2.5 cm marked peg, once again irrigation was given, so that the soil was then kept always at above the saturation level upto panicle initiation stage followed by maintaining (3±2 cm) standing water till maturity. In each main plots of AWDI practice, field water tube was placed to measure the depth of standing water and water table in the field, either above the surface or below the surface. Using this tube, irrigation was given when water depth goes below the surface to 5 cm. Water table depth in this tube was measured by simple ruler. The subsequent irrigation was given to re-flood the field to a depth of 5 cm as per the treatments. These practices suspended in the treatments from one week before to one week after flowering. During which ponded water was always kept at 5 cm depth over the surface. Irrigation was withheld 15 days ahead of harvest. The crop was harvested on 20.11.2014.Water productivity (WP) (kg m^{-3}) was calculated by the following formula as adopted by Grassi *et al*. (2009).

$$WP = \frac{\text{Grain yield } \left(\text{kg ha}^{-1}\right)}{\text{Total water used } (\text{mm})}$$

The efficiency with which the applied nitrogen is used by the crop towards grain production was evaluated through partial factor productivity. Partial factor productivity of nitrogen (PFP N)was computed as follows:

Partial factor productivity of nitrogen =

$$\frac{\text{Grain yield } \left(\text{kg ha}^{-1}\right)}{\text{Total amount of N applied } \left(\text{kg ha}^{-1}\right)}$$

The experimental data recorded on different yield parameters, yield, water productivity and PFP N were analyzed statistically by applying the technique of analysis of variance for split plot design and significance was tested by F- test (Gomez and Gomez, 1984). Critical difference for examining means for their significance was calculated at 5 per cent level of probability.

RESULTS AND DISCUSSION

The yield attributes (number of panicles m^{-2}, filled spikelets panicle $^{-1}$and 1000-grain weight) significantly varied with irrigation regimes and nitrogen levels (Table1).Irrigation maintained at saturation up to PI stage followed by submergence condition had registered higher number of panicles m^{-2} and filled spikelets panicle $^{-1}$and it was at par with AWDI and significantly superior over submergence throughout the crop period. The difference in panicles m^{-2} between saturation and AWDI is narrow (3.4 per cent) and between saturation condition and AWDI was 2.9 per cent only. Significantly lower

Table 1: Yield attributes, grain and straw yield, harvest index, water productivity and PFP N of rice as influenced by irrigation regimes and N levels under mechanized transplanting

Treatment	Panicles m^{-2}	Filled spikelets $panicle^{-1}$	1000 - grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Water productivity (kg m^{-3})	PFP N (kg grain kg^{-1} N applied)
I_1	293	129	17.9	6804	9008	42.9	0.41	51.5
I_2	323	140	18.2	7386	9638	43.2	0.55	55.8
I_3	312	136	18.1	6979	9178	43.1	0.49	53.0
SEm (+)	**5.0**	**2.1**	**0.1**	**113**	**117**	**0.1**	**0.01**	**0.9**
LSD (0.05)	**15.6**	**8.3**	**NS**	**443**	**460**	**NS**	**0.03**	**NS**
N_1 : 90	281	117	16.7	5306	7471	41.5	0.37	58.9
N_2 : 120	298	132	17.6	6680	8896	42.9	0.46	55.7
N_3 : 150	319	142	18.5	7873	10120	43.7	0.54	52.5
N_4 : 180	339	149	19.4	8366	10611	44.1	0.57	46.4
SEm (+)	**2.7**	**1.3**	**0.1**	**47**	**52**	**0.1**	**0.003**	**0.35**
LSD (0.05)	**8.1**	**4.0**	**0.2**	**140**	**154**	**0.3**	**0.010**	**1.05**
Interaction								
N at same level of I								
SEm (+)	**4.7**	**2.3**	**0.1**	**81.9**	**89.5**	**0.2**	**0.01**	**0.6**
LSD (0.05)	**14.0**	**NS**	**NS**	**243.2**	**266.0**	**NS**	**0.03**	**NS**
I at same or different level of N								
SEm (+)	**27.5**	**12.6**	**0.6**	**557.9**	**589.4**	**0.8**	**0.04**	**4.36**
LSD (0.05)	**95.4**	**NS**	**NS**	**2006.9**	**2106.4**	**NS**	**0.14**	**NS**

I_1: Submergence (3+2 cm) throughout the crop period; I_2: Saturation upto panicle initiation stage followed by maintaining (3+2 cm) standing water till maturity; I_3: Alternate wetting and drying through PVC water pipe at (5 cm) fall from ground level

number of panicles and filled spikelets were recorded under submergence throughout the crop period. It might be due to more number of tiller production and better root growth with less mortality led to more number of panicles m^{-2} with maintenance of thin film of water up to the panicle initiation stage. This condition facilitates adequate moisture supply and more nutrient uptake resulted in efficient partitioning of dry matter at grain filling stage. These results were in line with Lin *et al.* (2006), Sairam and Anuar (2010) and Wang *et al.* (2011).

