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# To find out the suitable irrigation scheduling of transplanted rice, to assess the growth and yield of various treatments

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## Abstract
The present investigation entitled “To find out the suitable irrigation scheduling of transplanted rice, to assess the growth and yield of various treatments.” A field experiment was conducted at Agronomy Research Farm of, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Kharif* season of 2020-21. The experiment was laid out in Randomized block design with four replications and eight treatments viz. One Irrigation at tillering, Two Irrigation at tillering + PI stage, Three Irrigation at tillering + PI + Flowering stage, Four Irrigation at tillering + PI + Flowering + milking stage, Two Irrigation at tillering + milking stage, Two Irrigation at PI + milking stage, Five Irrigation at tillering + PI + Flowering + milking + dough stage, No Irrigation. Results revealed that irrigation scheduling among treatments application Five Irrigation at tillering + PI + Flowering +milking +dough stage proved superior to other treatments with respect to higher crop growth, yield and yield attributes.

**Keywords:** Irrigation scheduling

## Introduction
Rice (*Oryza sativa* L.) is one of the most important cereal crops belongs to Poaceae (Gramineae) family, diverse ecosystem of rice cultivated in India. It is most important staple food of about more than 65% of total world population. Rice occupies a pivotal role in Indian agriculture and it is staple food for more than 70% of population and a source of a livelihood for about 120-150 million rural households. It accounts for about 43% of total food grain production and 55% of total cereal production in the country. Rice is grown on over 158.7 million hectares around the world, with an annual production of about 700. Million tonnes and average productivity 4.19 tonnes per hectares. The Asian region produces and consumes about 90% of all rice formed worldwide. It is grown on 43.78 million hectare in India, producing 115.60 million tonnes with an average productivity of 25.78 q ha$^{-1}$ (Anonymous, 2018).

Uttar Pradesh is the largest rice growing state after west Bengal where rice is grown in 5.81 million hectare with annual production of 13.27 million tonnes and average productivity of UP is 22.83 q ha$^{-1}$ which is considered low as compared to productivity of Punjab 43.66 q ha$^{-1}$, Haryana 31.81 q ha$^{-1}$ and West Bengal 29.26 q ha$^{-1}$ (Anonymous, 2018). Transplanting at the right time may be one of the agronomic strategies maximizing a crops maximum potential and photoperiod sensitivity, resulting in higher yield and better grain quality. Delay in seeding causes poor emergence worse yield attributes, and ultimately lower yields. Manual transplanting require a lot of labors and also very expensive. Scarcity of labors in another major problem in some paddy growing areas of the countries. Rice has substantially lower water consumption efficiency than other crops. (Bouman 2009) [1]. actices such as improved irrigation management (Bouman and Tuong, 2001) [2] Earlier rice crop was transplanted in may under maximum temperature of 39-42 C, which increased the irrigation water requirement of crop to the tune of 180-240 cm per season (Brar, *et al*. 2012) [3]. Yield may decline under this practice, but water saving and water productivity increases. These previous studies focused on the applied amount of irrigation water without much attention in matching rain occurrence with the crop high needed water stage. Basically the main target was to keep daily soil moisture at saturation level and irrigation frequently stopped when rain occurred. However, high water productivity can not be achieved in irrigation regardless of rainfall occurrence opportunities at specific growth stage, specially for an area like Taiwan where there is high rain variability the water productivity can be increased when taking advantage of both irrigated and rainfed agriculture. Decreasing irrigation water supply and taking full advantages of rain water during high needed water period may lead to high water productivity for both irrigation and rain water, consequently cutting down irrigation costs. That system for require water pumping, water costs and high labour, saving water gives advantage for reducing particularly, and globally inputs, that follow to farm output increase. The international rice year (2004) i.e. “Rice is a life” is an apt slogan for India, since it plays a critical role in national food security and provides a source of income million of rural poor. That water is a looming crises due to competition among agricultural, industrial, environmental and domestic users. A growing scarcity of fresh water will pose the problems for rice production in future years. All these planters have their own limitation and restriction. The field capacity and planting efficiency and field efficiency where also measure to recommend a suitable machine.

