

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.609.468>

Water requirement of Paddy under Different Land Levelling, Cultivation Practices and Irrigation Methods

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ABSTRACT

Water saving by innovative techniques is essential to prevent salinity and land degradation in paddy production. Therefore, the field investigations were conducted in the farmer's field under the jurisdiction of the University of Agricultural Sciences (UAS) Raichur during the *kharif* 2015 and *kharif* 2016 using randomized complete block design (RCBD) with 7 treatments to determine water requirement of Paddy under different levelling, cultivation practices and irrigation methods for paddy production. The results showed that the dry Direct Seeded Rice (DSR) plot with laser land levelling and subsurface drip irrigation at 60 cm lateral spacing required the lowest quantity of irrigation water of 3872, 2864 and 3368 m³ ha⁻¹, respectively during 2015, 2016 and in pooled mean. The control plot with conventional land levelling using flood irrigation (farmers' practice) recorded the highest quantity of water usage of 20260, 19112 and 19686 m³ ha⁻¹ during 2015, 2016 and in pooled mean, respectively. The highest per cent water saving was observed in the plot with dry DSR with laser land levelling and sub-surface drip irrigation with 60 cm lateral spacing with 80.89, 85.01 and 82.89 per cent during 2015, 2016 and in pooled mean, respectively when compared with control *i.e.* farmers' practice.

Keywords

Direct seeded rice (DSR), Laser levelling, Drip Irrigation and Water requirement

Article Info

Accepted:
25 August 2017
Available Online:
10 September 2017

Introduction

Rice (*Oryza sativa* L.) is the staple food of more than half of the population of the world and its production is an important target to provide food security and livelihood for millions. The world's total estimated area under rice production is 159 M ha with a production of 670 M t with an average yield of 3,889 kg per ha (Anon., 2011). India ranks second in rice production, as it is grown in almost all the states of the country. In India, rice is cultivated in a wide range of ecosystems *viz.*, irrigated (21 M ha), rainfed

lowlands (14 M ha), rainfed uplands (6 M ha) and flood prone (3 M ha). The most common method that is being followed by the farmers is generally transplanting, while dry seeding or wet seeding method for cultivation of rice is also adopted depending upon the situation. India faces the challenge of meeting the future demand of food grains due to diversion of land and water resources to not only agriculture but also to other sectors of economy. With the current estimates, India would need 37 per cent more rice and wheat

by 2025 with 9 to 10 per cent less water available for irrigation compared to the year 2000. The total area under rice in Karnataka is 1.33 M ha with an annual production of 3.54 M t and with a productivity of 2,670 kg per ha (Anon., 2016). It is cultivated in the command areas of Cauvery basin in south, Tungabhadra and Upper Krishna projects in north where transplanting with flood irrigation is the major method of cultivation. The traditional irrigation method like flooding water in paddy fields consumes more water leading to wastage of precious water resources and the least water productivity. Imminent water crisis due to increasing demands from various sectors, water-demanding nature of traditionally cultivated rice and climbing labour costs all call for search of alternative management methods to increase water productivity, system sustainability and profitability in rice. With this in mind the field investigations were conducted on water requirement of paddy with innovative techniques of laser land levelling and drip irrigation methods for paddy production were taken up in the farmer's field.

Materials and Methods

The experiment was carried out in farmer's field located at Govinadoddi village in Manvi taluka of Raichur district under during *kharif* 2015 and *kharif* 2016 using randomized complete block design with 7 treatments which were replicated thrice. The treatments included the land levelling methods *viz.*, laser levelling with near table top level or zero per cent slope and conventional levelling, cultivation practices *viz.*, transplanted rice (TPR) and direct seeded rice (DSR) and irrigation methods *viz.*, drip and flood irrigation. The treatments included the land levelling methods *viz.*, laser levelling with near table top level or zero per cent slope and conventional levelling, cultivation practices *viz.*, transplanted rice (TPR) and direct seeded

rice (DSR) and irrigation methods *viz.*, drip and flood irrigation. The treatments were *viz.*, T₁ - Dry direct seeded rice (DSR) with laser land levelling and surface drip irrigation with 80 cm lateral spacing, T₂ - Dry direct seeded rice with laser land levelling and surface drip irrigation with 60 cm lateral spacing, T₃ - Dry direct seeded rice with laser land levelling and subsurface drip irrigation with 60 cm lateral spacing, T₄ - Dry direct seeded rice with laser land levelling and subsurface drip irrigation with 80 cm lateral spacing, T₅ - Transplanted rice (TPR) with laser land levelling and conventional method of flood irrigation, T₆ - Dry direct seeded rice with conventional land levelling and conventional method of flood irrigation and T₇ - Control (transplanted rice with conventional land levelling using flood irrigation) *i.e.*, farmer's practice. The test crop used was paddy with variety BPT - 5204 (145-150 days duration). The Diagram showing schematic chart of precise laser land levelling concept is given in Fig.1. Fig.2. shows drip irrigation system with treatments installed in farmers field.