Significantly higher number of panicles m^{-2} and filled spikelets $panicle^{-1}$ were recorded with 180 kg N ha^{-1}. Significantly lower yield attributes were observed with 90 kg N ha^{-1}(Table 1). Increased nitrogen application under saturated condition might have led to availability of N in sufficient quantities required by the crop which encouraged the increased sink formation led to more number of panicles. These results were supported by Pandey *et al.* (2008), Salem *et al.* (2011), Srinivasan *et al.* (2008), Philip *et al.* (2012) and Santhosh *et al.* (2013). Significantly more test weight was recorded with 180 kg N ha^{-1} which was on par with 150 and 120 kg N ha^{-1}(Table 1). It might be due to more amount of carbohydrate transfer to grain under higher nitrogen levels. Similar results were reported by Manzoor *et al.* (2006).

The grain yield of rice was significantly higher with saturation upto PI stage followed by submergence till maturity than the submergence throughout the crop growth period, but it was at par with AWDI regime (Table 1) . It might be due to more number of productive tillers and filled grains per panicle helped in increased grain yield compared to other irrigation regimes. With respect to straw yield, saturation upto PI stage followed by submergence was superior to the rest of the irrigation regimes(Table 1).This may be due to adequate moisture availability and better nutrient absorption under saturated condition increased the dry matter accumulation led to higher straw yield. Similar trend was observed by Dhar *et al.* (2008), Sairam and Anuar (2010) and Kumar *et al.* (2014). Harvest index remained unaffected by the irrigation regimes.

Among the nitrogen levels, highest grain, straw yield and harvest index were observed with 180 kg N ha^{-1} superior to the lower levels. Higher in grain yield with higher N application was due to increased number of panicles, more number of filled grains per panicle and higher 1000 grain weight. These results were in accordance with the findings of Manzoor *et al.* (2006), Salem *et al.* (2011) and Santhosh *et al.* (2013).

Significantly higher water productivity was recorded in saturation upto PI stage followed by submergence till maturity over the other two irrigation regimes (Table 1).This might be due to more amount of water applied under submergence throughout the crop period produced lesser yield. These results were in line with that of Shenggang *et al.* (2009). PFP N (nitrogen use efficiency) did not vary due to different irrigation treatments. Water productivity increased with increased levels of nitrogen from 90 to 180 kg N ha^{-1} .This is because adequate supply of nitrogen throughout the crop period led to higher yield and hence higher water productivity. These results were in conformity with Ramakrishna *et al.* (2007).While PFP N (nitrogen use efficiency) followed the reverse trend where it was the lowest with 180 kg N ha^{-1} over the rest of the levels (Table 1).This was in accordance to the statement that crop response to applied nutrients typically follows a diminishing return function as yields approach the potential limit (Hegde *et al*., 2007). These results were in line with Mahajan *et al.* (2012) and Majid Ashouri (2014).

The amount of irrigation water applied was 1325.5 mm in submergence throughout the crop growth period which was more compared to saturation up to PI stage followed by submergence and alternate wetting and drying irrigation (AWDI) (1005.8 mm and 1062.4 mm, respectively). Irrigation with submergence throughout the crop growth period used 19.84 and 24.10 per cent more water compared to the saturation up to PI stage followed by submergence and alternate wetting and drying irrigation, respectively. Among the irrigation regimes, alternate wetting and drying irrigation used more rainfall (338.7 mm) as compared to saturation up to PI stage followed by submergence till maturity (325.0 mm) and submergence throughout the crop growth period (293.3 mm). Water requirement (irrigation water + effective rainfall) of the crop ranged from 1330.5 to 1618.8 mm in different irrigation regimes. Among the irrigation regimes, the highest quantity of water was consumed in the submergence throughout the crop period and the lowest was consumed by saturation up to PI stage followed by submergence till maturity. Water saving of 21.6 per cent was observed with saturation up to PI stage followed by submergence till maturity over submergence throughout the crop period. Considerable water saving with intermittent method of irrigation over flooded method had been brought out by several researchers (Belder *et al*.,2005 and Geethalakshimi *et al*., 2009)

It can be concluded that the combination of maintenance of saturation up to panicle initiation stage followed by submergence till maturity and 150 kg N ha^{-1} was found to be the best for higher yield, water productivity and PFP N in rice under mechanized transplanting.

REFERENCES

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

Dhar, R., Gupta, N.K and Samata, A. 2008. Effect of irrigation scheduling on the performance of *kharif* rice grown under different establishment methods. *J. of Research SKUAST-J.*, **7**(2): 277-280.

