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Influence of different establishment methods and irrigation management on physiological and yield parameters in rice (*Oryza sativa* L.)

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Abstract

A field experiment was conducted to know the effect of influence of different establishment methods and irrigation management on morphological and yield parameters in rice (*Oryza sativa* L.) at Agricultural Research Station Dhadesugur, during *kharif* 2017. The experiment was laid out in a split plot design and treatments were replicated thrice. Rice plants were grown under 3 establishment methods *viz.*, transplanted rice, direct seeded rice (DSR), and system of rice intensification (SRI) with different irrigation management practices namely Alternate wetting and drying (AWD), Critical stage approach, Continuous saturation and Farmers irrigation practice. SRI method of rice establishment practice registered significantly superior performance in terms of NDVI values (0.625), photosynthetic rate (22.66), chlorophyll content (3.63), at flowering stages over the rest of the establishment methods but leaf temperature (29.18) and transpiration rate (5.28) were higher in DSR followed by SRI method whereas, transplanted recorded lower leaf temperature (27.27) and lower transpiration rate (4.82). Among irrigation methods NDVI values (0.619), photosynthetic rate (22.39), chlorophyll content (3.67), were higher in AWD followed by farmer's irrigation practice and lower values were recorded in critical stage approach. Leaf temperature (28.11) and transpiration rate were higher in critical stage approach followed closely followed by AWD and lower leaf temperature and lower transpiration rate recorded in farmers irrigation practice.

Keywords: SRI, AWD, NDVI, establishment methods, irrigation management practice

Introduction

Rice is one of the important cereal crop which consumes nearly 80% of the total irrigated fresh water of Asia. Rice provides about 700 calories day^{-1} person^{-1} for about 3000 million people living mostly in developing countries. The problems and prospects of rice production in different ecosystems vary greatly (Senthilkumar *et al.*, 2007) [21]. Transplanting has been the most important and common method of crop establishment under favourable rainfed and irrigated lowland rice in Tropical Asia. Manual transplanting is the most common practice of rice cultivation in South and South East Asia. Traditional method of transplanting rice involves higher labour cost, increased water demand and higher inputs resulted in switch to alternative methods of rice establishment such as SRI and DSR (De Datta, 1986) [9]. Transplanted rice (TPR) system of crop establishment include increased nutrient availability (e.g. iron, zinc, phosphorus), weed suppression (Surendra *et al.*, 2001) [24] but puddling adversely affects soil physical properties by dismantling soil aggregates, reducing permeability in subsurface layers, and forming hard-pans at shallow depths (Sharma *et al.*, 2003) [22]. More than two decades ago, the System of Rice Intensification (SRI) was developed in Madagascar based on certain insights into how to improve the growing environment for rice plants by changing certain long-standing cultural practices (Laulanie´1993) [15]. Application of SRI principles has helped small farmers in that country to greatly increase their grain yields, from 2 t ha^{-1} to 8 t ha^{-1} and sometimes more (Hirsch 2000; Uphoff and Randriamiharisoa 2002) [13, 29] on soils that were evaluated as poor or very poor (Johnson 1994) [14]. A fundamental approach to reduce water inputs in rice is to grow the crop like an irrigated upland crop. Direct seeding of rice refers to the process of establishing rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. Raising direct seeded rice into non-puddled soils has been found to save 35–57% water (Singh *et al* 2002) [23]. Although aerobic rice has a great potential for saving water but all this is at the cost of severe reduction in yield. A less water availability at reproductive stage is found to be a reason for low yield of aerobic rice (Bouman *et al*. 2002) [5].

In AWD practices, the fields are managed as irrigated lowland rice but the top soil layer is allowed to dry out to some degree before irrigation is applied again (Bouman and Tuong, 2001; Belder *et al.*, 2004) [4, 2]. The number of days under non-flooded soil conditions can vary depending on plant development stages and availability of water. The AWD practice has been found to give lower (Eriksen *et al.*, 1985; Bouman and Tuong, 2001) [11, 4], similar (Cabangon *et al.*, 2004; Chapagain and Yamaji, 2010) [6, 8] or higher rice yield (Belder *et al*., 2005; Ceesay *et al*., 2006; Zhang *et al*., 2009) [5, 7, 32] as compared to conventional continuous flooding (CF) practices.

