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Effect of different crop establishment methods on soil physical, chemical and biological properties in rice-rice cropping sequence

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Abstract
To study the effect of different crop establishment methods of rice on soil physical, chemical and biological properties, the field experiments were conducted in *Kharif 2016* and *Rabi* 2016-17 seasons at Tamil Nadu Rice Research Institute, Aduthurai. The study consisted of six treatments *viz.,* T_1– Non-puddled transplanted rice (NPTR) in *kharif* – No Till (NT) in *rabi*, T_2 – NPTR in *kharif* – Puddled transplanted rice (PTR) in *rabi*, T_3 – Dry Seeded Rice (DSR) in *kharif* – NT in *rabi*, T_4 – DSR in *kharif* – PTR in *rabi*, T_5 – PTR in *kharif*– NT in *rabi* and T_6 – PTR in both *kharif* and *rabi*. The results revealed that there is no significant difference between crop establishment methods on soil physical properties like soil bulk density, particle density, porosity and infiltration rate during both *kharif* 2016 and *rabi* 2016-17 season. However there is Significant different observed between crop establishment methods on soil chemical and biological properties. The soil available nutrients were lower in DSR followed by PTR during *kharif* 2016 and DSR-PTR during *rabi* 2016-17. The microbial population of the beneficial organisms namely *Azotobacter*, *Azospirillum* and PSB were observed to be higher in DSR during *kharif*2016andDSR-PTRduring*rabi* 2016-17. Therefore the higher grain yield was obtained under DSR in *kharif*2016 and DSR- PTR in *rabi*2016-17 season.

Keywords: Crop establishment methods, soil physical, chemical, biological properties, yield

Introduction
Rice is a staple food for more than half of the world's population. Worldwide, rice is grown on 161 million hectares, with an annual production of about 678.7 million tons of paddy. Rice provides 30–75% of the total calories to more than 3 billion Asians. However, the sustainability of irrigated rice production, let alone the ability to increase productivity to keep up with population growth, is threatened by increasing water scarcity (Barker and Molle, 2004) [2]. In India, most commonly practiced establishment method under irrigated rice cultivation is transplanting of seedlings into puddled soil (Rao *et al.,* 2007) [4]. In puddled condition the field was flooded for prolonged periods throughout the cropping period until shortly before harvest. The puddling have several disadvantages, including higher tillage costs, adverse effects on soil structure (So and Voase, 2000) [6], and high water requirement for crop establishment. The amount of irrigation water required for puddling varies from 100 mm (Yadav *et al.,* 2011) [7] to 544 mm (Bhuiyan *et al.,* 1995) [3].Water input for crop establishment can be reduced by avoiding puddling. Transplanting can be done in non-puddled soil after saturating the soil and for dry seeded rice sowing was done on non-puddled dry soil, both reduce the water requirement for crop establishment (Balasubramanian and Hill, 2002) [1]. In Tamil Nadu, especially in Cauvery delta zones due to late release of canal water from dams and also sometimes late onset of rainfall there will be scarcity of water availability for cultivation of rice during initial stage for puddling. In such situation these non-puddled and dry seeded rice establishment methods can be done as a contingency measures to reduce the water requirement during initial stage of cultivation.

Methodology
A field experiments were conducted on *Kharif* 2016 and *rabi* 2016-17 at Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, to study the effect of different crop establishment methods on soil physical, chemical, biological properties and yield in rice- rice cropping sequence. The soil of experimental field was clayey loam in texture with a pH of 7.4.

The soil was very low in organic carbon content (0.12%), available nitrogen (230 Kg ha^{-1}), high in available phosphorus (35 Kg ha^{-1}) and medium in available potassium (288 Kg ha^{-1}). The experiments were conducted in randomized block design with four replications. Treatments consisted of T_1– Non- puddled transplanted rice (NPTR) in *kharif* – No Till (NT) in *rabi*, T_2 – NPTR in *kharif* – Puddled transplanted rice (PTR) in *rabi*, T_3 – Dry Seeded Rice (DSR) in *kharif* – NT in *rabi*, T_4 – DSR in *kharif* – PTR in *rabi*, T_5 – PTR in *kharif*– NT in *rabi* and T_6 – PTR in both *kharif* and *rabi*. The varieties taken for experiment were ADT 43(110 days) during *kuruvai* 2016 and ADT 46(130 days) during *thaladi* 2016-17. The plot size of experiment was 10 x 10 m. A fertilizer schedule of 150: 50: 50 NPK kg ha^{-1} was adopted as the common practice for the experiment. Land preparation for DSR was done by ploughing the field. Same as DSR, the land preparation of NPTR was also done by ploughing the field without puddling. Sowing was done on DSR by using happy seeder. Transplanting was done by machine transplanter on both PTR and NPTR.

Result and Discussion

Soil Physical and chemical properties

During *Kharif* 2016 and *rabi*2016-17 there is no significant difference observed between different crop establishment methods. Rucknagel *et al.* (2004) [5] reported that the long term tillage systems had a clear influence on the measured soil physical parameter. The bulk density was lower in DSR (1.52 Mg m^{-3}) and particle density was lower in PTR (2.47 Mg m^{-3}) during *Kharif* 2016. During *rabi*2016-17 the bulk density and particle density was lower in DSR-PTR (1.53Mg m^{-3}) and DSR-NT (2.48Mg m^{-3}).

