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# INFLUENCE OF IRRIGATION REGIMES AND NITROGEN LEVELS ON GROWTH AND YIELD OF RICE UNDER MECHANISED SRI CULTIVATION

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## 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 MSRI (Mechanised System of Rice Intensification) cultivation. 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. Results revealed that taller plants, high LAI, higher tiller and dry matter production were observed with the maintenance of saturation up to panicle initiation (PI) stage. Irrigation to maintain saturation level up to PI stage had registered significantly higher grain yield (7386 kg ha$^{-1}$), which was 7.9 and 5.6 % higher than submergence throughout the CGP (6804 kg ha$^{-1}$) and AWDI (6979 kg ha$^{-1}$), respectively. Significantly higher values of growth parameters were recorded with 180 kg N ha$^{-1}$. Significantly higher grain yield (8366 kg ha$^{-1}$) was reported with180 kg N ha$^{-1}$ but the difference between 180 and 150 kg N ha$^{-1}$ is very narrow (5.9 %) compared to lower levels, which were 20.2 and 36.5 % lower than the 180 kg N ha$^{-1}$

## INTRODUCTION

In India, rice (*Oryza sativa* L.) occupies an area of 44.1 M ha with a production of 116.47 M tons and average productivity of 26.38 q ha$^{1}$(Indiastat, 2020). It is the major food crop of Telangana State, contributing 1.93 M ha area with the production of 6.66 M tons (Socio Economic Outlook-Telangana, 2020).

Traditional rice production involves submerged conditions with approximately 5 to 10 cm deep standing water throughout the crop growth period. This system requires around 3000 to 5000 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 irrigated rice ecosystem. Hence, the major challenges are to produce more rice, increase water productivity and reduce water input in the fields.

Rice is traditionally planted by transplanting method in India in spite of the fact that it is cumbersome practice and 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 (Manjappa and Kataraki, 2004). This is aggravated by untimely release of water from canals and delayed monsoon showers 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. System of Rice Intensification is an emerging water saving technology which can help the farmers to overcome the present water crisis (Mandal and Pramanick, 2015). 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 (Vasudevan *et al.,* 2014). Among different agronomic measures, nutrient management deserves special attention in hybrid rice cultivation. Rice is bulk consumer of nitrogen, but nitrogen use efficiency is very low in rice. Nitrogen applied in lowland rice is lost from soil through leaching and denitrification. Excessive N supply or inadequate N does not provide an appropriate environment for hybrid to exploit its potential (Mahender Kumar *et al.,* 2000) Thus, there is a need to work out optimum N requirement to find out the extent of yield improvement in rice production. Keeping these points in view, the present study is proposed to evaluate the irrigation regimes and nitrogen levels on production potential of hybrid rice under mechanized SRI cultivation method.

## MATERIALS AND METHODS

A field experiment was carried out during *kharif* 2014 on clay loam soil at Indian Institute of Rice Research, Hyderabad situated at an altitude of 542.3 m above mean sea level , 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 MSRI cultivation. 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 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 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 (15-30 cm) soil depth. Mat type of nursery was prepared by laying plastic sheets. The sprouted seeds were broadcasted uniformly and sparsely on each frame @ 30 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. A uniform dose of 60 kg $P_2O_5$ and 40 kg $K_2O$ ha$^{-1}$ was applied basally in the form of single super phosphate and murate of potash, respectively. Nitrogen (120 kg N) was applied in the form of urea as per the treatments. It was applied in three equal splits *viz.*, as basal, 30 DAT (Maximum tillering) and panicle initiation stages. Farmers practice was followed till 10 DAT for proper establishment. The irrigation water was measured by using water meter. After 10 DAT, the irrigation schedules were adopted as per the treatments. In conventional method of flooding with 3cm depth from 15 DAT to panicle initiation stage and 5 cm depth of irrigation from panicle initiation to Physiological maturity. In saturation method practice, the soil was kept as close to saturation as possible, thereby reducing the hydraulic head of the ponded water, in practice it means that a shallow irrigation is 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 were placed to measure the depth of standing water and water tables 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 respective to treatment. 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 experimental data recorded on different yield parameters, yield and water productivity 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 treatmental means for their significance was calculated at 5 percent level of probability.