Material methods

The field experiment was carried out at Agricultural Research Station Dhadesugur, during *kharif* 2017. It is situated in Northern Dry Zone (Zone-3) of Karnataka at $15^0 46''$ N latitude and 76^0 45 ″ E longitude with an altitude of 358 m above mean sea level. The soil of the experimental site is medium deep black and clayey in soil texture. The experiment was laid out in a split plot design and treatments were replicated thrice. Rice plants were grown under 3 establishment methods *viz.*, transplanted rice, direct seeded rice (DSR), and system of rice intensification (SRI) with different irrigation management practices namely Alternate wetting and drying (AWD), Critical stage approach, Continuous saturation and Farmers irrigation practice.

In DSR seeds were sown manually maintaining plant to plant distance of 10 cm and row to row spacing of 20 cm using. Twelve days old seedlings were planted (one seedling hill^{-1}) at a spacing of 25cm x 25cm from the nusery where as in transplanted rice twenty one days' old seedlings were planted (2-3 seedlings hill^{-1}) at a spacing of 20 cm X 10 cm . AWD method allows irrigation at 5-7 days interval depending up on the stage of the crop to bring the soil field capacity. Irrigation was given at critical stages *viz.*, active tillering, panicle initiation, booting, heading and flower in critical stage approach where as Water level of 5 cm depth was maintained in the experimental plot up to dough stage in case of farmers practice and In continuous saturation soil was kept as close to saturation as possible *i.e* 2cm depth of ponded water, thereby reducing the hydraulic head of the ponded water.

Observations were recorded for NDVI values, photosynthetic rate, chlorophyll content, leaf temperature and transpiration rate. Yield and yield attribute *i.e* number of productive tillers per hill, panicle length, test weight, grains per panicle, grain yield, straw yield at harvest. Yield and yield attribute *i.e* no. of productive tillers per hill, Panicle length, test weight, no. of grains per panicle, grain yield and straw yield of rice were also recorded.

Result and discussion

Physiological parameters

NDVI values of rice differed significantly in planting methods at all the stages of crop growth. Significantly higher NDVI values (0.317, 0.625 and 0.532) was noticed in SRI method of rice establishment closely followed by transplanted rice and DSR recorded significantly lower NDVI values (0.248, 0.461 and 0.353) at tillering, flowering and grain filling stages (Table 1). Higher NDVI values in SRI method may be due to increased plant biomass, vegetative coverage, chlorophyll content and due to maintenance of greenness as the variety maintained large number of leaves throughout the growth period with better nitrogen utilization. Similar results were obtained by Lukina *et al.* (1999) [16] and Harrell *et al.* (2011) [12]. Among scheduling of irrigation practice effect of alternate wetting drying was found more significant on NDVI values (0.313, 0.619 and 0.463) closely followed by farmers irrigation practice (0.286, 0.558 and 0.437) at tillering, flowering and grain filling stages, respectively which was on par with continuous saturation irrigation practice, while lower NDVI value was recorded with critical stage irrigation approach (0.255, 0.480 and 0.392) at tillering, flowering and grain filling stages. High NDVI values associated with AWD were due to high chlorophyll content whereas under critical stage approach chlorophyll content was reduced due to water stress causing lower NDVI values. Similar observations were reported by Harrell *et al.* (2011) [12].

