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Implications of Various Establishment Methods and Nutrient Management Practices on the Growth and Yield of Rice in the North Western Himalayan Region

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: For more than half of the world's population, rice is the primary staple food. The traditional method of producing rice uses a lot of water, requires a lot of labor, and is bad for the health of the soil and the environment. Additionally, an unbalanced nutrient supply causes plants to grow and develop slowly, the soil to deteriorate, and the environment to suffer. To know the effect

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of rice establishment and nutrient management on rice a field study was conducted at SKUAST-Jammu.

Methodology: In a split plot design with three replications, the field experiment was carried out with the rice variety Pusa-1121 using 3 establishment methods (system of rice intensification, conventional, and mechanical) and 6 nutrient management practices (100% RDF inorganic, 75% RDF inorganic, 125% RDF inorganic, 50% inorganic + 50% organic, 75% inorganic + 25% organic, and 100% organic manures with FYM).

Results: Among the nutrient management, 125% RDF gives the highest yield and B:C ratio of the rice crop during both years, according to the results. The highest yield was found in SRI crop establishment method, which also has the highest B:C ratio among all crop establishment methods.

Conclusion: In terms of productivity, soil studies and profitability, the establishment of rice by the system of rice intensification (SRI) technique in combination with 125% RDF inorganic approach was found to be superior to the other treatments.

Keywords: RDF; establishment; nutrient and FYM; nutrient management.

1. INTRODUCTION

Rice sustains millions of people's lives, culture, traditions, and means of subsistence, rice is acknowledged as the most valuable commodity in the world. For more than half of the world's population, it is an important staple meal [1]. The current state of affairs suggests that research on rice crop establishment and management methods is receiving more attention. This is primarily the result of variations in crop establishment techniques with regard to energy needs, resource usage, and potential to function as a climate change mitigation technique, which may have far-reaching implications for farmer yield and income as well as environmental health. To address issues like resource degradation and the rising cost of chemical and agronomic treatments or resources, novel crop establishment methods and management strategies are also becoming more and more crucial [2]. The majority of farmers in India favor the traditional (transplanting) system of growing rice because they don't want to take any risks with new technology. However, we are aware that traditional rice farming degrades soil and the environment, necessitates a lot of labor, and uses a lot of water. As a result, we require more effective alternative methods of producing rice in order to maintain long-term rice production [3], such as the system of rice intensification, which uses 22 to 38% less water than traditional methods of rice-growing [4]. The growth and development of rice crops are significantly influenced by nutrient management techniques. Each nutrient plays a unique role in the growth and development of a plant. The relative availability of nutrients from organic and inorganic sources for crops varies. Chemical fertilizers are rich in nutrients, provide nutrients quickly, and are easily accessible to plants because the majority of fertilizers are water soluble. Additionally, after just a few years of cropping, the production of cereal crops significantly declines when chemical fertilizers are still used [5]. Farmyard manure (FYM), on the other hand, is an easy and complete source of the majority of nutrients [6], and because of its low nutrient content, bulky nature, slow decomposition, and gradual release of nutrients into the labile pool, it becomes available for crop uptake for a longer period of time. Additionally, organic food sources improve the physical properties of soil by lowering bulk density, raising water holding capacity, and raising penetration rates [7]. In order to ensure that crops receive all necessary nutrients in the right amounts and that the nutrients are readily available during crop growth, an integrated approach involving the use of organic and inorganic fertilizers is required [8]. Therefore, the goal of the current investigation was to evaluate rice growth under various establishment techniques and nutrient management procedures.