## Materials and Methods

The experiment was conducted at Agronomy Research Farm Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (Uttar Pradesh).The experimental site is situated in the main campus of the university about 42 Km away from Ayodhya head quarter on Ayodhya- Raibarelli road. The field experiment was laid out in Randomized Block Design with four replication having eight treatments i.e. $T_1$ - One Irrigation at tillering, $T_2$ Two Irrigation at tillering + PI stage, $T_3$ Three Irrigation at tillering + PI + flowering stage, $T_4$ Four Irrigation at tillering + PI + flowering + milking stage, $T_5$ Two Irrigation at tillering + milking stage, $T_6$ Two Irrigation at PI + milking stage, $T_7$ Five Irrigation at tillering + PI + flowering + milking + dough stage, $T_8$ No Irrigation. The variety, NDR 2064 has been released in year 2014 and bred from Pant Dhan4, Saket-4 NDR 2017 at, Acharya Narendra Deva University Agriculture and Technology, Ayodhya (U.P.). Plant are dwarf green, erect with medium foliage. NDR 2064 is medium duration variety matured in 130-135 days and most suitable for irrigated condition, moderately resistant to BLB. Grain size is long and bold. Yield varies from 50- 55 q $ha^{-1}$ with good agronomical package and practices.

## Results and Discussion

The data pertaining to plant height have been presented in Table 1. There was progressive increase in plant height with increase in age of crop upto 90 DAT and slowed down thereafter indicating that grand growth lies between 30 to 90 DAT. The plant height was found significant at all the crop growth stages except 30 DAT due to irrigation scheduling treatments. The higher plant height was obtained with the application of (Five Irrigation at tillering + PI + Flowering +milking +dough stage) $T_7$ treatments, which was at $T_3$ (Three Irrigation at tillering + PI+ Flowering stage) and (Four Irrigation at tillering + PI +Flowering + milking stage) $T_4$ while significant over rest of the treatments at all the stages.

The data reveal that (Five Irrigation at tillering + PI + Flowering +milking +dough stage) at 60 DAT recorded higher plant height which was at par with $T_3$ (Three Irrigation at tillering + PI+ Flowering stage), and $T_4$ (Four Irrigation at tillering + PI +Flowering + milking stage) while significant over rest of the treatments.Plant height is an important vegetative character as it is an index of plant growth and vigour. Increasing rate of plant height has been noticed between 30 to 60,90 DAT. It is mainly acquired by the genetic make-up while it is also affected by Irrigation scheduling, and environmental conditions. Awanet, *et al.* (2007) [5], Safdar, *et al.* (2008) [6], Shekara, *et al.* (2010) [7]. Duvvada, *et al.* (2020) [8]. also reported similar results.

**Table 1:** Plant height (cm) as influenced by irrigation scheduling at different growth stages of rice.

| Treatments | Plant height (cm) | | | |
|---|---|---|---|---|
| | 30 Days after Transplanting | 60 Days after Transplanting | 90 Days after Transplanting | At harvest |
| One Irrigations at tillering | 33.3 | 64.1 | 91.6 | 92.5 |
| Two Irrigations at tillering + PI stage | 33.7 | 67.8 | 96.8 | 97.8 |
| Three Irrigations at tillering + PI+ Flowering stage | 34.2 | 71.3 | 102 | 103.5 |
| Four Irrigations at tillering + PI +Flowering + milking stage | 35.2 | 75.3 | 107.5 | 108.8 |
| Two Irrigations at tillering + milking stage | 33.6 | 67.3 | 96.2 | 97.2 |
| Two Irrigations at PI + milking stage | 33.4 | 67.2 | 96 | 97.1 |
| Five Irrigations at tillering + PI + Flowering +milking +dough stage | 35.6 | 75.9 | 108.38 | 109.6 |
| No Irrigations | 32.5 | 55.2 | 78.79 | 80.4 |
| SEm± | 1.14 | 2.31 | 3.31 | 3.38 |
| CD at 5% | NS | 6.81 | 9.74 | 9.94 |

**Table 2:** Leaf area index as influenced by irrigation scheduling at different growth stages of rice

| Treatments | LAI | | |
|---|---|---|---|
| | 30DAT | 60DAT | 90DAT |
| One Irrigation at tillering | 2.04 | 3.99 | 4.2 |
| Two Irrigation at tillering + PI stage | 2.07 | 4.28 | 4.5 |
| Three Irrigation at tillering + PI+ Flowering stage | 2.1 | 4.56 | 4.8 |
| Four Irrigation at tillering + PI +Flowering + milking stage | 2.12 | 4.75 | 5 |
| Two Irrigation at tillering + milking stage | 2.06 | 4.2 | 4.4 |
| Two Irrigation at PI + milking stage | 2.05 | 4.1 | 4.3 |
| Five Irrigation at tillering + PI + Flowering +milking +dough stage | 2.15 | 4.95 | 5.2 |
| No Irrigation | 2 | 3.4 | 3.6 |
| SEm± | 0.07 | 0.14 | 0.15 |
| CD at 5% | NS | 0.43 | 0.45 |

