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Effect of different crop establishment methods and nutrient management practices on yield of rice (*Oryza sativa* L.) under Kashmir valley conditions

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ABSTRACT

In Kashmir valley the shortage of labour and water are pressing farmers to explore the alternatives of conventional transplanting. Use of organics being an important component of SRI, but its availability and costs inhibit farmers from adoption of this method. Hence, impacts of other alternatives in SRI need to be assessed. A field experiment was conducted during kharif seasons of 2013-2015 at SKUAST-K, Khudwani, Jammu and Kashmir, to evaluate the performance of three rice establishment methods and six nutrient management practices on rice yield. The data revealed that crop establishment methods and nutrient management practices significantly influenced the grain yield of rice. SRI method of crop establishment had resulted in significantly higher rice grain yield over other two methods DSR and conventional transplanted rice. Among the methods of nutritional management, application of 150% RDF produced significantly higher grain yield compared to other practices. Average grain yield increase with SRI was to the tune of 8.9 per cent over DSR and 4.4per cent over TPR (SRI- 6.15 t ha^{-1}, DSR- 5.63 t ha^{-1} and TPR 5.89 t ha^{-1}). Application of 150% RDF or integrated nutrition involving RDF (50% fertilizers + 50% organic manures) proved promising for the improvement of rice productivity.

***Keywords*:** Crop establishment**,** conoweeding, direct seeded rice, normal transplanting, nutrient management and SRI

Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population including regions of high population density and rapid growth. It provides about 21 per cent of the total calorie intake of the world population. In India, rice occupies about one-quarter of the total cropped area, contributes about 40 to 43 percent of total food grain production, providing direct employment to 70 per cent rural population and plays a vital role in national food and livelihood security (DES, 2013). In Jammu and Kashmir, rice is cultivated on an area of about 0.26 million hectares producing 0.55 million tonnes of grain with a productivity of 2.1 tonnes per hectare, (DES, 2013). Transplanting is the most dominant method of rice establishment in Kashmir valley. The area under transplanted rice in world is decreasing due to scarcity of water and labour. So, there is need to search for alternate crop establishment methods to increase the productivity of rice (Farooq *et al*., 2011). Direct seeding reduces labour requirement, shortens the crop duration by 7-10 days and can produce as much grain yield as that of transplanted crop. It needs only 34per cent of the total labour requirement and saves 29 of the total cost (Sharma *et al.*, 2005). Pandey and Valesco (2005) advocated that transplanted rice be practiced in areas where low wages for labour and adequate water is available whereas, direct seeded rice can be practiced in areas with high wages and low water availability. The system of rice intensification was recently promoted as an alternative technology and resource management strategy for rice cultivation that offers the opportunity to boost rice yields with less external inputs. The system of rice intensification consists of a set of management practices that were mainly developed through participatory approach (on-farm experiments) in the central highland of Madagascar in the 1980s (Stoop *et al*., 2002) The main elements of SRI include transplanting of young seedlings below 15 days age nurtured on a raised bed, singly, widely spaced (25 x 25cm), mechanical weeding with a rotary push weeder that aerates the soil and controls weeds, water management in such a way that there is no continuously standing water during the vegetative growth phase and reliance on compost as far as possible, with supplemental or no use of chemical fertilizer. In areas with scarcity of water and labour, transplanting can be replaced by direct seeding under puddle condition and SRI (Parameswari *et al.*,2014). Balanced nutrient application is one of the decisive factors in realizing enhanced levels of productivity from the high yielding cultivars. Use of organics is an important component of SRI, but its availability and costs may inhibit farmers from this practice. Hence, impacts of other alternatives in SRI need to be assessed. Rice yield per unit area per unit time is dependent on adequate fertilization. But nutrient requirement may differ under various crop establishment methods. Hence, there is a need to evaluate different systems of rice crop establishment together with suitable nutrient management practices for realizing enhanced levels of rice productivity.

