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Soil Quality Assessment in Selected Dry-Direct Seeded Rice (Dry-Dsr) and Puddled Paddy Fields in Agro Climatic Zone 2 of Northern Karnataka

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ABSTRACT

A survey work was conducted during kharif 2014 to assess the impact of dry-direct seeded rice (Dry- DSR) cultivation and puddle transplanted rice cultivation on soil physical, fertility status and crop productivity in selected farmers fields of agroclimatic zone 2 of northern Karnataka region covering the villages of Kasbe camp, Mamdapur, Vijaynagar camp (zone 2). Soil samples and crop yields data were collected from farmers fields having direct seeded rice system and puddle paddy fields. The results revealed that, the soil bulk density was low in Dry-DSR system, available water was more in Dry-DSR system and also soil porosity and maximum water holding capacity was more in Dry-DSR system. The soil fertility status was also showed an improved status in Dry-DSR system. The yields were comparatively on par with both the system but when compared with the cultivation systems TPR system was higher yield.

Key words: *Direct seeded rice, transplanted puddle soil.*

INTRODUCTION

Rice is the world's most important crop and is staple food for more than half of the world's population. Worldwide, rice is grown over an area of 159 m ha with a production of 463.9 mt and productivity being 2.91t ha^{-1}. In India rice is grown over an area of 39.16 m ha with a production of 85.59 mt and productivity of 2.23 t ha^{-1} [1].

Direct seeding of rice refers to the process of establishing the crop from seeds sown in the field rather than by transplanting seedlings from the nursery[6]. Direct seeding avoids three basic operations, namely, puddling, transplanting and maintaining standing water.

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Repeated puddling adversely affects soil physical properties by dismantling soil aggregates, reducing permeability in subsurface layers, and forming hard-pans at shallow depths, all of which can negatively affect the following non-rice upland crop in rotation[12]. Excessive pumping of water for puddling in peak summers in north west Indo-gangetic plains (IGP) causes problems of declining water table and poor quality water for irrigation on one hand, whereas, in eastern IGP, rice transplanting depends mainly on monsoon rains. Furthermore, need of ponded water for customary practice of puddling delays rice transplanting by one to three weeks. Huge water inputs, labour costs and labour requirements for TPR have reduced profit margins[9].

MATERIALS AND METHODS

Site description

The study area comprised of Kasbe camp, Mamdapur, Vijaynagar camp in zone 2. The sampling locations were marked by using GPS.

Soil sampling and analysis

The survey work was conducted during *kharif* 2014 season before sowing. The surface (0-15 cm) and subsurface (15-30 cm) soil samples were collected from selected farmers fields under Dry-DSR and TPR system.

Before analysis the soils were air dried and powdered with wooden hammer and pass through a 2 mm sieve. For organic carbon, the soil samples were finely powdered to pass through a 0.25 mm sieve.

Processed soil samples were analyzed in the laboratory. The bulk density was determined by core sampler method, soil aggregate was determined by Yoder's apparatus[15], soil porosity and maximum water holding capacity was determined by keens cup method, soil available water was determined by pressure plate apparatus. The soil pH was measured by a glass electrode using a soil to water ratio of 1:2; electrical conductivity (EC) was determined by an EC meter using a soil to water ratio of 1:2. Organic C was determined using the Walkley-Black method[7] (Jackson, 1973). Available nitrogen in the soil samples was determined by alkaline potassium permanganate method as outlined by Subbaiah and Asija[14]. Available phosphorous was extracted with 0.5 M sodium bicarbonate at pH 8.5 (Olsen's reagent) method as outlined by Jackson[7]. Available potassium in soil was extracted by neutral normal ammonium acetate[7]. Available S was measured using 0.15% calcium chloride ($CaCl_2$) solution as an extractant[2].

RESULTS AND DISCUSSION

A summary of the physical analysis of soil sample collected from the selected farmer's fields during *kharif* 2014 showed that the fields had a low bulk density in Dry-DSR system than TPR system than TPR system and it increase in depth. This might be due to puddling resulted in destruction of soil aggregates and dispersion of soil particles to form a compact layer with reduced porosity[8,13]. Soil total porosity was high in TPR system than Dry-DSR system and it decrease with depth. This might be due to puddling results in aggregate breakdown and destruction of macropores and formation of sub-surface dense layer, which together helps in transplanting and reducing percolation loss of water[13]. The maximum water holding capacity was more in TPR system than Dry-DSR system and it increase with depth. This might be due to compaction, settling, and flocculation of dispersed clay particles[13]. The dispersion of soil aggregates during puddling destroys macro pore volume within soil aggregates. The available water content was more in Dry-DSR system than that of TPR system and it increase with depth. This might be due to decrease in bulk density there was increase in available water content which was due to increased porosity with decrease in bulk density[3] and also this could be due to attributed to the more organic matter content in Dry-DSR system (Table 1).