Photosynthetic rate (μ mol CO_2 $m^{-2}s^{-1}$) of rice differed significantly in planting methods at all the stages of crop growth. Significantly higher photosynthetic rate (7.91, 22.66 and 16.41) was noticed in SRI (M_2) method of rice establishment closely followed by transplanted rice and DSR recorded significantly lower photosynthetic rate (6.60, 20.55 and 14.95) at tillering, flowering and grain filling stages (Fig 1.). Higher photosynthetic rate in SRI leaves is due to higher light utilization capacity (Fv/Fm and UPS II) and a greater photosynthetic rate, especially during the reproductive and ripening stages of the crop. Actively photosynthesizing leaves ensure a sufficient supply of assimilates to the roots for their development and longevity, maintaining active root functioning. At the same time, high root metabolic activity supports a high photosynthetic rate by supplying a sufficient amount of nutrients to the shoot/leaf (Samejima *et al*., 2004; Yang *et al*., 2004; Mishra *et al*., 2006; Zhang *et al*., 2009) [19, 30, 17, 32]. Among scheduling of irrigation practice effect of alternate wetting drying was found more significant on photosynthetic rate (7.84, 22.39 and 16.61) closely followed by farmers irrigation practice (7.38, 21.71 and 16.05) at tillering, flowering and grain filling stages, respectively which was on par with continuous saturation irrigation practice, while lower photosynthetic rate was recorded with critical stage irrigation approach (6.59, 20.58 and 14.59) at tillering, flowering and grain filling stages). High root activity secures a high photosynthetic rate by supplying a sufficient amount of nutrients to shoots, thus ensures high productivity in AWD (Osaki *et al*., 1997) [18].

Transpiration rate (m mol H_2O m^{-2} s^{-1}) of rice differed significantly in planting methods at all the stages of crop growth. Significantly higher transpiration rate (1.24, 5.28 and 3.71) was noticed in DSR method of rice establishment at tillering, flowering and grain filling stages, respectively (Table 1.) which may be due to shortage of moisture plant experience low water potential lead to increased transpiration rate and leaf temperature. Transplanted rice recorded significantly lower transpiration rate. Among scheduling of irrigation practice critical stage irrigation approach (1.41, 5.11 and 3.44) recorded more transpiration rate closely followed by alternate wetting drying (1.10, 5.14 and 3.12) at tillering, flowering and grain filling stages, respectively which was on par with continuous saturation irrigation practice, while lower transpiration rate was recorded with farmers irrigation practice (0.85, 4.94 and 2.78) at tillering, flowering and grain filling stages due to maintenance of high LWP (Low water potential) is considered to be associated with optimal crop performance under water deficit conditions with dehydration avoidance mechanisms (Turner, 1982 and 1986) [27, 28].

Leaf temperature (^{0}C) of rice differed significantly in planting methods at all the stages of crop growth. Significantly higher leaf temperature (26.13, 28.47 and 29.18 ^{0}C) was noticed in

DSR method of rice establishment closely followed by SRI method and TPR recorded significantly lower leaf temperature (23.75, 26.22 and 27.27 ^{0}C) at tillering, flowering and grain filling, respectively (Table 1.). Among scheduling of irrigation practice effect of critical stage irrigation approach was found more significant on leaf temperature (26.07, 28.11and 29.12 ^{0}C) closely followed by AWD (25.43, 27.67 and 28.60 ^{0}C) method of irrigation, respectively. Lower leaf temperature (24.55, 26.56, and 27.49 ^{0}C) was recorded with continuous saturation at tillering, flowering and grain filling, respectively.

Significantly higher **c**hlorophyll-a content (1.76, 3.24 and 2.19) was noticed in SRI (M_2) method of rice establishment closely followed by transplanted rice and DSR (M_1) recorded significantly lower **c**hlorophyll-a content (1.13, 2.21 and 1.74) at tillering, flowering and grain filling, respectively (Table 2.). Among scheduling of irrigation practice effect of alternate wetting drying (AWD) was found more significant on **c**hlorophyll-a content (1.73, 2.87 and 2.15) closely followed by farmers irrigation practice (FP) (1.51, 2.83 and 2.05) at tillering, flowering and grain filling stage , respectively which was on par with continuous saturation irrigation practice, while lower **c**hlorophyll-a content was recorded with critical stage irrigation approach (CSI) (1.20, 2.54 and 1.81) at tillering, flowering and grain filling stages.