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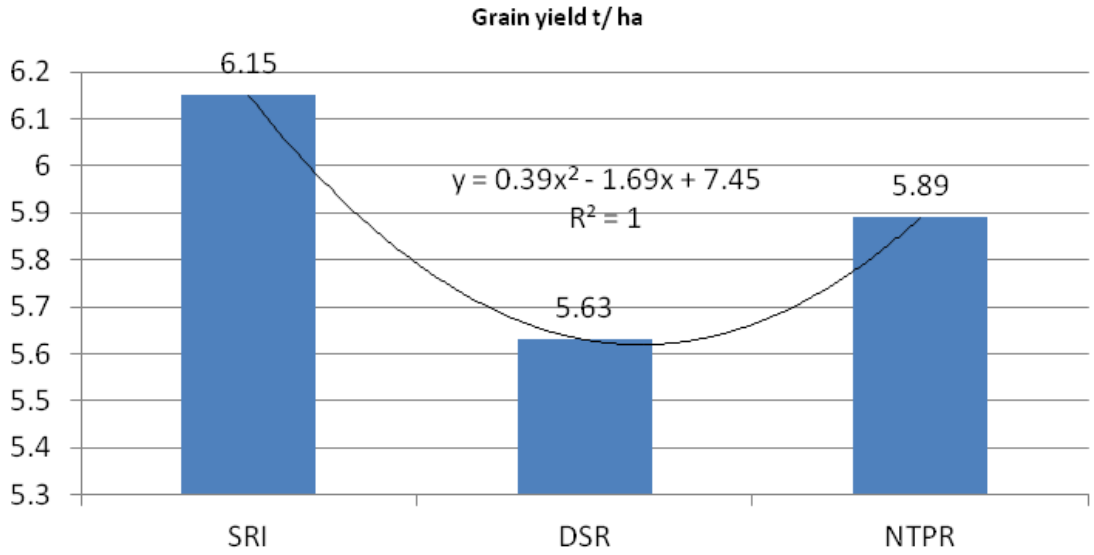

Fig. 1: Correlation of rice establishment methods with grain yield

MATERIALS AND METHODS

The field experiment was conducted to study the effect of different establishment methods and nutrient management practices on rice yield at Mountain Research Centre for Field Crops, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Khudwani, Anantnag, Jammu and Kashmir during *kharif* 2013, 2014 and 2015. The soil of experimental field was silty clay loam in texture, neutral in reaction (pH 7.3), low in available nitrogen, medium in available phosphorous and potassium. The treatments consisted of three crop establishment methods (M1 System of Rice Intensification, (SRI), Direct Seeded Rice (DSR) and Normal transplanted Rice (NTPR) (M_1-SRI, M_2-DSR, M_3-NTPR) in main plots and six nutrient management practices in sub plots (S_1: 100% of recommended inorganic fertilizers (120:60:40 kg $N:P_2O_5:K_2O$ ha^{-1} N K ha^{-1}), S_2: 50 % inorganic + 50% organic (equivalent of N dose), S_3: 100% of recommended dose through organic source (equivalent of N dose) S_4; 150 % recommended fertilizer dose, S_5; No fertilizer (Control), S_6; 50% inorganic + 50% N through biofertilizer (*Azospirrillum*) 50% through Bio fertilizer (*Azospirillum*). The treatments were replicated thrice in a split plot design. For SRI method, the seedlings (of variety Shalimar Rice-1) were raised on raised bed (mat nursery) and then planted in the demarcated plot transplanted in first week of June at a spacing of 25 x 25 cm during all the three seasons of experimentation. For direct seeded rice (DSR)) the pre-germinated seeds were sown in rows 20cm apart in well prepared plots on in 2nd week of May every season while for normal transplanted rice (NTPR) nursery sowing was done with same pre-germinated seeds on the same date and then 30 day old seedlings were transplanted at a spacing of 15 x15 cm during 2nd week of June. As per the treatments, well decomposed farm yard manure and biofertilizer *Azospirillum* (N equilvalent basis) was incorporated in treatment plots uniformly during land preparation. In the nutrient management treatments (inorganics) the entire quantity of phosphorus and potassium and half of nitrogen was applied as basal at the time of transplanting while remaining N was applied in two equal splits at active tillering and panicle initiation stages. Under SRI method all the principles (raised bed nursery, single seedling, wider spacing, use of organics(50%), Water management by alternate wetting and drying (AWD), mechanical weeding with conoweeder thrice at 15,25 and 35 days after sowing /transplanting DAS/DAT) Under NTPR, plots were flooded with water and for controlling weeds, butachlor 1.5 kg a.i. ha^{-1} was applied 3-5 days after transplanting. Yield attributes like effective tillers and panicles m^{-2} were recorded by using a quadrat (50x50 cm= 0.25 m^{-2}) whereas the yield and other yield attributes were recorded at maturity stage (at harvest). The crop was harvested during last week of September every year.