A summary of the chemical analysis of soil samples showed that the fields had a wide range in pH both in Dry-DSR and TPR system. The difference in soil reaction between Dry-DSR and TPR system at soil surface might be due to accumulation of nutrients and organic matter near the soil surface because of avoiding puddling in Dry-DSR system and in the long run soil reaction[10]. The electrical conductivity was more in Dry-DSR system than TPR system and it increase with depth. The organic carbon (OC) content in soils of TPR system was comparatively higher than Dry-DSR system and it decrease with depth. The low organic matter content in Dry-DSR system in general might be due to low organic carbon content apparently because of high temperature induced rapid rate of organic matter oxidation. The rate of oxidation of organic matter was less in Dry-DSR than in TPR system. However, the relatively high OC under TPR (Table 2) might be due to high biomass production through more roots and shoot biomass and addition to soil[5]. The soils in study area were low in available nitrogen and it decrease with depth. Results revealed that the nitrogen contents under TPR system were comparatively higher than the Dry-DSR system. It might be due to the lower organic carbon content under Dry-DSR system and imbalanced application of fertilizers[11]. The available phosphorus content of the soils under Dry-DSR system was higher than the TPR system and it decrease with depth. This might be due to minimum soil disturbance in Dry-DSR system and apparently higher microbiological activity[4]. Higher content of available potassium was recorded in TPR system compare to the Dry-DSR system and it increase with depth. Available potassium was medium in both Dry-DSR and TPR system. This might be due to puddling effect in TPR system and organic matter present in Dry-DSR system[4]. The available sulphur content in Dry-DSR soil samples was low as compared with TPR soil samples. This might be due to minimum soil disturbance in Dry-DSR system (Table 3). Numerous studied have indicated that higher available sulphur was recorded in soils under Dry-DSR system[4,5].

Table 1: Soil physical properties of selected farmers' fields under Dry-DSR and TPR system

Sample No.	Bulk density (Mg m^{-3})				Total porosity (% on v/v basis)				Maximum Water Holding Capacity (% on weight basis)				Available water content (% on weight basis)			
	Dry-DSR		TPR		Dry-DSR		TPR		Dry-DSR		TPR		Dry-DSR		TPR	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	1.25	1.32	1.28	1.34	49.32	43.21	58.17	53.27	42.64	43.56	40.12	42.54	12.2	12.3	9.1	9.4
2	1.24	1.29	1.28	1.36	48.44	42.65	59.19	51.38	40.65	41.23	48.65	51.27	13.6	14.4	10.6	10.7
3	1.27	1.33	1.27	1.33	50.22	45.55	61.23	55.48	44.53	45.71	44.26	48.82	13	14.5	9.3	10.1
4	1.29	1.34	1.29	1.33	47.21	42.19	54.68	39.49	40.12	47.31	38.41	42.97	9.0	9.4	8.4	8.8
5	1.29	1.36	1.35	1.39	48.19	42.38	49.66	46.38	41.62	49.21	48.63	53.18	8.0	8.3	7.9	8.5
6	1.28	1.35	1.38	1.41	43.56	39.55	54.87	50.19	45.37	46.32	51.5	55.27	8.9	9.3	9.4	9.6
7	1.24	1.29	1.3	1.39	48.33	43.47	60.12	54.38	42.28	43.2	46.48	50.9	9.9	10	9.2	9.4.0
8	1.25	1.3	1.29	1.36	45.7	40.33	57.54	54.39	43.61	45.21	47.98	53.43	10.8	11.1	10.4	10.9
9	1.27	1.36	1.32	1.4	43.98	39.95	56.35	50.82	42.53	44.53	40.48	43.49	11.9	12.2	9.7	10.0
10	1.21	1.29	1.38	1.41	46.88	40.32	53.98	47.27	33.91	47.32	48.65	52.18	10.8	11	9.6	9.8
11	1.22	1.3	1.31	1.39	49.21	41.66	53.88	46.87	46.72	42.62	43.79	51.87	12.8	12.9	10.0	10.5
12	1.23	1.32	1.33	1.39	46.73	40.54	50.98	45.57	36.61	39.21	50.13	54.57	13.4	13.6	12.7	12.8
Overall range	**1.21-1.29**	**1.29-1.36**	**1.27-1.38**	**1.33-1.41**	**43.56-50.22**	**39.55-45.55**	**49.66-61.23**	**39.49-55.48**	**33.91-46.72**	**39.21-49.21**	**38.34-51.5**	**42.54-55.27**	**8.0-13.6**	**8.3-14.5**	**7.9-12.7**	**8.5-12.8**
Average	**1.25**	**1.32**	**1.32**	**1.38**	**47.31**	**41.82**	**55.89**	**49.62**	**41.72**	**44.62**	**45.76**	**50.04**	**11.19**	**11.58**	**9.69**	**10.1**
SD±	**0.03**	**0.03**	**0.04**	**0.03**	**2.08**	**1.77**	**3.55**	**4.68**	**3.6**	**2.83**	**4.29**	**4.57**	**1.91**	**2.07**	**1.21**	**1.16**

