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Effect of different water and nutrient management practices on rice grown under SRI

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ABSTRACT

A field experiment with three irrigation levels of 2.5 cm irrigation 0 day after disappearance (DAD), 3 DAD and 6 DAD of ponded water and five nutrient levels i.e. 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} (F_1), FYM 10 t ha^{-1} + 100%F_1 (F_2), FYM 10 t ha^{-1} + 75% F_1(F_3), FYM 10 t ha^{-1} + 50% F_1(F_4) and FYM 10 t ha^{-1} (F_5) was conducted at Rajendra Agricultural University Farm, Pusa during kharif 2009 and 2010 respectively in Split Plot Design with three replications. The test variety was Rajendra Mashuri-1. Results of the experiments indicated that all the growth and developmental parameters viz. plant height, number of tillers per hill, dry matter accumulation, panicle per m^2, grain and straw yield were better at 2.5 cm irrigation 0 DAD over 6 DAD but were at par with 3 DAD. Both the gross and net return were significantly higher at 0 DAD over 6 DAD but at par with 3 DAD while, F_2 (FYM 10 t ha^{-1}+ 100% F_1) was significantly higher over all nutrient levels. The highest return per rupee of investment was recorded at 2.5 cm irrigation 3 DAD while, it was significantly higher at F_1 (120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}) over all the nutrient levels but at par with F_2 (10 t FYM ha^{-1} + 100%F_1) level.

***Key words*:** Nutrient management, rice, SRI, water management

Rice is a staple food for about 50 per cent of the world population that resides in Asia, where 90 per cent of the world rice is grown and consumed. More than 400 million people in rice-producing areas of Asia, Africa and South America still suffer chronic hunger, with the demand for food expected to rise by another 38% within 30 years (Surridge, 2004). This increase in production could be achieved by intensification of paddy cultivation rather than increasing the area. As per the FAO estimates, Borker *et al*. (2000) reported that rice crop consumes about SRI is an emerging water saving technology, with many fold increase in crop yield. By adopting this system of cultivation one could save water, protect soil productivity, save environment by checking methane gas from water submerged paddy cultivation practices, bring down the input cost, besides increasing the production for providing food to the growing population. Careful water management needs to be followed. Intermittent irrigation *i.e.* alternate drying and wetting should be practiced in such a way that water is kept at a shallow level (up to 2.5 cm). This type of water management may save 30-40 percent water (Anon., 2008).

This system of cultivation not only helps to minimize loss of nutrients specially nitrogen but also helps to increase nutrient use efficiency and enhance the tillering of rice plants. Increased soil aeration and organic matter help in improving soil biology leading to better nutrient availability. Pest incidence also reduces due to increased spacing, thereby drastically reducing the need for pesticides.4000-5000 liters water per kg of grain produced. Since water for rice production has become increasingly scarce, water saving strategies has become a priority in rice research.

System of Rice Intensification (SRI) developed in Madagascar about 20 years back and synthesized in the early 1980's (Stoop *et al.,* 2002), offers opportunity to researchers and farmers to expand their understanding of the potentials already existing in the rice genome.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2009 and 2010 at Pusa farm, Rajendra Agricultural University, Bihar, Pusa (Samastipur) situated at 25°58′43″ N latitude, 85°54′78″ E longitude, 52.92 m above mean sea level with 1276.1 mm of average (out of which nearly 1026.0 mm is received during the monsoon period from June to September) to find out the optimum level of irrigation and nutrient applied through organic and inorganic sources and to work out the monetary advantages of the treatments under SRI cultivation. The soil of the experimental plot was sandy loam in texture, alkaline in reaction (pH 8.14) and low in available nitrogen (157 kg ha^{-1}), phosphorous (19.85 kg ha^{-1}) and medium in potassium (163.2 kg ha^{-1}) content.

The experiment was laid out in a split plot design with irrigation in main plot and nutrient in sub plot with three replications. The main plot treatments were I_1- Irrigation up to 2.5 cm at 0 days after disappearance of ponded water (DAD), I_2- Irrigation up to 2.5 cm at 3 DAD, I_3- Irrigation up to 2.5 cm at 6 DAD and sub-plot treatments were F_1-120kg N, 60 kg P_2O_5, 40 kg K_2O ha^{-1} [RDF (Adhunik Kishan, 2008)], F_2-FYM @ 10 t ha^{-1} + 100% F_1, F_3- FYM @ 10 t ha^{-1} +75%F_1, F_4-FYM @ 10 t ha^{-1} + 50% F_1, F_5- FYM @ 10 t ha^{-1}. The whole amount of P_2O_5 in the form of DAP and K_2O as MOP were applied as basal during final land preparation. Nitrogen was applied in 3 split doses with ⅓ nitrogen as basal in the form of DAP.