**Table 1: Plant height (cm) as influenced by irrigation regimes and N levels under MSRI in rice**

| Treatment | 30 DAT | 60 DAT | 90 DAT | Harvest |
|---|---|---|---|---|
| Irrigation Regimes (I) | | | | |
| $I_1$ | 46.9 | 78.5 | 96.8 | 95.9 |
| $I_2$ | 50.6 | 84.7 | 104.4 | 103.1 |
| $I_3$ | 47.1 | 81.5 | 103.1 | 102.9 |
| SEm ± | 1.3 | 0.9 | 1.5 | 1.1 |
| CD (P = 0.05) | NS | 3.6 | 5.7 | 4.6 |
| Sub Plots: N Levels (kg ha-1) (N) | | | | |
| $N_1$ : 90 | 42.8 | 72.9 | 94 | 93 |
| $N_2$ : 120 | 46.9 | 80.2 | 99.8 | 98.3 |
| $N_3$ : 150 | 50.6 | 86.5 | 106.7 | 105.1 |
| $N_4$ : 180 | 52.7 | 86.6 | 107.2 | 105.9 |
| SEm ± | 0.3 | 0.7 | 0.9 | 0.9 |
| CD (P = 0.05) | 1.1 | 2.2 | 2.6 | 2.7 |
| Interaction | | | | |
| N at same level of I | | | | |
| SEm ± | 0.6 | 1.3 | 1.5 | 1.6 |
| CD (P = 0.05) | NS | NS | NS | NS |
| I at same or different level of N | | | | |
| SEm ± | 6.1 | 6.4 | 8.8 | 7.9 |
| CD (P = 0.05) | NS | NS | NS | 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

## RESULTS AND DISCUSSION

The growth parameters of rice cultivated under Mechanised SRI method were significantly influenced by the irrigation regimes and nitrogen levels (Table.1, 2, 3 and 4). Taller plants, higher tiller, higher LAI and dry matter production was observed with the maintenance of saturation up to panicle initiation (PI) stage followed by submergence till maturity at all stages of observation *i.e.,* 30, 60, 90 DAT and harvest except

**Table 2: Leaf area index as influenced by irrigation regimes and N levels under MSRI cultivation**

| Treatment | 30 DAT | 60 DAT | 90 DAT | Har vest |
|---|---|---|---|---|
| Irrigation Regimes (I) | | | | |
| $I_1$ | 1.48 | 3.52 | 5.13 | 3.72 |
| $I_2$ | 1.71 | 3.86 | 5.44 | 4.11 |
| $I_3$ | 1.54 | 3.61 | 5.19 | 3.75 |
| SEm ± | 0.04 | 0.07 | 0.06 | 0.08 |
| CD (P = 0.05) | 0.14 | 0.26 | 0.21 | 0.3 |
| N Levels (kg ha$^{-1}$) (N) | | | | |
| $N_1$ : 90 | 1.15 | 1.88 | 3.44 | 2.97 |
| $N_2$ : 120 | 1.44 | 3.56 | 4.88 | 3.25 |
| $N_3$ : 150 | 1.8 | 4.54 | 6.32 | 4.56 |
| $N_4$ : 180 | 1.93 | 4.65 | 6.38 | 4.65 |
| SEm ± | 0.02 | 0.03 | 0.03 | 0.04 |
| CD (P = 0.05) | 0.07 | 0.1 | 0.08 | 0.12 |
| Interaction | | | | |
| N at same level of I | | | | |
| SEm ± | 0.04 | 0.06 | 0.05 | 0.07 |
| CD (P = 0.05) | NS | NS | NS | NS |
| I at same or different level of N | | | | |
| SEm ± | 0.22 | 0.35 | 0.32 | 0.44 |
| CD (P = 0.05) | NS | NS | NS | NS |

**Table 3: Dry matter accumulation (kg $ha^{-1}$) as influenced by irrigation regimes and N levels under MSRI cultivation**

| Treatment | 30 DAT | 60 DAT | 90 DAT | Harvest |
|---|---|---|---|---|
| Irrigation Regimes (I) | | | | |
| $I_1$ | 6408 | 10606 | 13827 | 14491 |
| $I_2$ | 6932 | 11370 | 14769 | 15960 |
| I3 | 6618 | 11006 | 14387 | 15559 |
| SEm ± | 100 | 145 | 179 | 286 |
| CD (P = 0.05) | 393 | 569 | 704 | 1125 |
| N Levels (kg $ha^{-1}$) (N) | | | | |
| $N_1$ : 90 | 5857 | 9492 | 12668 | 13643 |
| $N_2$ : 120 | 6394 | 10703 | 14097 | 15241 |
| $N_3$ : 150 | 7002 | 11888 | 15222 | 16172 |
| $N_4$ : 180 | 7358 | 11895 | 15325 | 16288 |
| SEm ± | 49 | 49 | 51 | 152 |
| CD (P = 0.05) | 145 | 146 | 151 | 451 |
| Interaction | | | | |
| N at same level of I | | | | |
| SEm ± | 85 | 85 | 88 | 263 |
| CD (P = 0.05) | NS | NS | NS | NS |
| I at same or different level of N | | | | |
| SEm ± | 524 | 672 | 799 | 1554 |
| CD (P = 0.05) | NS | NS | NS | NS |

