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# Crop Establishment Methods and Irrigation Scheduling on Water Stress Parameters of Rice

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## ABSTRACT

Rice is the stable food for more than 70% of Indian population. In upland rice, water stress causes serious yield loss of rice due to affect the physiological parameters. An experiment was carried out at Soil and Water Management Research Institute, TNAU, Kattuthottam, Thanjavur. The crop establishment methods and irrigation scheduling on physiological parameters of rice were observed with chlorophyll index, specific leaf weight (SLW) and relative water content (RWC). The results revealed that among the treatments, direct dry seeded rice with irrigation on the day of disappearance of ponded water has recorded higher values of chlorophyll index, specific leaf weight and relative water content of rice compared to other treatments.

**Keywords** Chlorophyll index, Relative water content, Specific leaf weight, Irrigation, Rice.

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## INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop of the world population. Transplanting is the traditional method of establishment in wet land rice. The area under transplanted rice in world is decreasing due to lack of water and labor. So, there is a need to initiate different establishment methods to increase the productivity of rice (Farooq *et al.* 2009). Under such circumstances the mechanical transplanting of rice has been considered most promising option, as it saves labor, timely operations and attains optimum plant density that contributes to high productivity. Another major concern in rice production systems is the diminishing trend of availability of water resources. The traditional methods of irrigation is consuming more water and used large amount of labor, energy and time for the increased pumping water in flooded fields (Mahajan *et al*. 2012). Therefore, water saving technologies are required to grow rice with less amount of water and to increase the water use efficiency. So, the sustainability of the irrigated rice production systems would not be threatened by the decreased water availability for agriculture and food security could be assured (Yao *et al.* 2012). Due to rising shortage of freshwater resources available for irrigated agriculture and increasing demand of food around the world in the future, it will be essential to produce more food grains with less quantity of water (Selvakumar *et al.* 2020). Since, more irrigated land is devoted to rice than to any other crops in the world, consumption of water resource in the rice field should be minimized (IRRI 2004). Hence, the present investigation was taken up to study the effect of different crop establishment methods and irrigation scheduling on physiological parameters of rice.

## MATERIALS AND METHODS

Field experiment was conducted during *rabi* season at Soil and Water Management Research Institute, Thanjavur, Tamil Nadu. The experimental field is situated in CDZ of Tamil Nadu. The experiment was laid out in split plot design in replicated thrice. The treatments comprised of establishment methods viz., DSR, NPTR and PTR in main plots and seven irrigation scheduling practices in sub plots viz., $I_1$,$I_2$,$I_3$ - AWDI at 10, 15, 20 cm depletion of ponded water, $I_4$,$I_5$,$I_6$ - AWDI at 10, 15,20 cm depletion of ponded water and submergence at flowering and $I_7$ - irrigation on the day of disappearance of ponded water. Rice variety CR 1009 with the duration of 160 days was used as test variety. Each individual plot was separated with buffer channels for proper maintenance of the treatments. The irrigation water was measured with the parshall flume. In order to evaluate the effect of crop establishment methods and irrigation scheduling practices on chlorophyll content, specific leaf weight, relative water content, the data were statistically analyzed using analysis of variance test (Gomez and Gomez 1984).

### Chlorophyll index

Chlorophyll content of leaves was recorded as described by Peng *et al*. (1996) using the chlorophyll meter (SPAD). The readings were recorded on the upper most fully expanded leaves in five randomly chosen plants at active tillering and flowering stages. The average values were worked out and expressed as chlorophyll index.

### Specific leaf weight (SLW)

The SLW was arrived at by employing the formula suggested by Garnier *et al.* (2001) and expressed in g cm$^{-2}$ at flowering stage.

$$\text{SLW} = \frac{\text{Leaf dry weight (g)}}{\text{Total leaf area (cm}^2\text{)}}$$

### Relative leaf water content (RLWC)

The RWC was estimated by the formula given by Barrs and Weatherley (1962). Samples were collected at flowering stages for analysis and mean values were arrived.

$$\text{Relative Water Content (\%)} = \frac{\text{Fresh weight (g) - Dry weight (g)}}{\text{Turgid weight (g) - Dry weight (g)}} \times 100$$

## RESULTS AND DISCUSSION

Chlorophyll index of leaves was recorded by using SPAD meter. In all the growing seasons, crop establishment methods and irrigation scheduling practices had no significant effect on chlorophyll index at tillering and flowering stage and are shown in Table 1. Among the treatments, direct seeded rice with irrigation on the day of disappearance of ponded water recorded higher value of chlorophyll index and it was comparable with puddled transplanted rice with irrigation on the day of disappearance of ponded water. On the other hand, lesser chlorophyll index was observed with non puddled machine transplanted rice with AWDI at 20 cm depletion of ponded water. Water stress condition reduced the chlorophyll content in leaves and controls crop productivity through $CO_2$ assimilation was reported by Santos *et al.* (2009), Gloria *et al.* (2009), Jahan *et al.* (2014) and Khairi *et al.* (2015). Cabangon *et al.* (2011) suggested that SPAD meter reading can be used to estimate leaf nitrogen of rice under AWDI condition as it is used in continuous submergence of rice.