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Rest ⅔ N was given in the form of Urea in two equal split doses, one at active tillering stage and rest at panicle initiation stage. The gross and net plot size were 5 m × 3.5 m and 4 m × 2.5 m respectively. Seedlings were transplanted 25 cm apart in rows at 25 cm distance. The cultivar was *Rajendra Mashuri-1.* Growth attributes and yield components such as plant height (cm), dry matter accumulation (g m^{-2}), panicles per m^2, number of grains $panicle^{-1}$, grain weight $panicle^{-1}$ (g), test weight (g), grain yield (q ha^{-1}) and net return (Rs. ha^{-1}) were recorded and statistically analysed (Fisher 1962).

Table 1: Water requirement as affected by different treatments (pooled)

Treatments	Number of irrigation	Water applied (cm)	Total rainfall (cm)	Total water applied (cm)
I_1	28	70	48.05	118.05
I_2	13	32.5	48.05	80.55
I_3	9	22.5	48.05	70.55

RESULTS AND DISCUSSION

Growth attributes were significantly influenced by different water and nutrient management practices. Significantly higher plant height of 111.40 cm was recorded at harvest with I_1 level of irrigation as compared to I_3 level of irrigation (103.71 cm) but was at par with I_2 level of irrigation (108.01). The maximum plant height of 116.47 cm was observed with F_2 level of nutrient and the minimum of 98.63 cm with F_5 level. Dry matter accumulation increased up to the harvest and was found to be maximum with I_1 (761.13 g m^{-2}) and F_2 (768.86 g m^{-2}) and was recorded minimum with I_3 (682.62 g m^{-2}) and F_5 (651.29 g m^{-2}).

The yield attributes *viz.,* Number of panicles m^{-2}, number of grains per panicle and grain weight per panicle was better at I_1 than I_3 but was at par with I_2. The test weight did not change with irrigation levels. Significantly higher grain yield of 52.76 q ha^{-1} was recorded in I_1 level of irrigation as compared to I_3 level of irrigation (45.93 q ha^{-1}) but was at par with I_2 level of irrigation (49.96 q ha^{-1}). It was apparent that all the yield components played an important role in deciding the grain yield of rice and was influenced by nutrient levels. The maximum grain yield was recorded with F_2 (56.41 q ha^{-1}) and the minimum with F_5 (39.79 q ha^{-1}) level of nutrient.

Table 2: Effect of irrigation and nutrients on growth and yield attributes of rice under SRI (pooled)

Treatments	Plant height(cm)	Dry matter (g m^{-2})	Panicles m^{-2}	No. of grains $panicle^{-1}$	Grain weight $panicle^{-1}$ (g)	1000-grain weight (g)
Irrigation Levels						
I_1	109.9	754.5	278.5	182.4	3.804	20.84
I_2	106.6	715.6	267.2	179.4	3.654	20.33
I_3	102.3	676.7	253.7	173.7	3.484	19.92
SEm (±)	**1.53**	**17.01**	**6.39**	**2.04**	**0.06**	**0.24**
LSD(0.05)	**4.25**	**47.22**	**17.73**	**5.66**	**0.22**	**NS**
Nutrients levels						
F_1	108.0	726.0	266.2	180	3.724	20.65
F_2	115.4	762.5	287.1	182.2	3.934	21.09
F_3	108.1	740.0	268.5	180.3	3.754	20.84
F_4	104.5	705.1	264.6	178.8	3.584	20.26
F_5	97.74	645.9	243.4	170.3	3.205	19.03
SEm (±)	**2.03**	**19.89**	**5.17**	**1.59**	**0.1**	**0.2**
LSD(0.05)	**4.20**	**41.05**	**10.68**	**3.29**	**0.14**	**0.57**
Interaction I × F						
SEm (±)	**3.17**	**27.69**	**7.92**	**1.33**	**0.10**	**0.33**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

The farmers are more concerned with higher net return (per ha). The gross and net return was significantly higher at I_1 (0 DAD) over I_3 (6 DAD) but was at par with I_2 (3 DAD) while, F_2 (FYM @ 10 t ha^{-1} + 100% F_1) was significantly superior over all the nutrient levels.