Higher **c**hlorophyll-b content (0.46, 0.93 and 0.80) was noticed in SRI method of rice establishment closely followed by transplanted rice and DSR recorded significantly lower **c**hlorophyll-b content (0.38, 0.79 and 0.61) at tillering, flowering and grain filling, respectively (Table 2.). Among scheduling of irrigation practice effect of AWD was found more significant on **c**hlorophyll-b content (0.46, 0.94 and 0.79) closely followed by farmers irrigation practice (FP) (0.43, 0.86 and 0.73) at tillering, flowering and grain filling stage, respectively which was on par with continuous saturation irrigation practice, while lower **c**hlorophyll-b content was recorded with critical stage irrigation approach (CSI) (0.39, 0.73 and 0.62) at tillering, flowering and grain filling stage.

Higher total chlorophyll content (2.22, 3.63 and 2.91) was noticed in SRI method of rice establishment closely followed by transplanted rice and DSR recorded significantly lower total chlorophyll content (1.51, 2.99 and 2.34) at tillering, flowering and grain filling, respectively (Table 2.). Similar trend was also followed at tillering, flowering and grain filling stages. Among scheduling of irrigation practice effect of AWD was found more significant on total chlorophyll content (2.19, 3.67 and 2.93) closely followed by farmers irrigation practice (FP) (1.95, 3.45 and 2.72) at tillering, flowering and grain filling stage, respectively which was on par with continuous saturation irrigation practice, while lower total chlorophyll content was recorded with critical stage irrigation approach (CSI) (1.59, 3.10 and 2.41) at tillering, flowering and grain filling stages. Thakur *et al*. (2011) [26] reported that the improvement in vegetative and generative growth of rice plants under SRI method was due to increasing of photosynthesis rate, high chlorophyll content, and it caused increase in grain yield.

Yield parameters

Significantly higher no. of productive tillers per hill (13.93), Panicle length (22.72 cm), test weight (23.95 g), number of grains per panicle (149.92), grain yield (5096 kg ha^{-1}) and straw yield of rice (5711 kg ha^{-1}) was noticed in SRI method of rice establishment followed by transplanted rice at harvesting stage. DSR recorded significantly lower values in all the above mentioned yield parameters (Table 3). Among the scheduling of irrigation practice effect of alternate wetting drying found significantly more on number of productive tillers per hill (14.16), Panicle length (22.62 cm), test weight (23.81g), number of grains per panicle (150.67), grain yield (4985 kg ha^{-1}) (Fig 2.) while lower values were recorded with critical stage irrigation approach at harvesting stage. The higher grain yield was mainly due to higher yield attributing characters *viz.,* number of productive tillers m^{-2}, panicle length, number of filled grains panicle^{-1} and thousand grain weight. The large root volume, profuse and strong tillers with big panicles and well filled spikelets with higher grain weight contributed to higher yield. Similar results were observed by Satyanarayana and Babu (2004) [20]. The lower yield in DSR was due to lesser production of yield attributing characters because of competition by closer spacing. The results were in line with the findings of Barison and Uphoff *et al*. (2011) [1] and Elamathi *et al*. (2012) [10]. AWD strengthens the air exchange between soil and the atmosphere (Tan *et al.*, 2013) [25], thus sufficient oxygen is supplied to the root system to accelerate soil organic matter mineralization and inhibit soil N mobilization, all of which should increase soil fertility and produce more essential plant-available nutrients to favour rice growth (Tan *et al.*, 2013) [25]. A elevated ABA level in rice plants under AWD regimes during grain filling could increase the grain-filling rate of spikelets, enhance the remobilization of pre-stored assimilates in vegetative tissues to grains and reduce stomatal conductance, consequently, increase grain weight, harvest index and water productivity (Yang and Zhang, 2010) [31].