The data pertaining to leaf area index have been presented in Table 2. There was progressive increase in leaf area index with increase in age of crop upto 90 DAT. The leaf area index was found significant due to irrigation scheduling at all the stages of crop growth except 30 Days after transplanting. The data reveal that Five Irrigation at tillering + PI + Flowering +milking +dough stage) at 60 DAT recorded higher leaf area index which was at par with $T_3$ (Three Irrigation at tillering + PI+ Flowering stage) and $T_4$ (Four Irrigation at tillering + PI +Flowering + milking stage) while significant over rest of the treatments. LAI increased up to 90 DAT thereafter, it decreased due to leaf senescence and declined in number of tillers as crop approached towards the maturity. There was significant increase in LAI with increasing the no. of irrigations as Five Irrigation at tillering + PI + Flowering +milking +dough stage ($T_7$) produced higher LAI (4.95, 5.2) at 60 and 90 DAT. Higher LAI because of increased number of leaf expansion of leaf produced and higher dry matter because of more area available for photosynthesis. Kumar, *et al.* (2015) [9], Duvvada, *et al.* (2020) [10] also reported similar results.

**Table 3:** (Number of shoots/hill$^{-1}$) as influenced by irrigation scheduling at different growth stages of rice.

| **Treatments** | **Number of shoots/hill$^{-1}$** | | | |
|---|---|---|---|---|
| | **30 Days after transplanting** | **60 Days after transplanting** | **90 Days after transplanting** | **At harvest** |
| One Irrigation at tillering | 2.1 | 5.2 | 5.4 | 5.3 |
| Two Irrigation at tillering + PI stage | 2.2 | 5.7 | 5.9 | 5.8 |
| Three Irrigation at tillering + PI+ Flowering stage | 2.3 | 7 | 7.3 | 7.1 |
| Four Irrigation at tillering + PI +Flowering + milking stage | 2.3 | 7.2 | 7.5 | 7.3 |
| Two Irrigation at tillering + milking stage | 2.3 | 5.7 | 5.9 | 5.8 |
| Two Irrigation at PI + milking stage | 2.25 | 5.6 | 5.8 | 5.6 |
| Five Irrigation at tillering + PI + Flowering +milking +dough stage | 2.4 | 7.4 | 7.7 | 7.5 |
| No Irrigation | 2.1 | 4.7 | 4.9 | 4.7 |
| SEm± | 0.07 | 0.21 | 0.21 | 0.21 |
| CD at 5% | NS | 0.61 | 0.64 | 0.62 |

The data pertaining to number of shoots/hill$^{-1}$ have been presented in Table 3.Number of shoots/hill$^{-1}$ increased with age of crop upto 90 days after transplanting.

The number of shoots/hill$^{-1}$were observed significant at all the stages of crop growth except 30 DAT as influenced by different irrigation scheduling treatments.

The higher number of shoots/hill$^{-1}$ recorded with the application of T7 as the number of shoots hill$^{-1}$ was found 2.4, 7.4, 7.7 and 7.5 shoots hill$^{-1}$ at 30, 60, 90, and at harvest respectively.

The data reveal that $T_7$ (Five Irrigations at tillering + PI + Flowering +milking +dough stage) at 60 DAT recorded higher number of shoots which was at par with $T_3$ (Three Irrigation at tillering + PI+ Flowering stage) and $T_4$ Four Irrigation at tillering + PI +Flowering + milking stage while significant over rest of treatments.

The number of shoots hill$^{-1}$ was increased significantly with an increase in Irrigation scheduling. The scrutiny of results for number of shoots hill$^{-1}$ indicates that $T_7$ (Five Irrigation at tillering + PI + Flowering +milking +dough stage) of rice recorded higher number of shoots hill$^{-1}$ This may be because of better nutrient availability under adequate supply of moisture and better soil condition for increasing the number of shoots. Safdar, *et al*. (2008) [11] also reported similar results.