RESULTS AND DISSCUSSIONS

Effect of crop establishment methods

Crop establishment methods and nutrient management practices had a significant effect on yield attributes and grain yield of rice (Table 1 and 2). Maximum number of panicles (401 m^{-2}) was recorded in SRI followed by normal transplanting (366) during 2013. Under SRI, significantly higher number of grains $panicle^{-1}$ was recorded in comparison to DSR and normal transplanting (Table 1). During 2013, SRI recorded 96.2

Table 1 : Effect of establishment methods and nutrient management practices on yield attributes of rice.

Treatment	Panicles (No. m^{-2})			Panicle weight (g)			Grains $Panicle^{-1}$ (No.)		
Method of Esablishment	2013	2014	2015	2013	2014	2015	2013	2014	2015
M_1 - SRI	401	369	377	2.81	2.74	2.80	96.2	82.7	90.7
M_2 – DSR	349	345	355	2.67	2.60	2.74	86.3	74.2	80.4
M_3 – NTPR	366	351	360	2.75	2.67	2.77	88.5	76.1	84.3
LSD (0.05)	**13.1**	**7.5**	**8.1**	**NS**	**NS**	**NS**	**5.6**	**4.5**	**4.9**
Nutrient Management									
Recommended Fertilizer Dose (RFD)	428	406	402	3.01	2.93	3.04	97.6	83.8	92.4
50 % inorganic + 50% organic(N equivalent dose)	393	377	376	2.68	2.60	2.57	94.9	81.6	90.3
100% of RFD through organic source (N equivalent dose)	328	314	320	2.52	2.45	2.41	88.6	76.2	83.8
150% RFD	436	418	420	3.29	3.20	3.47	99.5	85.6	95.9
50 % inorganic + Biofertilizer (N equivalent dose)	374	350	409	2.61	2.54	3.07	91.8	77.6	85.1
Control (No Fertilizer)	273	264	259	2.37	2.30	2.10	69.6	61.2	63.3
LSD (0.05)	**15.1**	**15.2**	**11.3**	**0.16**	**0.17**	**0.24**	**8.5**	**7.8**	**8.1**

Table 2: Effect of establishment methods and nutrient management practices on yield and harvest index of rice.

Treatment	Grain yield (t ha^{-1})				Straw yield (t ha^{-1})			Harvest index (%)		
Method of Esablishment										
	2013	2014	2015	Mean	2013	2014	2015	2013	2014	2015
M_1 - SRI	6.85	4.96	6.63	6.15	9.73	6.58	9.85	0.4131	0.4298	0.4023
M_2 - DSR	6.35	4.36	6.18	5.63	8.31	5.43	7.89	0.4332	0.4454	0.4392
M_3 - NTPR	6.50	4.74	6.42	5.89	8.57	5.98	8.39	0.4313	0.4422	0.4335
LSD (0.05)	**0.20**	**0.15**	**0.14**	**0.16**	**0.25**	**0.19**	**0.18**			
Nutrient Management										
Recommended Fertilizer Dose (RFD)	7.03	5.46	7.32	6.60	9.75	7.68	9.52	0.4190	0.4155	0.4347
50 % inorganic + 50% organic(N equivalent dose)	6.86	4.77	6.99	6.21	8.74	6.54	8.98	0.4397	0.4218	0.4377
100% of RFD through organic source (N equivalent dose)	6.05	4.39	5.97	5.47	7.44	5.47	7.92	0.4485	0.4452	0.4298
150% RFD	7.29	5.69	7.51	6.83	11.37	8.78	11.56	0.3907	0.3932	0.3938
50 % inorganic + Biofertilizer (N equivalent dose)	6.47	4.36	6.71	5.85	8.56	6.38	8.95	0.4305	0.4060	0.4285
Control (No Fertilizer)	5.51	3.45	3.96	4.31	7.38	4.95	5.89	0.4275	0.4107	0.4020
LSD (0.05)	**0.37**	**0.34**	**0.36**	**0.36**	**0.46**	**0.42**	**0.45**	**-**	**-**	**-**

grains panicle^{-1} which was 11.47 and 8.94 per cent higher as compared to DSR (86.3) and transplanting (88.3), respectively while the corresponding figures for 2015 were 90.7 as compared to 80.4 and 84.3. Kumar *et. al.* (2015) reported that yield attributes like number of tillers hill^{-1}, length of panicles (cm), number of fertile grains panicle^{-1} and 1000- grain weight registered significantly higher values in case of SRI method than standard method of crop establishment.