**Table 4: Number of tillers $m^{-2}$ as influenced by irrigation regimes and N levels under MSRI in rice**

| Treatment | 30 DAT | 60 DAT | 90 DAT | Harvest |
|---|---|---|---|---|
| Irrigation Regimes (I) | | | | |
| $I_1$ | 247 | 362 | 351 | 325 |
| $I_2$ | 273 | 395 | 387 | 358 |
| $I_3$ | 260 | 380 | 371 | 351 |
| SEm ± | 5 | 6 | 5.7 | 6.1 |
| CD (P = 0.05) | 19.6 | 23.8 | 22.7 | 24.2 |
| N Levels (kg $ha^{-1}$) (N) | | | | |
| $N_1$ : 90 | 236 | 341 | 333 | 315 |
| $N_2$ : 120 | 258 | 371 | 362 | 336 |
| $N_3$ : 150 | 269 | 393 | 381 | 353 |
| $N_4$ : 180 | 279 | 412 | 402 | 374 |
| SEm ± | 1.3 | 1.4 | 1.9 | 1.4 |
| CD (P = 0.05) | 4 | 4.3 | 5.8 | 4.3 |
| Interaction | | | | |
| N at same level of I | | | | |
| SEm ± | 2.3 | 2.5 | 3.3 | 2.5 |
| CD (P = 0.05) | 7 | 7.4 | 10 | 7.5 |
| I at same or different level of N | | | | |
| SEm ± | 22.1 | 26.3 | 26.8 | 26.7 |
| CD (P = 0.05) | 83.1 | 99.6 | 98.8 | 101.3 |

**Table 5: SPAD chlorophyll meter reading as influenced by irrigation regimes and N levels under MSRI cultivation**

| Treatment | 30 DAT | 60 DAT | 90 DAT | Harvest |
|---|---|---|---|---|
| Irrigation Regimes (I) | | | | |
| $I_1$ | 39.38 | 35.73 | 33.64 | 15.26 |
| $I_2$ | 40.61 | 38.58 | 36.17 | 15.41 |
| $I_3$ | 39.57 | 37.59 | 35.59 | 15.35 |
| SEm ± | 0.48 | 0.56 | 0.62 | 0.06 |
| CD (P = 0.05) | NS | NS | NS | NS |
| N Levels (kg $ha^{-1}$) (N) | | | | |
| $N_1$ : 90 | 38.37 | 36 | 33.22 | 15 |
| $N_2$ : 120 | 39.36 | 36.01 | 33.79 | 15.11 |
| $N_3$ : 150 | 40.4 | 37.52 | 35.74 | 15.27 |
| $N_4$ : 180 | 41.29 | 39.67 | 37.78 | 15.97 |
| SEm ± | 0.25 | 0.35 | 0.44 | 0.03 |
| CD (P = 0.05) | 0.75 | 1.04 | 1.3 | 0.09 |
| Interaction | | | | |
| N at same level of I | | | | |
| SEm ± | 0.44 | 0.61 | 0.76 | 0.05 |
| CD (P = 0.05) | NS | NS | NS | NS |
| I at same or different level of N | | | | |
| SEm ± | 2.61 | 3.3 | 3.92 | 0.33 |
| CD (P = 0.05) | NS | NS | NS | NS |

**Table 6 : Days to 50 per cent flowering as influenced by irrigation regimes and N levels under MSRI cultivation**

| Treatment | Number of days taken to 50 per cent flowering |
|---|---|
| Irrigation Regimes (I) | |
| $I_1$ | 88.1 |
| $I_2$ | 88.3 |
| $I_3$ | 87.8 |
| SEm ± | 0.2 |
| CD (P = 0.05) | NS |
| N Levels (kg $ha^{-1}$) (N) | |
| $N_1$ : 90 | 92.3 |
| $N_2$ : 120 | 89.7 |
| $N_3$ : 150 | 86.2 |
| $N_4$ : 180 | 83.9 |
| SEm ± | 0.3 |
| CD (P = 0.05) | 0.9 |
| Interaction | |
| N at same level of I | |
| SEm ± | 0.5 |
| CD (P = 0.05) | NS |
| I at same or different level of N | |
| SEm ± | 2.3 |
| CD (P = 0.05) | NS |