The scheduling of drip irrigation was done based on daily PE values during the crop growth period and the duration of irrigation was computed as follows:

$$\text{Irrigation hours (h)} = \frac{\text{ET}_c \text{ (mm)}}{\text{Application rate (mm h}^{-1}\text{)}} \times 100 \text{ (Eq. 1)}$$

Whereas,

Actual evaporation or crop evapotranspiration (ET_c) in mm = ET₀ x Crop factor

Reference evaporation or evapotranspiration (ET₀) in mm = Previous day evaporation x Pan factor.

Crop factors for paddy at its initial, crop development, reproductive and maturity

stages is used were 1.15, 1.23, 1.14 and 1.02 respectively and constant pan factor of 0.7 was used. Application rate with discharge of 2 Lph @ 1.5 kg cm⁻² was calculated using Eq.2.

$$\text{Application rate (mm/hr)} = \left[\frac{\text{Discharged(ph)} \times 100}{\text{Lateral distance(m)} \times \text{Dripper distance(m)}} \right] \quad (\text{Eq. 2})$$

Two lateral spacings of 0.6 m and 0.8 m were used in the study with a constant dripper distance of 0.4 m throughout the experiment.

Results and Discussion

For the field investigations, the data regarding irrigation water used (m³ ha⁻¹) and per cent water saving as influenced by different land levelling (Laser and Conventional), cultivation practices (DSR and TPR) and irrigation (Drip and Flood) methods for paddy production are presented in Table 1.

It was observed that the treatment T₃ required the lowest quantity of irrigation water of 3872, 2864 and 3368 m³ ha⁻¹ during 2015, 2016 and in pooled mean, respectively followed the treatment T₂ (3918, 2928 and 3423 m³ ha⁻¹), T₄ (4034, 3061 and 3548 m³ ha⁻¹) and T₁ which recorded water usage of 4260, 3142 and 3701 m³ ha⁻¹ during 2015, 2016 and in pooled mean, respectively. The control plot with farmers' practice (T₇) recorded the highest quantity of water usage of 20260, 19112 and 19686 m³ ha⁻¹ during 2015, 2016 and in pooled mean, respectively. It was followed by T₅ (17260, 16065 and 16663 m³ ha⁻¹) and T₆ (11680, 10662 and 11171 m³ ha⁻¹).

From the pooled mean the highest per cent water saving was observed in the treatment T₃ (82.89 per cent) when compared with control (conventional land levelling with flood irrigation) *i.e.* farmers' practice (T₇). It was

followed by T₂ (82.61 per cent), T₄ with 81.98 and T₁ (81.20 per cent). Dry DSR with conventional land levelling and conventional method of flood irrigation (T₆) recorded 43.25 per cent water saving followed by TPR with laser land levelling and conventional method of flood irrigation (T₅) with 15.36 per cent water saving when compared to farmers' practice.

The similar trend was noticed with the depth of irrigation water applied during 2015, 2016 and pooled mean. From Table 1 and Fig. 3 (a) and (b) considering the effective rainfall during crop period, the quantity of irrigation water applied for paddy was the least in T₃ (33.68 cm).

It was followed by T₂ with 34.23 cm, T₄ with 35.48 cm and T₁ with 37.01 cm. The water requirement was the highest in T₇ (196.86 cm). It was followed by T₅ (166.63cm) and T₆ (111.71 cm). Significant difference was observed in depth of water requirement of paddy as influenced by different cultivation practices, land levelling and irrigation methods.

Among sown rice, the pooled effective rainfall during the crop period, the total quantity of water requirement of paddy was lowest in T₃ (66.65 cm) followed by 67.20, 68.44 and 69.98 cm, respectively in T₂, T₄ and T₁. The total water requirement was the highest in T₆ (144.68 cm). In transplanted rice the water requirement in T₅ (199.59 cm) was lesser than T₇ (229.83 cm).