Table 1: Influence of different methods of establishment and scheduling of irrigation on NDVI, leaf temperature (^{0}c) and transpiration rate (m mol H_2O m^{-2} s^{-1}) at different growth stages of rice

Treatment	**NDVI**			**Leaf temperature (^{0}c)**			**Transpiration rate (m mol H_2O m^{-2} s^{-1})**		
	Tillering	**Flowering**	**Grain filling**	**Tillering**	**Flowering**	**Grain filling**	**Tillering**	**Flowering**	**Grain filling**
Establishment Method (M) M_1 Direct seeded rice	0.248	0.461	0.353	26.13	28.47	29.18	1.24	5.28	3.71
M_2 System of rice intensification	0.317	0.625	0.532	25.86	27.46	28.44	1.11	5.01	3.13
M_3 Transplanted rice	0.281	0.554	0.406	23.75	26.22	27.27	0.94	4.82	2.43
S.Em.±	0.003	0.017	0.006	0.34	0.16	0.13	0.02	0.04	0.02
C.D. @5%	0.012	0.057	0.024	1.32	0.64	0.51	0.08	0.14	0.10
Irrigation scheduling (S) S_1 Alternate wetting and drying	0.313	0.619	0.463	25.43	27.67	28.60	1.10	5.14	3.12
S_2 Critical stage approach	0.255	0.480	0.392	26.07	28.11	29.12	1.41	5.11	3.44

S_3 Continious saturation	0.272	0.527	0.428	24.55	26.56	27.49	1.04	4.95	3.01
S_4 Farmers irrigation practice	0.286	0.558	0.437	24.94	27.19	27.98	0.85	4.94	2.78
S.Em.±	0.009	0.015	0.007	0.17	0.13	0.23	0.04	0.05	0.08
C.D. at 5%	0.025	0.044	0.020	0.5	0.38	0.69	0.13	0.15	0.24
Interaction (M×S) M_1 S_1	0.290	0.536	0.383	26.03	28.81	29.34	1.32	5.32	3.82
M_1 S_2	0.207	0.423	0.312	26.66	29.14	30.37	1.61	5.79	4.10
M_1 S_3	0.240	0.425	0.343	25.84	27.73	28.19	1.09	5.08	3.66
M_1 S_4	0.253	0.460	0.370	26.01	28.2	28.81	0.94	4.94	3.24
M_2 S_1	0.342	0.677	0.577	25.86	27.75	28.80	0.99	5.07	3.08
M_2 S_2	0.301	0.581	0.485	26.67	28.49	29.02	1.30	5.09	3.41
M_2 S_3	0.303	0.612	0.540	25.05	26.53	27.92	1.21	4.93	3.04
M_2 S_4	0.320	0.628	0.526	25.83	27.06	28.01	0.94	4.91	3.00
M_3 S_1	0.307	0.643	0.430	24.39	26.45	27.66	0.98	5.02	2.48
M_3 S_2	0.260	0.435	0.381	24.87	26.69	27.97	1.30	4.46	2.85
M_3 S_3	0.273	0.547	0.402	22.74	25.41	26.35	0.82	4.81	2.32
M_3 S_4	0.283	0.590	0.413	23.00	26.32	27.10	0.67	4.98	2.11
Mean	0.282	0.547	0.430	25.25	27.38	28.3	1.10	5.04	3.09
Subplot at same level of main plot									
S.Em.±	0.015	0.026	0.012	0.29	0.22	0.40	0.07	0.09	0.14
C.D. @5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Main plot at same or different level of subplot									
S.Em.±	0.016	0.04	0.017	0.73	0.39	0.48	0.08	0.11	0.15
C.D. @5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