Geethalakshmi,V., Ramesh,T., Azhapalamuthirsolai and Lakshmanan, A. 2009. Productivity and water usage of rice as influenced by different cultivation systems. *Madras Agricultural J.*., **96** (7-12):349-352.

Grassi, C., Bouman, B.A.M., Castaneda, A.R., Manzelli, M. and Vecchio, V. 2009, Aerobic rice: crop performance and water use efficiency. *J. of Agriculture and Environment Development*, **103**(4):259-270.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research* (1st Edition). John Wiley and Sons, Wiley and Sons, Wiley Inter Science Publication, New York, USA., 680.

Hegde, D.M., Babu, S.N.S., Qureshi, A.A and Murthy, I.Y.L.N. 2007. Enhancing nutrient-use efficiency in crop production- a review. *Indian J. of Agron.,***52**(4): 261-274.

Indiastat. 2020. https://www.indiastat.com/agriculture-data/2/ agricultural production/225/ stats.aspx.

Joshi, R., Mani, S.C., Shukla, A. and Pant, R.C.2009. Aerobic rice: Water use sustainability. *Oryza.*,**46**(1): 1-5

Kumar, S., Singh, R.S. and Kumar, K. 2014. Yield and nutrient uptake of transplanted rice (*Oryza sativa*) with different moisture regimes and integrated nutrient supply. *Current Adv. in Agricultural Sci.,***6**(1): 64-66.

Lin, X., Zhou, W., Zhu, D., Chen, H. and Zhang, Y. 2006. Nitrogen accumulation, remobilization and portioning in rice under an improved irrigation condition. *Field Crops Res.,* **96**:67-75

Mahajan, G., Chauhan, B.S., Timsinia, J., Singh, P.P. and Singh, K. 2012. Crop performance and water and nitrogen use efficiencies in dry-seeded rice in response to irrigation and fertilizer amounts in northwest India. *Field Crops Res.,* **134**: 59-70.

Majid Ashouri. 2014. Water Use Efficiency, Irrigation Management and Nitrogen Utilization in Rice Production in the North of Iran. *APCBEE Proceedings.,* **8**: 70 – 74.

Manzoor, Z., Awan, T.M., Zahid, M.A and Faiz.2006. Response of rice crop (Super Basmati) to different nitrogen levels. *J. of Animal and Plant Science.,* **16**: 1-2.

Mitra, B., Mookherjee, S., Biswas,S. and Mukhopadhyay, P. 2013. Potential water saving through system of rice intensification (SRI) in Terai region of West Bengal,India. *Intl. J. Bio Res. and Stress Management*: 449-451.

Pandey, N., Verma, A.K. and Tripathi, R.S. 2008. Effect of planting dates and N levels on N concentration in the leaf, grain yield and N uptake by hybrid rice. *Oryza.,* **45**(1): 18-22.

Philip, P.J., Girish, S., Pushpraj, S. and Smita. 2012. Effect of different nitrogen levels on newly developed rice varieties under transplanted condition. *Agricultural Science Digest.*,**32** (1)75.

Ramakrishna, Y., Singh, S. and Parihar, S.S. 2007. Influence of irrigation regime and nitrogen management on productivity, nitrogen uptake and water use by rice (*Oryza sativa*).*Indian J. of Agron.*,**52**(2): 102-106.

Sairam, O. and Anuar, A.R. 2010. Effect of irrigation regime on irrigated rice. *J. of Tropical Agriculture and Food Science.*,**38**(1): 1-9.

Salem, A.K.M., Elkhoby, W.M., Abou, K. and Ceesay, M. 2011. Effect of nitrogen fertilizer and seedling age on inbreed and hybrid rice varieties. *American-Eurasian J. of Agriculture and Environmental Science.*, **11**(5): 640-646.

Santhosh, K. ., Srinivasa Raju, M. and Mahender Kumar, R. 2013. Production potentialities of rice genotypes as influenced by nitrogen levels. *Indian J. Agric. Sci.*,**47**(2): 169-172.

Shenggang, P., Cougui, C., Mingli, C., Wang, J., Jing, Z. and Shengqi, H. 2009. Effects of irrigation regime and nitrogen management on grain yield, quality and water productivity in rice. *J. of Food Agriculture and Environment.,***7**(2): 559-564.

Socio Economic Outlook. 2020. *Directorate of Economics and Statistics*, Government of Telangana, Hyderabad

Srinivasan, E.K., Natarajan, S., Ganapathy, M. and ArivaZhagan, K. 2008. Effect of nitrogen levels and weed management in hybrid rice. *Oryza*., **45**(2): 160-162.

Wang, X., Suo, Y., Feng, Y., Shohag, M. J.I and Lin, X. 2011. Recovery of N-labelled urea and soil nitrogen dynamics as affected by irrigation management and nitrogen application rate in a double rice cropping system. *Plant and Soil.,***343**:195-208.