Among sown rice, the pooled depth of irrigation water requirement was higher in T₆ (111.71 cm). It was followed by T₁ (37.01 cm), T₄ (35.48 cm) and T₂ (34.23 cm) respectively. The least was recorded in T₃ (33.68 cm). Treatment T₅ recorded total water requirement of 166.63 cm followed by T₇ (196.86 cm).

Table.1 Quantity of irrigation water applied and per cent saving as influenced by different cultivation practices, land levelling and irrigation methods for paddy production

Treatment	Total depth of irrigation water applied (cm)			Total quantity of irrigation water applied (m ³ ha ⁻¹)			Quantity of irrigation water saved over control (T ₇) (m ³ ha ⁻¹)			Per cent of irrigation water saved over control (T ₇)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T ₁	42.6	31.42	37.01	4260	3142	3701	16000	15970	15985	78.97	83.56	81.20
T ₂	39.18	29.28	34.23	3918	2928	3423	16342	16184	16263	80.66	84.68	82.61
T ₃	38.72	28.64	33.68	3872	2864	3368	16388	16248	16318	80.89	85.01	82.89
T ₄	40.34	30.61	35.48	4034	3061	3548	16226	16051	16139	80.09	83.98	81.98
T ₅	172.6	160.65	166.63	17260	16065	16663	3000	3047	3024	14.81	15.94	15.36
T ₆	116.8	106.62	111.71	11680	10662	11171	8580	8450	8515	42.35	44.21	43.25
T ₇	202.6	191.12	196.86	20260	19112	19686	---	---	---	---	---	---

Legend

- T₁ - Dry Direct Seeded Rice (DSR) with Laser land levelling and Surface Drip irrigation (80 cm Lateral spacing)
- T₂ - Dry Direct Seeded Rice (DSR) with Laser land levelling and Surface Drip irrigation (60 cm Lateral spacing)
- T₃ - Dry Direct Seeded Rice (DSR) with Laser land levelling and Sub-surface Drip irrigation (60 cm Lateral spacing)
- T₄ - Dry Direct Seeded Rice (DSR) with Laser land levelling and Sub-surface Drip irrigation (80 cm Lateral spacing)
- T₅ - Transplanted Rice (TPR) with Laser land levelling and Conventional method of flood irrigation
- T₆ - Dry Direct Seeded Rice (DSR) with Conventional land levelling and Conventional method of flood irrigation
- T₇ - Control (Conventional land levelling with Conventional method flood irrigation) *i.e.* Farmers' Practice