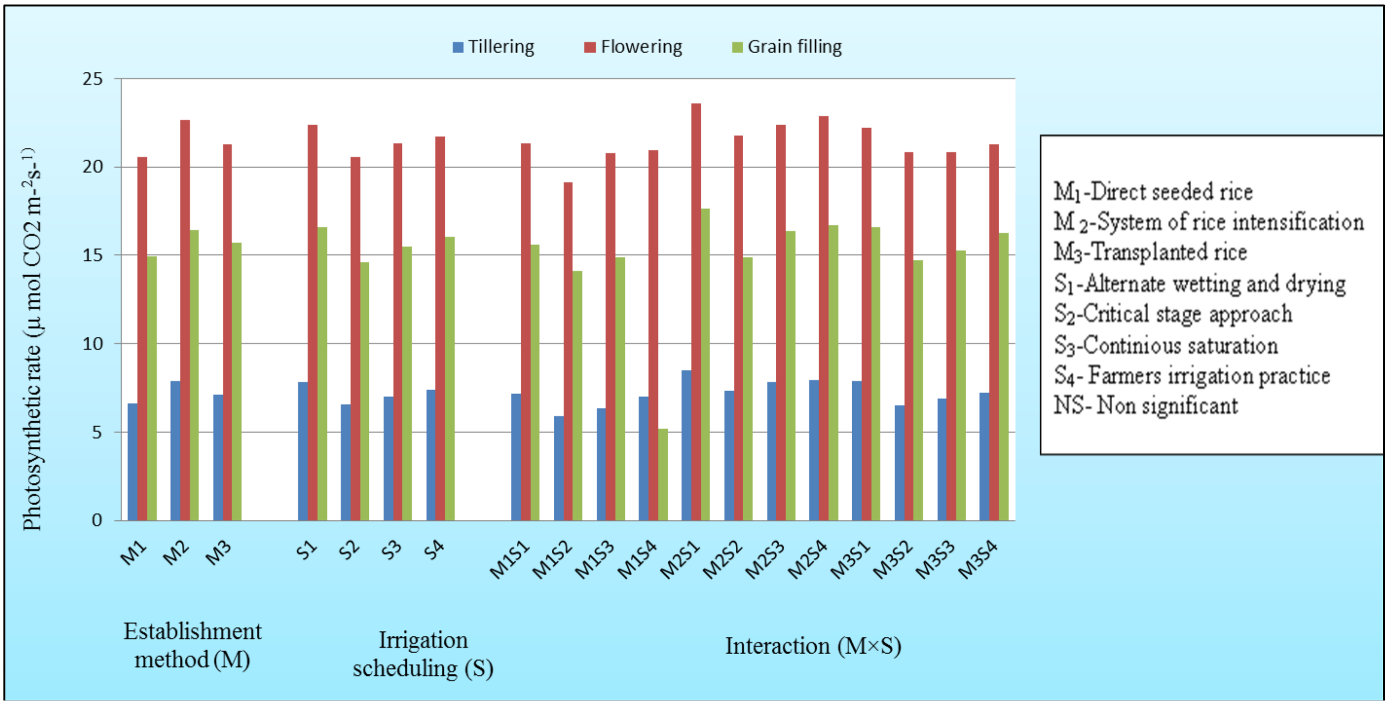

Fig 1: Influence of different methods of establishment and scheduling of irrigation on photosynthetic rate (µ mol CO_2 $m^{-2}s^{-1}$) at different growth stages of rice

Table 2: Influence of different methods of establishment and scheduling of irrigation on chlorophyll-a content, chlorophyll-b content and total chlorophyll content (mg g^{-1} fresh weight) at different growth stages of rice

Treatment	**Chlorophyll-a content (mg g^{-1} fresh weight)**			**Chlorophyll-b content (mg g^{-1} fresh weight)**			**Total chlorophyll content (mg g^{-1} fresh weight)**		
	Tillering	**Flowering**	**Grain filling**	**Tillering**	**Flowering**	**Grain filling**	**Tillering**	**Flowering**	**Grain filling**
Establishment Method (M) M_1 Direct seeded rice	1.13	2.21	1.74	0.38	0.79	0.61	1.51	2.99	2.34
M_2 System of rice intensification	1.76	3.24	2.19	0.46	0.93	0.80	2.22	3.63	2.91
M_3 Transplanted rice	1.44	2.72	2.04	0.44	0.87	0.73	1.88	3.44	2.82
S.Em.±	0.08	0.08	0.06	0.01	0.02	0.02	0.08	0.08	0.07
C.D. @5%	0.22	0.24	0.20	0.03	0.06	0.06	0.27	0.23	0.21
Irrigation scheduling (S) S_1 Alternate wetting and drying	1.73	2.87	2.15	0.46	0.94	0.79	2.19	3.67	2.93