at 30 DAT for plant height and it was at par with alternate wetting and drying irrigation (AWDI) regime. Both these regimes were superior to submergence throughout the crop growth period. It could be due to rapid growth by maintenance of saturated water supply up to panicle initiation stage followed by submergence till maturity helped in maintaining good metabolic processes that perform better nutrient mobilization, which resulted in increased activity of meristematic cells and cell elongation of internodes helps to maintain higher growth rate of stem in turn promoting the increased plant height of rice. Further, better root growth coupled with better uptake of nutrients under saturated condition which increased cell division and cell enlargement due to increased photosynthetic rate resulted in higher leaf area index and higher dry matter accumulation. Similar results were also reported by Wopereis *et al*. (1996) Ramakrishna *et al*. (2007) and Sandhu *et al*. (2012).SPAD chlorophyll meter reading at all the stages of observation and number of days taken to 50 per cent flowering were not influenced by the irrigation regimes. (Table 5 and 6) (Pasha, 2010 and Mahajan *et al*., 2012). Among the nitrogen levels, significantly higher values of plant height, LAI, SPAD chlorophyll meter reading, drymatter production and number of tillers $m^{-2}$ were recorded at 180 kg N $ha^{-1}$ over the lower doses except 150 kg N $ha^{-1}$ at all the stages of observation. The plots supplied with 180 kg N $ha^{-1}$ flowered to 50 per cent earlier than the lower doses. This might be due to timely availability of nitrogen in right proportion at the critical stages of the growth and continuous availability of higher nitrogen resulted in stimulation of meristematic growth leading to increase in plant height at all the growth stages. These results are in line with Chandrasekaran (2002) and Santhosh *et al.* (2013).

**Table 7: Grain, straw yield and harvest index as influenced by irrigation regimes and N levels under MSRIcultivation**

| Treatment | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|
| Irrigation Regimes (I) | | | |
| $I_1$ | 6804 | 9008 | 42.9 |
| $I_2$ | 7386 | 9638 | 43.2 |
| I3 | 6979 | 9178 | 43.1 |
| SEm ± | 113 | 117 | 0.1 |
| CD (P = 0.05) | 443 | 460 | NS |
| N Levels (kg ha$^{-1}$) (N) | | | |
| $N_1$ : 90 | 5306 | 7471 | 41.5 |
| $N_2$ : 120 | 6680 | 8896 | 42.9 |
| $N_3$ : 150 | 7873 | 10120 | 43.7 |
| $N_4$ : 180 | 8366 | 10611 | 44.1 |
| SEm ± | 47 | 52 | 0.1 |
| CD (P = 0.05) | 140 | 154 | 0.3 |
| Interaction | | | |
| N at same level of I | | | |
| SEm ± | 81.9 | 89.5 | 0.2 |
| CD (P = 0.05) | 243.2 | 266 | NS |
| I at same or different level of N | | | |
| SEm ± | 557.9 | 589.4 | 0.8 |
| CD (P = 0.05) | 2006.9 | 2106.4 | NS |

**Table 8: Interaction effect of irrigation regimes and N levels on Number of tillers m$^{-2}$ at 60 DAT under MSRI cultivation**

| Irrigation Regimes (I) | Nitrogen level (kg ha$^{-1}$) 90 | 120 | 150 | 180 | Mean |
|---|---|---|---|---|---|
| $I_1$ | 324.3 | 347.7 | 378.3 | 399.3 | 362.4 |
| $I_2$ | 350.7 | 394 | 410.4 | 427.7 | 395.6 |
| $I_3$ | 348 | 373 | 392.2 | 409 | 380.5 |
| Mean | 341 | 371.6 | 393.7 | 412 | |
| | | | SEm± | CD (P = 0.05) | |
| I | | | 6.1 | 23.9 | |
| N | | | 1.5 | 4.3 | |
| Interaction | | | | | |
| N at same level of I | | | 2.5 | 7.4 | |
| I at same or different level of N | | | 26.3 | 99.6 | |