Grain and straw yield of rice differed significantly during all the seasons of experimentation (Table 2 and Fig 1). SRI method of crop establishment recorded significantly higher grain yield (6.15 t ha^{-1}), followed by normal transplanting (5.89 t ha^{-1}). Lowest grain yield of 5.63 t ha^{-1} was The crop established by SRI method provided a mean yield advantage of 9.23 per cent over DSR and 4.41per cent over normal transplanting. Hugar *et al.* (2009) also reported higher grain yield of rice under SRI from Bhadra command area in Karnataka. Bhat *et al*. (2016) obtained higher grain yield with four conoweedings in SRI method of rice establishment. SRI method also recorded significantly higher straw yield than DSR and normal transplanting. The higher grain and straw yield realized with SRI method may be due to transplanting of seedlings at younger age which preserves a potential for more tillering and rooting. Further, wider spacing in square pattern (25 x 25 cm) provides more room for both canopy and root growth and for subsequent grain filling. The increase in the grain yield under SRI method was attributed to larger root volume, profuse and strong tillers with longer panicles, more and well filled spikelets with higher grain weight. Higher grain yield of rice under SRI was also recorded by Satyanarayana and Babu, (2004). Comparable yields in rice through alternate systems of crop establishment with that of transplanting has been reported by Mankotia *et al.* (2009) and Mahajan *et al.* (2012). Positive correlation was observed between establishment methods and grain yield (Fig 1).

Effect of nutrient management practices

Various nutrient management practices significantly influenced the yield attributes and grain yield of rice. Among the nutrient management practices, integrated use of inorganic (50%) and organic (50% N equivalent) proved promising as it recorded yield attributes at par with recommended fertilizer dose. Higher number of panicles (412) m^{-2} were recorded in the plots receiving RFD which was comparable and at par with 150% RFD (424). Highest mean number of grains per panicle (93.5) was obtained with application of 150% recommended fertilizer dose followed by recommended fertilizer dose (91.2) and integrated 50% inorganic + 50% organic (88.9). Application of recommended fertilizer dose on an average produced 41.05 per cent more number of grains (91.26) panicle^{-1} (though at par with 150% RFD) as compared to control (64.7). Similar results have been reported by Krishna Murthy and Pushpa (2017).

Maximum grain and straw yield was noticed with the application of 150% RFD. Application of 150% RFD recorded highest grain yield of 6.83 t ha^{-1} which was however statistically at par with RFD (6.60 t ha^{-1}) while as lowest grain yield of 4.31 t ha^{-1}

was obtained without fertlizer application (control). Application of 50% of RFD augmented with 50% through organics proved promising and registered a mean grain yield of 6.21 t ha^{-1} which was slightly lower than that of 100% RDF. Integrated application of RFD + FYM 5 t/ha followed by 50% RDF + FYM 10 t ha^{-1} recorded higher values of all the yield-attributing parameters and grain yield of rice under Meghalya conditions (Wahlang *et. al.*, 2015). Krishna Murthy and Pushpa (2017) also reported that integrating *dhainchia* manuring with RDF significantly improved grain yield of rice. Superior yield attributes resulted in higher grain yield under recommended fertilizer application (though at par with 150% RFD) which might be due to availability of nutrients leading to better accumulation of photosynthates during vegetative growth and their effective translocation during the reproductive phase in to the sink. Higher harvest index ranging from 42 to 45 per cent was observed in treatments receiving organics either solely or in combination with inorganic fertilizers.

From the three year studies it is concluded that System of rice intensification with integrated nutrition involving inorganic fertilizers and organic manures or biofertilizers is promising for improving rice productivity under Kashmir conditions.

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