Table 2: Soil chemical properties of selected farmers' fields under Dry-DSR and TPR system

Sample No.	pH (1:2.5)				EC (dS m^{-1})				Organic carbon (%)			
	Dry-DSR		TPR		Dry-DSR		TPR		Dry-DSR		TPR	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	8.2	8.3	8.3	8.4	0.32	0.39	0.29	0.33	0.47	0.38	0.61	0.48
2	8	8.2	8.3	8.5	0.11	0.19	0.23	0.25	0.42	0.42	0.57	0.48
3	8.3	8.4	8.4	8.5	0.1	0.21	0.3	0.41	0.48	0.48	0.53	0.42
4	8.2	8.3	8.3	8.5	0.15	0.21	0.26	0.29	0.43	0.22	0.75	0.42
5	8.1	8.2	8.1	8.3	0.13	0.2	0.2	0.29	0.65	0.42	0.63	0.48
6	7.9	8.1	8.2	8.4	0.15	0.22	0.23	0.31	0.63	0.5	0.49	0.42
7	8	8.1	8.3	8.5	0.31	0.37	0.26	0.45	0.65	0.48	0.55	0.38
8	8.2	8.4	8.3	8.6	0.22	0.28	0.24	0.36	0.49	0.38	0.65	0.48
9	8.3	8.4	8.2	8.6	0.33	0.39	0.24	0.26	0.51	0.42	0.63	0.42
10	7.9	8.1	8.2	8.3	0.21	0.32	0.23	0.28	0.65	0.52	0.49	0.5
11	8	8.2	8.2	8.4	0.21	0.31	0.2	0.22	0.41	0.3	0.55	0.48
12	7.9	8.2	8.3	8.4	0.31	0.42	0.25	0.31	0.49	0.28	0.55	0.44
Overall range	**7.9-8.3**	**8.1-8.4**	**8.1-8.3**	**8.3-8.6**	**0.1-0.33**	**0.19-0.42**	**0.2-0.3**	**0.22-0.45**	**0.41-0.65**	**0.22-0.52**	**0.49-0.75**	**0.38-0.50**
Average	**8.08**	**8.24**	**8.26**	**8.45**	**0.21**	**0.29**	**0.24**	**0.31**	**0.52**	**0.4**	**0.58**	**0.45**
SD±	**0.15**	**0.12**	**0.08**	**0.1**	**0.09**	**0.09**	**0.03**	**0.07**	**0.09**	**0.09**	**0.07**	**0.04**

Table 3: Soil fertility status of selected farmers fields under Dry-DSR and TPR system

Sample No.	N (kg ha^{-1})				P_2O_5 (kg ha^{-1})				K_2O (kg ha^{-1})				S (mg kg^{-1})			
	Dry-DSR		TPR		Dry-DSR		TPR		Dry-DSR		TPR		Dry-DSR		TPR	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	224	196	230	210	25.2	22.5	23.5	19.5	348	372	309	340	19.2	17.4	10.9	9
2	213	184	224	210	22.7	19.5	25	19	260	328	295	328	21.4	19.3	12.3	10.4
3	198	179	252	237	23.4	19.5	19.5	17.5	343	373	301	345	15.7	12.8	11	9.1
4	224	214	258	241	24.7	20	23.5	20	286	337	285	303	22.5	18.3	14.1	11.8
5	253	238	276	254	23.5	21	24.2	21	261	295	315	343	16.5	13.6	11.4	10.1
6	224	203	259	227	26.7	24.2	21.7	17.8	282	300	297	339	12.4	10.7	9.9	8.1
7	196	183	281	263	23.5	21	22.7	19	236	251	279	310	17.3	15.9	14.3	11.3
8	220	198	284	269	22	19.5	25	21.7	336	368	303	327	21.2	19.3	13.2	11
9	217	193	224	192	22.7	20.2	25.5	22	318	352	325	358	15.3	12.4	11.3	9.5
10	224	207	253	227	24.2	21.7	18.5	16.5	219	300	314	337	19.4	17.3	13.8	11.2
11	253	236	225	193	26.4	24	22	18.5	319	336	305	322	16.9	13.8	10.8	9.4
12	225	205	210	187	22.7	20.2	22.2	19.5	327	349	270	303	24.4	22.5	11.5	10.3
Overall range	**196-253**	**179-238**	**210-284**	**187-269**	**22-26.7**	**19.49-24.2**	**18.5-25.5**	**16.5-22**	**219-348**	**251-373**	**270-325**	**303-358**	**12.4-24.40**	**10.7-22.50**	**9.9-14.30**	**8.1-11.80**
Average	**222**	**203**	**248**	**225**	**23.98**	**21.11**	**22.78**	**19.33**	**294**	**330**	**299**	**329**	**18.5**	**16**	**12**	**10**
SD±	**17.33**	**18.99**	**25.01**	**28.01**	**1.51**	**1.68**	**2.16**	**1.67**	**43.49**	**37.24**	**15.84**	**17.43**	**3.45**	**3.5**	**1.47**	**1.11**

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