**Table 4:** Dry matter accumulation (gm$^{-2}$) as influenced by irrigation scheduling at different growth stages of rice.

| **Treatments** | **Dry matter accumulation** | | | |
|---|---|---|---|---|
| | **30 Days after transplanting** | **60 Days after transplanting** | **90 Days after transplanting** | **At harvest** |
| One Irrigations at tillering | 219 | 459.66 | 766.1 | 901.3 |
| Two Irrigations at tillering + PI stage | 225 | 511.25 | 852.12 | 1002.5 |
| Three Irrigations at tillering + PI+ Flowering stage | 227 | 628.68 | 1047.8 | 1232.7 |
| Four Irrigations at tillering + PI +Flowering + milking stage | 228 | 665 | 1108.4 | 1304 |
| Two Irrigations at tillering + milking stage | 223 | 497.3 | 828.84 | 975.1 |
| Two Irrigations at PI + milking stage | 221 | 485.75 | 809.62 | 952.5 |
| Five Irrigations at tillering + PI + Flowering +milking +dough stage | 232 | 688.25 | 1147.1 | 1349.5 |
| No Irrigations | 216 | 414.75 | 691.3 | 813.3 |
| SEm± | 7.51 | 18.92 | 31.54 | 37.11 |
| CD at 5% | 22.10 | 55.67 | 92.78 | 109.16 |

The data pertaining to dry matter accumulation (gm$^{-2}$) have been presented in Table 4. There was progressive increase in dry matter accumulation (gm$^{-2}$) with increase in age of crop upto 90 DAT and slowed down thereafter indicating that grand growth period lies between 30, 60, 90 at harvest DAT. The dry matter accumulation (gm$^{-2}$) was found significant at all the stage of crop growth influenced by different irrigation scheduling treatments. The higher attained with the application Five Irrigation at tillering + PI + Flowering +milking +dough stage) $T_7$ treatment with 232, 688.25, 1147.1 and 1349.5 gm$^{-2}$ at 30, 60, 90, and at harvest respectively. The data reveal that $T_7$ (Five Irrigation at tillering + PI + Flowering +milking +dough stage) at 60 DAT recorded higher dry matter which was at par with $T_4$ (Four Irrigation at tillering + PI +Flowering + milking stage) while significant over rest of treatments. The $T_7$ (Five Irrigation at tillering + PI + Flowering +milking +dough stage) had significant effect on dry matter accumulation under various treatments at different growth stages of rice, Irrigation scheduling $T_7$ of treatment rice recorded the higher dry matter stockpile at 60 and 90 Days after transplanting due to cell division, cell elongation, maximum chlorophyll content and plant height, number of shoots which increased the dry matter accumulation under $T_7$ treatments. Crop of $T_8$ (no irrigation) recorded lowest dry matter accumulation of rice Mishra, *et al.* (2008) [12] Shekara, *et al.* (2010) [13]. Duvvada, *et al.* (2020**)** [14]**.** also reported that similar results.

**Table 5:** Days taken to 75% Fl. & maturity as influenced by irrigation scheduling at different growth stages of rice

| Treatment | Days taken to 75% flowering | Days taken to maturity |
|---|---|---|
| One Irrigation at tillering | 94 | 125 |
| Two Irrigation at tillering + PI stage | 97 | 129 |
| Three Irrigation at tillering + PI+ Flowering stage | 98 | 131 |
| Four Irri. at tillering + PI +Flowering + milking stage | 100 | 133 |
| Two Irrigation at tillering + milking stage | 96 | 128 |
| Two Irrigation at PI + milking stage | 95 | 127 |
| Five Irrigation at tillering + PI + Flowering +milking +dough stage | 101 | 135 |
| No Irrigation | 92 | 123 |
| SEm± | 3.24 | 4.33 |
| CD at 5% | NS | NS |

The data pertaining to Days taken to 75% flowering and Maturity have been presented in Table 5. There was progressive increase in Days taken to 75% flowering and Maturity, Days taken to 75% flowering and maturity was found non significant due to irrigation scheduling.

**Table 6:** Yield attributes of rice as influenced by irrigation scheduling at different growth stages of rice.

| Treatments | Effective tillers ( $m^{-2}$) | Panicle length (cm) | Grains $panicle^{-1}$ | 1000 grain wt (g) | Grain yield ($qha^{-1}$) | HI (%) |
|---|---|---|---|---|---|---|
| One Irrigations at tillering | 223 | 23.6 | 79.2 | 22.2 | 35.6 | 38.2 |
| Two Irrigations at tillering + PI stage | 244 | 23.4 | 81.4 | 22.4 | 40.4 | 39 |
| Three Irrigations at tillering + PI+ Flowering stage | 295.5 | 24 | 82.5 | 22.5 | 49.8 | 39.7 |
| Four Irrigations at tillering + PI +Flowering + milking stage | 300.5 | 24.9 | 85.8 | 22.7 | 53.2 | 40.3 |
| Two Irrigations at tillering + milking stage | 237.5 | 24.7 | 81.4 | 22.3 | 39.2 | 38.9 |
| Two Irrigations at PI + milking stage | 234 | 24.3 | 80.3 | 22.3 | 38.1 | 38.6 |
| Five Irrigations at tillering + PI + Flowering +milking +dough stage | 304.8 | 25.3 | 88 | 22.8 | 55.6 | 40.6 |
| No Irrigations | 203.8 | 18.6 | 74.8 | 22 | 30.5 | 37.6 |
| SEm± | 8.80 | 0.80 | 2.75 | 0.75 | 1.50 | 1.31 |
| CD at 5% | 25.89 | 2.36 | 8.10 | NS | 4.41 | NS |