**Table 9: Interaction effect of irrigation regimes and N levels on Number of tillers m$^{-2}$ at 30 DAT under MSRI cultivation**

| Irrigation Regimes (I) | 90 | Nitrogen level (kg ha$^{-1}$) 120 | 150 | 180 | Mean |
|---|---|---|---|---|---|
| $I_1$ | 227.3 | 245.5 | 255.6 | 261.8 | 247.5 |
| $I_2$ | 248 | 270 | 283.1 | 294 | 273.9 |
| $I_3$ | 235.3 | 258.6 | 267.5 | 281.3 | 260.7 |
| Mean | 236.9 | 258 | 269 | 280 | |
| | | SEm± | CD (P = 0.05) | | |
| I | | 5 | 19.7 | | |
| N | | 1.4 | 4.1 | | |
| Interaction | | | | | |
| N at same level of I | | 2.4 | 7 | | |
| I at same or different level of N | | 22.2 | 83.1 | | |

Irrigation regimes and nitrogen levels interacted significantly with each other for tiller production at 30, 60, 90 DAT and harvest (Table 8,9,10 and 11). In all the irrigation regimes, every incremental application of N *i.e.,* 90, 120,150 and 180 kg ha$^{-1}$. Significantly increased the tiller production over the preceding lower dose except in submergence at 30 DAT where in the difference between 150 and 180 kg N ha$^{-1}$ was not significant. Highest number of tillers was produced when saturation was maintained upto PI stage followed by standing water till maturity and 180 kg N ha$^{-1}$ followed by 150 kg N ha$^{-1}$ in the same irrigation regime.

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 7). 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. This may be due to adequate moisture availability

**Table 10: Interaction effect of irrigation regimes and N levels on Number of tillers m$^{-2}$ at 90 DAT under MSRI cultivation**

| Irrigation Regimes (I) | Nitrogen level (kg ha$^{-1}$) | | | | |
|---|---|---|---|---|---|
| | 90 | 120 | 150 | 180 | Mean |
| I1 | 318 | 340.3 | 361.6 | 388 | 351.5 |
| I2 | 342 | 385 | 402.7 | 421 | 387.4 |
| I3 | 340 | 364 | 382 | 402 | 371.3 |
| Mean | 333.1 | 362.4 | 381.9 | 403.8 | |
| | | SEm± | CD (P = 0.05) | | |
| I | | 5.8 | 22.7 | | |
| N | | 2 | 5.8 | | |
| Interaction | | | | | |
| N at same level of I | | 3.4 | 10.1 | | |
| I at same or different level of N | | 26.8 | 98.8 | | |

**Table 11: Interaction effect of irrigation regimes and N levels on Number of tillers m$^{-2}$ at harvest under MSRI cultivation**

| Irrigation Regimes (I) | Nitrogen level (kg ha$^{-1}$) | | | | |
|---|---|---|---|---|---|
| | 90 | 120 | 150 | 180 | Mean |
| $I_1$ | 302 | 317 | 329 | 352 | 325.1 |
| $I_2$ | 327 | 345 | 370 | 389 | 358.3 |
| $I_3$ | 319 | 345 | 361 | 382 | 351.7 |
| Mean | 315.9 | 336.6 | 353.3 | 374.5 | |
| | | SEm± | CD (P = 0.05) | | |
| I | | 6.2 | 24.3 | | |
| N | | 1.5 | 4.3 | | |
| Interaction | | | | | |
| N at same level of I | | 2.5 | 7.5 | | |
| I at same or different level of N | | 26.7 | 101.3 | | |

and better nutrient absorption under saturated condition increased dry matter accumulation led to higher straw yield. Similar results were reported by Dhar *et al.* (2008), Sariam and Anuar (2010), Kumar *et al.* (2014), Chowdhury *et al.* (2014) and Diproshan *et al.* (2015).

Harvest index remained unaffected by the irrigation regimes. The results were in tune with the findings of Diproshan *et al.* (2015). Among the nitrogen levels, highest grain, straw yield, harvest index and nitrogen uptake was observed with 180 kg N ha$^{-1}$ superior to the lower levels but for HI at par with 150 kg N ha$^{-1}$. 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 and also lead to more dry matter accumulation. These results are in accordance with the findings of Mahender Kumar, (2000) Manzoor *et al.* (2006), Salem *et al.* (2011) and Santhosh *et al.* (2013).

A significant interaction was recorded between the irrigation regimes and N levels for yield. It was gradually and significantly improved

with the increased levels of N from 90 to 180 kg N ha$^{-1}$ in all the irrigation regimes. It was highest with saturation + 180 kg N ha$^{-1}$ which was superior to all other treatment combinations except those with saturation at 150 kg N ha$^{-1}$ and AWDI at 150 and 180 kg N ha$^{-1}$which were again at par with each other.

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 ideal practices for higher growth and productivity in rice under MSRI cultivation.

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