S_2 Critical stage approach	1.20	2.54	1.81	0.39	0.73	0.62	1.59	3.10	2.41
S_3 Continious saturation	1.32	2.66	1.96	0.42	0.85	0.68	1.74	3.28	2.64
S_4 Farmers irrigation practice	1.51	2.83	2.05	0.43	0.86	0.73	1.95	3.45	2.72
S.Em.±	0.07	0.05	0.05	0.01	0.02	0.02	0.07	0.06	0.05
C.D. at 5%	0.21	0.14	0.14	0.02	0.07	0.05	0.21	0.17	0.16
Interaction (M×S) M_1 S_1	1.38	2.40	1.95	0.40	0.85	0.67	1.77	3.25	2.62
M_1 S_2	0.94	2.02	1.63	0.36	0.74	0.56	1.30	2.76	2.19
M_1 S_3	1.03	2.17	1.64	0.37	0.75	0.61	1.40	2.93	2.22
M_1 S_4	1.18	2.26	1.72	0.39	0.76	0.62	1.57	3.02	2.31
M_2 S_1	2.09	3.52	2.38	0.48	1.03	0.90	2.59	3.97	3.16
M_2 S_2	1.53	3.01	1.87	0.43	0.84	0.70	1.96	3.34	2.55
M_2 S_3	1.59	3.12	2.19	0.46	0.90	0.76	2.05	3.48	2.88
M_2 S_4	1.82	3.34	2.34	0.47	0.94	0.87	2.28	3.73	3.06
M_3 S_1	1.74	2.66	2.11	0.48	0.96	0.81	2.22	3.47	2.97
M_3 S_2	1.12	2.60	1.92	0.39	0.83	0.67	1.51	3.21	2.59
M_3 S_3	1.37	2.69	2.05	0.44	0.85	0.69	1.80	3.43	2.81
M_3 S_4	1.54	2.88	2.10	0.45	0.89	0.73	1.98	3.64	2.93
Mean	1.44	2.70	1.99	0.43	0.86	0.71	1.87	3.35	2.69
Subplot at same level of main plot									
S.Em.±	0.12	0.08	0.08	0.01	0.04	0.03	0.12	0.10	0.09
C.D. @5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Main plot at same or different level of subplot									
S.Em.±	0.20	0.15	0.17	0.02	0.05	0.04	0.19	0.19	0.17
C.D. @5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Influence of different methods of establishment and scheduling of irrigation on yield and yield attributes at harvesting stage of rice

Treatment	**Yield and yield attributing parameters**			
	Panicle length(cm)	**Test weight(g)**	**Grains per panicle**	**Productive tillers/hill**
Establishment method (M)				
M_1	20.89	20.76	131.79	11.43
M_2	22.72	23.95	149.92	13.93
M_3	21.85	22.02	143.58	12.95
S.Em.±	0.21	0.16	1.38	0.24
C.D. @5%	0.84	0.64	4.12	0.95
Irrigation schedule (N)				
S_1	22.62	23.81	150.67	14.16
S_2	20.91	20.66	132.20	11.45
S_3	21.79	22.05	139.44	12.51
S_4	21.97	22.44	142.73	12.97
S.Em.±	0.21	0.44	2.25	0.33
C.D. at 5%	0.62	1.30	6.68	0.99
Interaction (M×N)				
M_1 S_1	21.58	22.36	135.00	12.31
M_1 S_2	20.34	19.09	128.05	10.25
M_1 S_3	20.73	20.61	130.33	11.16
M_1 S_4	20.92	20.97	133.82	12.00
M_2 S_1	23.91	26.22	164.36	14.57
M_2 S_2	20.97	21.65	141.39	12.98
M_2 S_3	22.78	23.20	143.31	13.84
M_2 S_4	23.23	24.73	150.67	14.32
M_3 S_1	22.36	22.85	152.68	15.59
M_3 S_2	21.42	21.24	136.33	11.11
M_3 S_3	21.86	22.35	141.67	12.52
M_3 S_4	21.75	21.63	143.62	12.59
Mean	21.82	22.24	142.10	12.77
Subplot at same level of main plot				
S.Em.±	0.36	0.76	3.89	0.58
C.D. @5%	NS	NS	NS	NS
Main plot at same or different level of subplot				
S.Em.±	0.56	0.82	4.77	0.76
C.D. @5%	NS	NS	NS	NS