2. MATERIALS AND METHODS

The field experiments were conducted during the *Kharif* season of 2013 and 2014 at the Research Farm of Main Campus, Chatha of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. Jammu is situated at 32^0-40´ N latitude and 74^0-58´ E longitude with an altitude of 332 m above mean sea level. The climate of the experimental site was mainly sub-tropical in nature endowed with hot and dry early summers followed by hot and humid monsoon and cold winter. The mean annual rainfall varies from 1050-1115 mm of which about 75 per cent is received from June to September. Soil of experimental area was sandy clay loam having pH value of 7.76; organic carbon (3.6 g kg^{-1}),available nitrogen (183.12 kg ha^{-1}),available phosphorus (20.18 kg ha^{-1}) and potassium (131.07 $kgha^{-1}$). The experiment was laid out with rice variety Pusa-1121in a split plot design (SPD) with three replications and 18 treatment combinations comprising three establishment methods *i.e* .system of rice intensification (SRI), conventional (transplanted rice) and mechanical method and six nutrient management practices which are N_1=100% RDF inorganic (120:60:40 NPK), N_2=75% RDF inorganic,N_3=125% RDF inorganic, N_4= 50% inorganic + 50 % organic through FYM (on N bases), N_5= 75% inorganic + 25% organic through FYM (on N bases) and N_6= 100% organic manures (FYM). Prior to transplanting, FYM, full dose of phosphorus and potassium, as well as 50% nitrogen was applied as a basal and incorporated into the soil as needed in each treatment. The remaining nitrogen was administered in two equal splits, one at tillering and the other at panicle initiation. Plant protection measures were taken to prevent infestation of insects, weeds and diseases.

3. RESULTS AND DISCUSSION

3.1 Yield Attributes and Yield

Crop establishment techniques differed significantly in their ability to produce all variables. In the years 2013 and 2014 the effective number of tillers are highest in the crop establishment method that is SRI method (263.66 and 263.26) which is at par with mathematical value of establishment method of conventional method (259.56 and 260.62). In nutrient management practices there is in first year the highest effective number of tillers are observed in the treatment N_3= 125% RDF inorganic which was at par with treatment N_1= 100% RDF inorganic. In second year, the trend was change and the significantly highest number of tillers are found in the treatment N_3= 125% RDF inorganic that is (272.43).

The grainstiller^{-1} in establishment method was significantly highest in the SRI method in both the years and in nutrient management method the highest grainstillers^{-1} was found in N_4=50% inorganic+50% Organic which were at par withN_5=75% Inorganic+25% organic on both the years. In test weight there is no significant difference were obtained in establishment method and nutrient management practices. In crop establishment method system of rice intensification (SRI) produced the highest grain yields of 40.15 and 41.45q ha^{-1}in 2013 and 2014, respectively, (Table 1) which were significantly higher than those obtained with conventional method of transplanting (33.91 and 34.70q ha^{-1} in 2013 and 2014, respectively). These findings are consistent with those of Thakur et al. [9] and Rashid et al. [10]. Conversely, in transplanted method root damage due to nursery uprooting and transplanting trauma reduced early growth and vigour in transplanted method [11]. In nutrient management practices N_3=125% RDF inorganic produced highest yield in both the years (38.41 and 38.68 q ha^{-1}) the same trend is also observed in the straw yield on both the years. The results are supported by the findings of Dissanayke et al. [12] and Jeyajothi and Durairaj [13].

3.2 Soil Studies

Soil data presented in Table 2 indicates that non-significant influence of the treatments in crop establishment method and significant in nutrient management practices.In establishment method the highest value of organic carbon was recorded in the treatment of SRI methodand the lowest value in mechanical method however in nutrient management practicesthe highest OC was found in the treatment N_5=75% inorganic+25% organic.Available N, P and K data presented in Table 2 revealed non-significantcrop establishment method and significant in nutrient management practices. Among the crop establishment method numerically higher available N (192.49 kg ha^{-1}), P (21.88kg ha^{-1}) and K (139.93kg ha^{-1}) were recorded in mechanical method over the other treatments. Among the Nutrient management practices, highest available N, P and K were observed underN_6=100% organic manures (FYM) (196.88, 22.47 and 152.78kg ha^{-1}) which was superior over all the nutrient management practices.

3.3 Economics

Variable cost varied due to the variation of labor number for crop establishment and for different fertilizer doses. In crop establishment there is SRI method took the maximum cost of cultivation in both the years and in nutrient management practices treatment N_6=100% organic manures (FYM) found highest cost of cultivation. The study on the economic feasibility of different crop establishment methods in rice revealed that the gross returns, net returns were the highest with SRI during both the years (Table 3).