Specific leaf weight (SLW) showed clear variation among different transplanting methods and irrigation management practices (Table 2). Direct seeded rice with irrigation on the day of disappearance of ponded water recorded higher specific leaf weight and lowest value was recorded in non puddled machine transplanted rice with AWDI at 20 cm depletion of ponded water during the growing seasons. The higher SLW in direct seeded rice plants indicated higher number of leaves as compared to puddled transplanted rice and this might be the reason for higher photosynthetic rate. The results are in line with that whose report also exhibited the similar outcome of Munamava and Riddoch (2001), Khairi *et al.* (2016)

**Table 1.** Effect of crop establishment methods and irrigation scheduling on chlorophyll index (SPAD reading) rice.

| Treatments | Chlorophyll index (SPAD reading) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | At active tillering | | | | At flowering | | | |
| | DSR | NPMT | PTR | Mean | DSR | NPMT | PTR | Mean |
| $I_1$ | 37.6 | 35.8 | 36.2 | 36.5 | 40.0 | 38.0 | 38.5 | 38.8 |
| $I_2$ | 36.4 | 34.6 | 35.7 | 35.6 | 38.7 | 36.8 | 38.0 | 37.8 |
| $I_3$ | 34.5 | 33.0 | 33.8 | 33.8 | 36.7 | 35.1 | 35.9 | 35.9 |
| $I_4$ | 38.7 | 36.7 | 37.8 | 37.7 | 41.2 | 39.1 | 40.2 | 40.2 |
| $I_5$ | 37.9 | 36.5 | 36.7 | 37.0 | 40.3 | 38.9 | 39.1 | 39.4 |
| $I_6$ | 35.6 | 35.0 | 34.5 | 35.0 | 37.9 | 37.2 | 36.7 | 37.3 |
| $I_7$ | 38.4 | 37.0 | 37.2 | 37.5 | 40.8 | 39.4 | 39.6 | 39.9 |
| Mean | 37.0 | 35.5 | 36.0 | | 39.4 | 37.8 | 38.3 | |
| | M | I | M at I | I at M | M | I | M at I | I at M |
| SEd | 0.6 | 1.5 | 2.4 | 2.6 | 0.6 | 1.6 | 2.6 | 2.7 |
| CD (p=0.05) | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 2.** Effect of crop establishment methods and irrigation scheduling on specific leaf weight (g $cm^{-2}$) and relative water content (%) rice.

| Treatments | Specific leaf weight (g $cm^{-2}$) | | | | Relative leaf water content (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | DSR | NPMT | PTR | Mean | DSR | NPMT | PTR | Mean |
| $I_1$ | 5.45 | 4.95 | 5.31 | 5.24 | 93.9 | 93.2 | 96.5 | 94.5 |
| $I_2$ | 5.23 | 4.90 | 5.17 | 5.10 | 91.4 | 89.3 | 94.9 | 91.9 |
| $I_3$ | 5.05 | 4.72 | 5.01 | 4.93 | 85.6 | 82.4 | 87.3 | 85.1 |
| $I_4$ | 5.62 | 5.27 | 5.59 | 5.49 | 95.2 | 94.5 | 97.4 | 95.7 |
| $I_5$ | 5.50 | 5.08 | 5.40 | 5.32 | 91.7 | 90.6 | 95.3 | 92.5 |
| $I_6$ | 5.20 | 4.83 | 5.14 | 5.06 | 87.4 | 86.7 | 90.9 | 88.3 |
| $I_7$ | 5.65 | 5.36 | 5.54 | 5.51 | 96.7 | 95.8 | 98.5 | 97.0 |
| Mean | 5.39 | 5.02 | 5.31 | | 91.7 | 90.4 | 94.4 | |
| | M | I | M at I | I at M | M | I | M at I | I at M |
| SEd | 0.07 | 0.14 | 0.24 | 0.24 | 1.6 | 3.8 | 6.3 | 6.6 |
| CD (p=0.05) | 0.21 | 0.28 | NS | NS | NS | 7.7 | NS | NS |

and Thakur *et al.* (2010).

Relative water content (RWC) of leaves significantly differ with irrigation management practices but not significantly varied with different crop establishment methods are present in Table 2. Higher Relative water content was recorded with irrigation on the day of disappearance of ponded water and lower Relative water content was observed with alternate wetting and drying irrigation at 20 cm depletion of ponded water. Plant water status in terms of the physiological consequence of cellular water deficit accurately indicating the water input, absorbed water by plant and ET found by Farquhar *et al.* (1989), Lobato *et al.* (2011), Agugoy *et al*. (2013) and Sathish *et al.* (2017). Decrease in soil water content increases soil water tension (i.e., decreases soil water potential) and rice roots experience difficult to absorbing water thereby reducing the plant water content. This influences the ability of the plant to recover from stress and consequently affects yield and yield stability. Similar finding was also observed by Khairi *et al.* (2015) and Timung *et al.* (2017).

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