The grain yield of rice depends on the number of panicles m^{-2}, number of grains $panicle^{-1}$, grain weight $panicle^{-1}$ and panicle length. The relative magnitude of these yield attributes varies substantially with the agronomic practices (Yoshida, 1972). Numbers of panicle m^{-2} *i.e.* effective tillers were determined before harvest.

Except test weight all the other yield attributing characters differed significantly with the difference in the levels of irrigation. Maximum value was recorded at I_1 2.5cm 0 DAD. This is due to the fact that the tranquil availability of water keeps all the physiological activities of the plants active resulting in proper translocation of photosynthates from source to sink ultimately escalating the crop yield. Similar observation was also reported by Parihar (2004) and Kumar (2006).

Yield is the ultimate outcome of the crop efficiency as influenced by the various management practices. Proper and timely management of production factors under a given set of environment and input acts on the plant which consequently produce the desirable economic products (Madhu Priya, 2008).

Therefore, proper management of rice plant both at vegetative as well as reproductive phase is necessary for successful rice production. The final yield of rice is the result of successful completion of the growth and development activities which in turn depends on the hereditary potential of a genotype, the environmental condition to which it is exposed during the course of its life cycle and agronomic management practices.

From the above discussion, it becomes apparent that the number of panicles m^{-2}, length of panicle, grain weight per panicle, number of grains per panicle, test weight played an important role in deciding the grain yield of rice and their progressive response to NPK application resulted in increased yield of grain.

Moisture stress condition for a long period causes reduced entry of CO_2 resulted from partial stomatal closing due to excessive evapotranspiration. Thus scarcity of CO_2 *vis-à-vis* water ultimately hampers the process of photosynthesis resulting in poor translocation and accumulation of photosynthates which finally reduces crop yield. This result corroborates the findings of Chauhan *et al.* (1999) and Patjoshi and Lenka (1998).

Table 3: Effect of water and nutrient levels on grain and straw yield, gross and net return and net return per rupee investment of rice grown under SRI (pooled over two years)

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross Return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	Net return per rupee investment
Irrigation Levels					
I_1	52.32	73.8	59087	41212	2.276
I_2	49.55	71.48	56039	39649	2.372
I_3	45.55	67.63	51633	35640	2.191
SEm (±)	**1.21**	**1.01**	**1916.74**	**806.34**	**0.07**
LSD(0.05)	**4.73**	**3.96**	**5320.80**	**2238.54**	**NS**
Nutrients levels					
F_1	49.77	70.64	56098	41183	2.506
F_2	55.97	77.08	63030	44533	2.345
F_3	51.38	72.42	57946	40438	2.227
F_4	49.21	70.98	55612	38799	2.221
F_5	39.48	63.79	45030	29856	1.914
SEm (±)	**1.13**	**0.89**	**1837.8**	**1309.57**	**0.074**
LSD(0.05)	**3.29**	**2.60**	**3793.22**	**2702.90**	**0.212**
Interaction I × F					
SEm (±)	**2.08**	**1.42**	**2262.92**	**1611.28**	**0.131**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**

It has been found that under treatment I_1 (2.5 cm irrigation 0 DAD) the required number of irrigation was 28 for which applied amount of water was 70 cm (excluding the rainfall amount), whereas under treatment I_2 (2.5 cm irrigation 3 DAD) and I_3 (2.5 cm irrigation 6 DAD) the values were 32.5 cm and 22.5 cm respectively. Regarding nutrient management treatments the application of FYM @ 10 t ha^{-1} + 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was found to be the best one. Though from the point of view of crop yield the treatment I_1 (2.5 cm irrigation 0 DAD) has been proved to be the best one, but considering the economic returns (gross return, net return and net return per rupee investment) irrigating the rice crop up to 2.5 cm 3 DAD of ponded water (I_2) and fertilizing the rice crop with FYM @ 10 t ha^{-1} + 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} (F_2) have been recorded to be best treatments.

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