Table 2: Effect of different crop establishment method onsoil physical properties at post-harvest stage (After first crop) during *Kharif*2016 and *Rabi* 2016-17

Treatments		Physical properties							
		Bulk Density (Mg m^{-3})		Particle Density (Mg m^{-3})		Porosity (%)		Infiltration Rate (cm hr^{-1})	
		K	***R***	***K***	***R***	***K***	***R***	***K***	***R***
T_1	NPTR-NT	1.57	1.56	2.57	2.58	42.16	42.17	3.23	3.24
T_2	NPTR-PTR	1.57	1.56	2.57	2.58	42.16	42.17	3.23	3.24
T_3	DSR-NT	1.52	1.53	2.52	2.53	42.81	42.82	3.11	3.13
T_4	DSR-PTR	1.52	1.53	2.52	2.53	42.81	42.82	3.11	3.13
T_5	PTR-NT	1.54	1.54	2.47	2.48	43.01	43.01	3.21	3.24
T_6	PTR-PTR	1.54	1.54	2.47	2.48	43.01	43.01	3.21	3.24
	SEd	0.03	0.03	0.40	0.04	0.05	0.77	0.16	0.05
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Note: *K-Kharif* 2016, R-Rabi2016-17, NPTR- Non- Puddled Transplanted Rice, DSR - Dry Seeded Rice, PTR- Puddled Transplanted Rice, NT- No Till

The soil available N, P and K was lower in DSR (203, 65 & 216 NPK kg ha^{-1}) followed by PTR (290, 68 & 236 NPK kg ha^{-1}) during *Kharif* 2016.Whereas during *rabi*2016-17 the same was lower in DSR-PTR (205, 64 & 203 NPK kg ha^{-1}) these results shows that utilization of nutrients by crop was higher in those establishment methods.

Table 4: Effect of different crop establishment method onsoil available nutrients N, P and K kg ha^{-1} during *Kharif* 2016 and *Rabi* 2016-17

Treatments		Nkg ha^{-1}		Pkg ha^{-1}		Kkg ha^{-1}	
		***Kharif* 2016**	***Rabi* 2016-17**	***Kharif* 2016**	***Rabi* 2016-17**	***Kharif* 2016**	***Rabi* 2016-17**
T_1	NPTR	297	297	69	79	245	246
T_2	NPTR	295	277	68	73	242	220
T_3	DSR	203	280	65	77	216	232
T_4	DSR	200	205	64	64	213	203
T_5	PTR	290	273	68	75	236	223
T_6	PTR	289	269	67	70	233	215
	SEd	5.5	4.6	1.7	1.3	5.1	4.1
	CD (P=0.05)	11.6	9.7	3.6	2.7	10.8	8.3

Note: *K-Kharif* 2016, R-Rabi2016-17, NPTR- Non- Puddled Transplanted Rice, DSR - Dry Seeded Rice, PTR- Puddled Transplanted Rice, NT- No Till

Effect on beneficial microbial population

During *kharif* 2016 the different crop establishment methods had significant impact on soil microbial properties. The microbial population of the beneficial organisms namely *Azotobacter* (17), *Azospirillum* (0.72) and PSB (80) were observed to be higher in DSR and the lowest population of *Azospirillum* (0.39) was noticed in NPT. The *Azotobacter* (6) and PSB (50) population were recorded to be lowest in PT. Meanwhile *Azotobacter* (9), *Azospirillum* (2.8) and PSB (45) were observed to be higher in DSR-NT during *rabi* 2016-17.

Table 4: Effect of different crop establishment method on microbial population during *Kharif* 2016 and *Rabi* 2016-17

Treatments	Microbial population ((cfu/g of soil)x10^5)					
	Azotobacter		***Azospirillum***		**PSB**	
	K	***R***	***K***	***R***	***K***	***R***
NPTR-NT	12	2	0.52	1.7	72	25
NPTR- PTR	10	0	0.39	1.3	69	23
DSR – NT	17	9	0.72	2.8	80	45
DSR- PTR	15	7	0.54	2.2	70	38
PTR-NT	8	5	0.70	2.5	50	34
PTR-PTR	6	3	0.54	2.1	60	29

Note: *K-Kharif* 2016, R-Rabi2016-17, NPTR- Non- Puddled Transplanted Rice, DSR - Dry Seeded Rice, PTR- Puddled Transplanted Rice, NT- No Till

Yield and yield attributes

The grain yield was higher in DSR (5355 kg ha^{-1}) during *kharif* 2016 and DSR-PTR (7753 kg ha^{-1}) during *rabi*2016-17. Only weeds are the major problem in DSR cultivation. However availability of high-yielding short-duration varieties and new herbicides for weed control largely made suitable chance for high yielding of DSR than puddled transplanted rice. Meanwhile the panicles Nos. $m^{-2}$was also higher in DSR (309) during *kharif* 2016 and DSR followed by PTR (364) during *rabi*2016-17.

Table 2: Effect of different crop establishment methods on productive tillers (Nos. m^{-2}) and grain yield ($Kgha^{-1}$) *Kharif* 2016 and *Rabi* 2016-17

Treatments		Panicles (Nos. m^{-2})		Grain yield ($Kgha^{-1}$)		
		K	R	K	R	Total
T_1	NPTR- NT	218	315	4820	6519	11339
T_2	NPTR- PTR	221	349	4813	7675	12488
T_3	DSR- NT	297	323	5328	6627	11955
T_4	DSR- PTR	309	364	5355	7721	13076
T_5	PTR- NT	244	315	4858	6561	11419
T_6	PTR- PTR	257	353	4862	7753	12615
SEd		6.8	8.9	131.2	189.3	
CD (P=0.05)		14.2	18.6	274.2	395.4	

Note: *K-Kharif* 2016, R-Rabi 2016-17, NPTR- Non- Puddled Transplanted Rice, DSR - Dry Seeded Rice, PTR- Puddled Transplanted Rice, NT- No Till

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