M_1-Direct seeded rice
M_2-System of rice intensification
M_3-Transplanted rice
NS- Non significant

S_1-Alternate wetting and drying
S_2-Critical stage approach
S_3-Continious saturation
S_4- Farmers irrigation practice

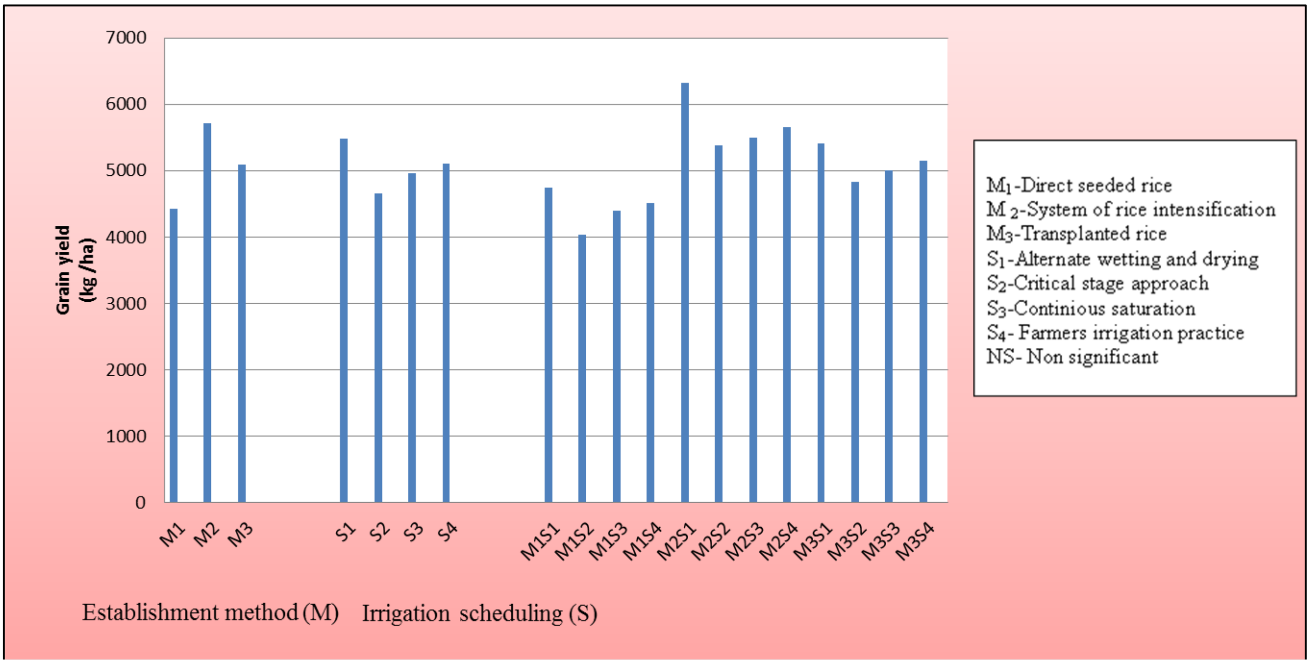

Fig 2: Influence of different methods of establishment and scheduling of irrigation on grain yield at harvest of rice

Reference

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