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

Treatment	Effective Tillers (no./m^2)		Grains/panicle		Test weight(g)		Grain yield(qha^{-1})		Straw yield(qha^{-1})	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Establishment method										
SRI	263.66	263.26	68.54	68.54	23.46	23.66	40.15	41.45	60.27	61.40
Conventional	259.56	260.62	67.18	67.18	23.37	23.51	33.91	34.70	50.86	51.97
Mechanical	255.20	254.58	65.42	65.42	23.31	23.33	32.73	33.37	49.16	50.32
SEm±	1.26	0.70	0.09	0.09	0.01	0.06	0.79	0.70	0.59	0.63
CD(P=0.05)	4.95	2.77	0.36	0.36	0.05	0.22	3.09	2.74	2.32	2.48
Nutrient management										
N_1=100% RDF Inoganic	265.49	262.29	64.76	64.76	23.46	23.64	37.69	38.18	56.55	57.73
N_2=75% RDF Inorganic	256.21	253.93	64.17	64.17	23.39	23.49	34.20	35.03	51.32	52.33
N_3=125% RDF Inorganic	273.37	272.43	71.24	71.24	23.43	23.52	38.41	38.68	57.62	58.68
N_4=50% Inorganic+50% Organic	252.24	255.99	73.24	73.24	23.41	23.57	34.51	36.17	51.71	52.69
N_5=75% Inorganic+25% Organic	258.39	259.89	72.54	72.54	23.42	23.41	36.31	37.04	54.48	55.58
N_6=100% Organic Manures (FYM)	251.13	252.39	56.32	56.32	23.18	23.38	32.47	33.93	48.89	50.35
SEm±	2.72	2.96	0.52	0.52	0.07	0.07	1.06	0.75	1.09	1.31
CD(P=0.05)	7.86	8.55	1.49	1.49	NS	NS	3.07	2.15	3.14	3.79

Table 2. Effect of different crop establishment methods and nutrient management practices on fertility status of soil after harvest of rice

Treatment	OC(g kg^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Establishment methods				
SRI	4.21	185.96	20.89	132.54
Conventional	4.09	188.51	21.50	136.41
Mechanical	3.94	192.49	21.88	139.93
SEm±	0.08	2.81	0.21	1.48
CD(P=0.05)	NS	NS	NS	NS
Nutrient management				
N_1=100% RDF Inoganic	3.90	184.77	21.35	127.95
N_2=75% RDF Inorganic	3.78	177.02	19.41	121.27
N_3=125% RDF Inorganic	4.03	188.82	21.51	134.65
N_4=50% Inorganic+50% Organic	4.28	194.54	22.22	143.99
N_5=75% Inorganic+25% Organic	4.14	191.88	21.58	137.11
N_6=100% Organic Manures (FYM)	4.35	196.88	22.47	152.78
SEm±	0.06	4.43	0.56	2.39
CD(P=0.05)	0.19	12.78	1.62	6.90
Initial status	3.60	183.12	20.18	131.07

Table 3 Relative economics of rice crop with different treatments

Treatment	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Net returns (Rs./ha)		B: C ratio	
	2013	2014	2013	2014	2013	2014	2013	2014
Establishment method								
SRI	31900	32400	109415	112835	77515	80435	2.43	2.48
Conventional	28900	29400	92404	96895	63504	67495	2.2	2.30
Mechanical	24900	25400	89199	88473	64299	63073	2.58	2.48
Nutrient management								
N_1=100% RDF Inoganic	30459	30959	102707	104109	72248	73150	2.37	2.36
N_2=75% RDF Inorganic	29986	30486	93198	95424	63212	64938	2.11	2.13
N_3=125% RDF Inorganic	30932	31432	104668	106752	73736	75320	2.38	2.40
N_4=50% Inorganic+50% Organic	33512	34012	94031	98328	60519	64316	1.81	1.89
N_5=75% Inorganic+25% Organic	35039	35539	98947	100887	63908	65348	1.82	1.84
N_6=100% Organic Manures (FYM)	36566	37066	88508	91127	51942	54061	1.42	1.46

SRI could fetch higher gross return, and higher net return invested than conventional transplanting and mechanical, respectively as per mean yield. This was mainly because of higher yields obtained in SRI as compared to the other two methods during both the years. The results corroborate earlier findings of Singh et al. [14]. In nutrient management practices treatment N_3=125% RDF inorganic found that the highest gross returns and net returns (Table 3). But in cost benefit ratio mechanical method found highest and in second year SRI and mechanical method gives same cost benefit ratio numerically. In other hand nutrient management practices there are revealed that treatment N_3=125% RDF inorganic gives highest benefit cost ratio as compare to other treatments.

4. CONCLUSION

In terms of productivity, soil studies and profitability, the establishment of rice by the system of rice intensification (SRI) technique in combination with 125% RDF inorganic approach was found to be superior to conventional transplanting and mechanical method among crop establishment methods.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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