Fig.1 Schematic chart of laser land levelling concept

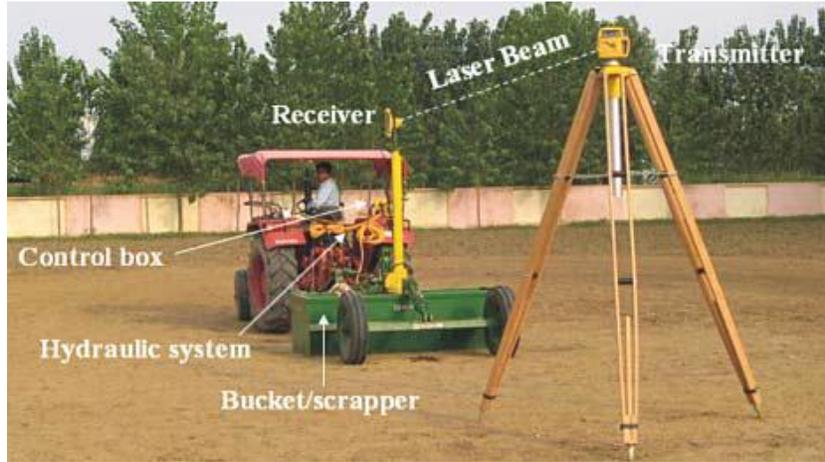


Fig.2 Drip irrigation system installed in farmer's field

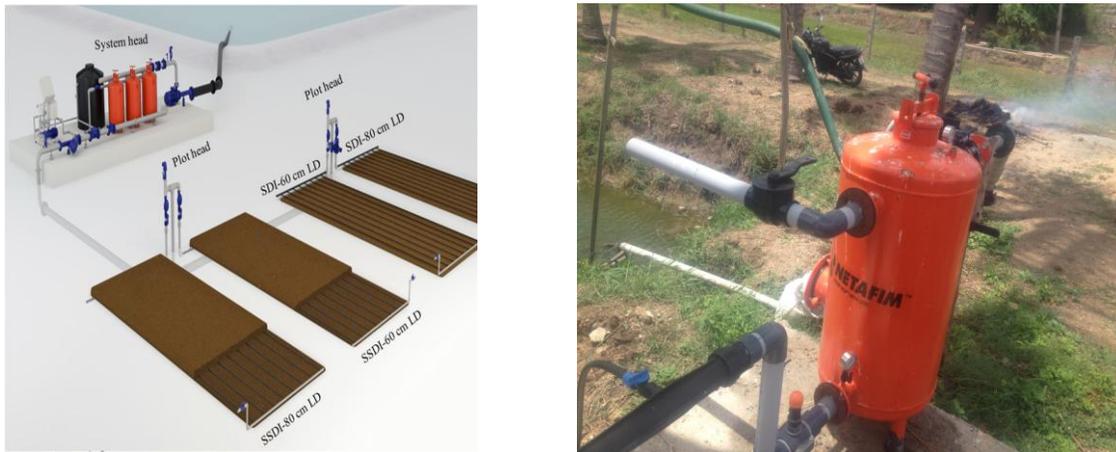


Fig.3 (a) Quantity of water applied as influenced by different cultivation practices, land levelling and irrigation methods for paddy production

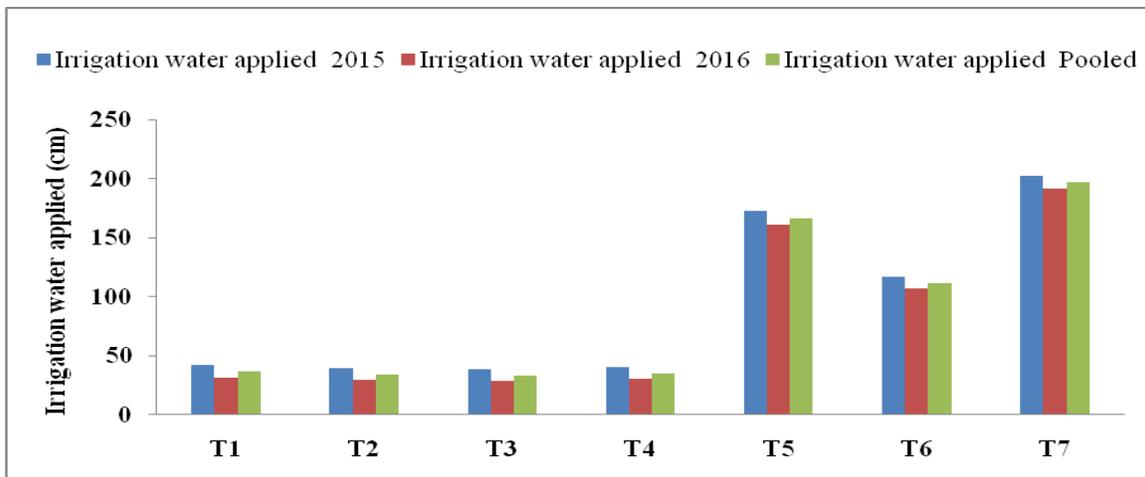
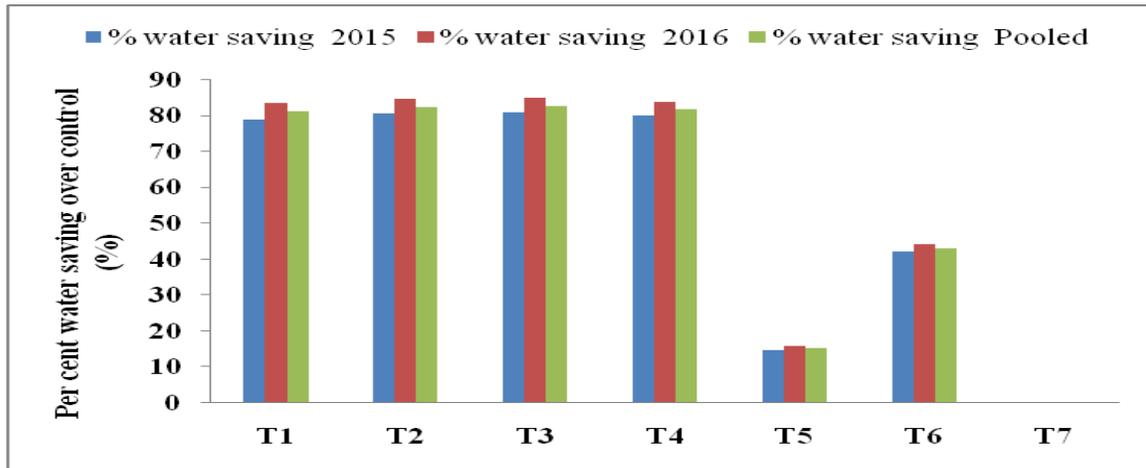