The data pertaining to yield attributes like length of panicle, grains $panicle^{-1}$, panicle weight and effective tillers $m^{-2}$ were recorded at harvest and subjected to statistical analysis. The data presented in table 6 indicated that all the yield attributes were affected significantly. Five Irrigation at tillering + PI + Flowering +milking +dough stage ($T_7$) recorded higher due to influence of irrigation scheduling.

**Number of effective tillers ($m^{-2}$)**

Irrigation scheduling treatments had considerable impact on the number of effective tillers ($m^{-2}$). The number of effective tillers ($m^{-2}$) was significantly higher with Five Irrigation at tillering + PI + Flowering + milking +dough stage ($T_7$) 304.8 $m^{-2}$ which was with at par with $T_3$ (Three Irrigation at tillering + PI+ Flowering stage 295.5 $m^{-2}$ ) and $T_4$ (Four Irrigation at tillering + PI +Flowering + milking stage) 300.5 $m^{-2}$ while significant over rest of the treatments.

The consequence of all growth parameter is yield. Grain yield is well –known fact that increase the number of effective tillers per unit area. The yields is inextricably linked to all of the different factors. The yield attributing characters which also showed increasing with $T_7$ (Five Irrigation at tillering + PI + Flowering +milking +dough stage) and $T_4$ (Four Irrigation at tillering + PI +Flowering + milking stage) as rice recorded significantly higher number of effective tiller ($m^{-2}$) and is lowest in $T_8$ (no irrigation) of rice. Safdar, *et al*. (2008) [15] and, Singh, *et al.* (2019) [16], also reported similar results.

**Length of panicles (cm)**

The irrigation scheduling treatments have substantial impact on panicle length (cm). have a Significantly longer panicles length (cm) was recorded with Five Irrigations at tillering + PI + Flowering +milking +dough stage ($T_7$) 25.3 cm which was at par with $T_4$ while Significantly superior over rest of the treatments.$T_7$ (Five Irrigation at tillering + PI + Flowering +milking +dough stage) of rice recorded significantly higher panicle length (cm). The higher length of panicle produced more grains per panicle. *Awanet, et al.* (2007) [17]. Zulkarnain, *et al.* (2013) [18], and Keerthi, *et al.* (2018) [19] also reported similar results.

**Number of grains panicle$^{-1}$**

Grains Panicle$^{-1}$, were significantly affected due to irrigation scheduling Higher with Five Irrigation at tillering + PI + Flowering +milking +dough stage ($T_7$ ) 88 per panicle where recorded and at par with $T_4$ while significantly superior over rest of the irrigation. The Five Irrigation at tillering + PI + Flowering +milking +dough stage ($T_7$) of rice recorded higher grains panicles$^{-1}$ 88. Higher number of grains per panicle found due to higher translocation of photosynthate from source to sink. Keerthi, *et al.* (2018 2019) [20] and Singh, *et al.* (2019) [21]. also reported similar results.

**1000 grain wt**

Grain weight was not affected to significantly due to irrigation scheduling. Maximum with Five Irrigation at tillering + PI + Flowering +milking +dough stage. Grains weight (g) was not affected by irrigation scheduling.

**Grain yield (q/ha)**

Grain yield was affected significantly due to irrigation scheduling treatments. Significantly higher Grain yield was recorded with Five Irrigation at tillering + PI + Flowering +milking +dough stage ($T_7$) i.e. 55.6 q/ha which was at par with $T_4$ (Four Irrigation at tillering + PI +Flowering + milking stage 53.2 q/ha) while significant over rest of the treatment.

The grain yield of rice was higher, under $T_7$ resulted in higher grain yield due to better source to sink ratio and higher photosynthetic translocation of rice. Brar, *et al*., (2015) [22] Sharma, *et al.* (2016) [23] and Nayak, *et al.* (2017) [24] also reported similar results.

**Harvest index (%)**

The data recorded on harvest index have been presented in Table 6 Harvest index of rice was not affected significantly by different irrigation scheduling.

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