Fig.3 (b) Per cent saving as influenced by different cultivation practices, land levelling and irrigation methods for paddy production



Legend

- T₁ Dry Direct Seeded Rice (DSR) with Laser land levelling and Surface Drip irrigation (80 cm Lateral spacing)
- T₂ Dry Direct Seeded Rice (DSR) with Laser land levelling and Surface Drip irrigation (60 cm Lateral spacing)
- T₃ Dry Direct Seeded Rice (DSR) with Laser land levelling and Sub-surface Drip irrigation (60 cm Lateral spacing)
- T₄ Dry Direct Seeded Rice (DSR) with Laser land levelling and Sub-surface Drip irrigation (80 cm Lateral spacing)
- T₅ Transplanted Rice (TPR) with Laser land levelling and Conventional method of flood irrigation
- T₆ Dry Direct Seeded Rice (DSR) with Conventional land levelling and Conventional method of flood irrigation
- T₇ Control (Conventional land levelling with Conventional method flood irrigation) *i.e.* Farmers' Practice

Among sown rice the highest per cent water saving was observed T₃ (82.86 %). It was followed by T₂ (82.61 %), T₄ (81.98 %) and T₁ (81.20 %) when compared with control *i.e.* farmers' practice (T₇). The water saving was mainly due to precise levelling in laser levelled plots leading to smooth and faster movement of water thereby quick uniform distribution of water. Moreover, application of water to the root zone of crops by drip irrigation. But in control plot it was not so smooth. Whereas, water has to be applied so that the water reaches the high spots. The uniform distribution and reduced losses (Rajput and Patel, 2004, Abdullaev *et al.*, 2007) in laser levelling plots also led to reduced depth of application and more saving of water. The irrigation time reduced considerably in laser levelled drip plots. The similar results on irrigation water requirement, depth and saving were obtained by Ahmad *et al.*, (2001), Rickman (2002), Aggarwal *et al.*, (2010), Shahin *et al.*,(2013)

and Abdelraouf *et al.*, (2014). Thus, laser land levelling and drip irrigation methods by saving considerable quantity of water were proved to be a RCTs in paddy production.

Laser land levelling and drip irrigation techniques used for paddy cultivation were observed to save huge quantity of irrigation water in paddy cultivation. The dry DSR plot with laser land levelling and subsurface drip irrigation at 60 cm lateral spacing required the lowest quantity of irrigation water whereas farmers' practice of growing paddy recorded the highest quantity of water usage of 19686 m³ ha⁻¹ in pooled mean. This was followed by plot with TPR with laser land levelling and conventional method of flood irrigation. The highest water saving (82.89 per cent) was observed in the plot with dry DSR with laser land levelling and sub-surface drip irrigation with 60 cm lateral spacing when compared with control *i.e.* farmers' practice.

Acknowledgements

Authors express their gratitude to farmer Sri. Suresh Reddy who spared his land for drip irrigation studies in paddy. Authors also acknowledge the support of staff and Dean of College of Agricultural Engineering, UAS Raichur and CIMMYT New Delhi and Dean (PGS) of UAS Raichur for their help in successful completion of study.

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How to cite this article:

Ravindra Yaligar, P. Balakrishnan, U. Satishkumar, P. S. Kanannavar, A. S. Halepyati, M. L. Jat and Rajesh N. L. 2017. Water requirement of Paddy under Different Land Levelling, Cultivation Practices and Irrigation Methods. *Int.J.Curr.Microbiol.App.Sci.* 6(9): 3790-3796. doi: <https://doi.org/10.20546/ijcmas.2017.609.468>