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Effect of crop establishment methods and weed management options on physical and chemical properties of soil in rice

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Abstract
A field experiment was conducted at College Farm, College of Agriculture, Professor Jayashankar Telangana state agricultural university, Rajendranagar, Hyderabad during *kharif* season of 2016. The experiment was laid out in split-plot design with 15 treatments replicated thrice to study the effect of establishment method and weed management practices on soil properties of rice. There was no significant effect of different rice establishment methods and weed management practices on physical and chemical properties like N, P_2O_5, K_2O, pH, electrical conductivity, CEC, organic carbon, Bulk density and hydraulic conductivity.

Keywords: EC, OC, Bulk density and hydraulic conductivity, CEC, Establishment methods

1. Introduction
Rice is the most important cereal crop and is the staple diet for 70% of the world population. India occupies prominent position among the rice growing countries with a largest acreage of 44 million ha annually and is the second largest producer with a production of 103 Mt and with an average productivity of 2.3 t ha^{-1} (Department of Agriculture and Cooperation, 2015-16) [3]. India is important rice growing country with broad-spectrum agro-ecosystems where transplanting method persists as the major practice of rice planting under puddle condition. Often, farmers fail to transplant the seedlings in time either due to prolonged dry spell or intense rainfall resulting lower yields. Paucity of labours and increasing cost of transplanting encouraged many rice growers to switch over from transplanting to other planting methods of rice. Under these circumstances, the direct seedling of sprouted seeds and aerobic rice appears to be the alternate practices. In aerobic rice, weed control is the most crucial factor because the soil conditions are favorable for simultaneous of weeds seeds along with rice seeds and also caused complete reduction in yield (Singh and Singh, 2013) [13]. Thus, to avoid yield loss and to keep weed under threshold's level, planting methods become of paramount importance. Weed management is an important key factor in obtaining higher crop yield (Moorthy and Rao, 1991) [8]. Hence, timely weed control is necessary to get optimum grain yield. Though manual weeding is considered to be the best, the undependable labour availability and escalating wages in many cases has given impetus to the development and use of chemicals which can control broad spectrum of weeds (Pandey *et al.*, 2000) [10]. In light of these facts, the present study was undertaken with the aim of evaluating the effect of alternativerice establishment methods on soil physical and chemical properties.

2. Materials and methods
The experiment was carried in kharif 2016 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The farm is geographically situated at $17^0$19' 16.4" North latitude and 78^0 24' 43" East longitudes and at an altitude of 542.3 m above mean sea level. The soil of the experimental field was sandy clay loam in texture with pH 7.85, low in available nitrogen (213.2 kg ha^{-1}), high phosphorus (36.8 kg ha^{-1}) and potassium (379.0 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The treatments consisted of three establishment methods of rice *viz.*, transplanted rice, direct seeded rice and aerobic rice, five levels of weed management practices *viz.*, Farmers method (Hand weeding 20 and 40 DAT/DAS), bispyribac sodium 10% SC 25 g ha^{-1} as PE fb fenoxaprop-p-ethyl 9.3% EC 62 g ha^{-1} + 2, 4-D 80% WP 0.5 kg ha^{-1}, pendimethalin + penoxsulam 25% SE 25 g + 600 g ha^{-1} PE at 4-7 DAS/DAT, pretilachlor 50% EC 0.75 kg ha^{-1} as PE fb hand weeding at 20 and 40 DAT/ DAS and unweeded control. In aerobic rice, seeds were sown at 20 cm apart. While, in direct seeded rice (under puddled condition) sprouted seeds were sown in line manually at 20 cm.

The recommended nursery area (20 sq. m ha^{-1}) was puddled, leveled and the sprouted seeds (40 kg ha^{-1}) were broadcasted uniformly with a thin film of standing water. A uniform dose of 150, 60 and 60 kg N, P_2O_5 and K_2O ha^{-1}as urea, SSP and muriate of potash. Nitrogen was applied in three equal splits at transplanting, maximum tillering stage and panicle initiation stage. The recommended dose of phosphorous was applied as basal dose at the time of transplanting and potassium was applied in two splits at transplanting and panicle initiation stage.

Soil physical and chemical properties

The representative soil samples obtained from 0-15 and 15-30 cm soil depth of experimental field was analyzed for their physical and chemical properties like N, P_2O_5, K_2O, pH, electrical conductivity, organic carbon, Bulk density and hydraulic conductivity by adopting standard procedures depicted in the table 1.

Table 1: Different methods employed for soil analysis in experimental field.

S.No	Particulars	Method	Reference
Soil analysis			
Physical and chemical properties of soil			
1	Soil reaction [pH] (1:2.5)	pH meter	Jackson, 1973 [6]
2	Electrical conductivity [dS m^{-1}] (1:2.5)	EC meter	Jackson, 1973 [6]
3	Organic carbon [%]	Chromic acid wet digestion method	Walkley and Black's (1934) [15]
4.	Cation Exchange capacity (cmol (P^+) kg^{-1} of dry soil)	Ammonium saturation method	(Piper, 1966) [11]
5	Available nitrogen [kg N ha^{-1}]	Alkaline permanganate method using KELPLUS SUPRA LX – analyser	Subbaiah and Asija, (1956) [14]
6	Available phosphorus [kg P_2O_5 ha^{-1}]	Olsen's method for extraction and Ascorbic acid method for estimation by using Spectrophotometer at 420nm	Olsen's *et al.* (1954) [9]
7	Available potassium [kg K_2O ha^{-1}]	Neutral normal ammonium acetate method using ELICO CL361 Flame photometer	Jackson (1979) [7]
8.	Bulk density	Core sampler method	Buckman [2] (1960)
9	Hydraulic conductivity	Constant head method	Head (1982) [5]

3. Results and Discussion

Among the establishment methods direct seeded rice recorded slightly higher soil available nitrogen, phosphorus and potassium (219, 34.84 and 389 kg ha^{-1}) followed by transplanted (216, 33.31 and 386 kg ha^{-1}) and aerobic rice (215, 31.56 and 374 kg ha^{-1}). However, the variation in available nitrogen, phosphorus and potassium was non-significant. Similar finding was reported by the Bhattacharyya *et al*., (2008) [1] and Gangwar *et al*., (2010) [4]. Among the weed management practices highest soil available nitrogen, phosphorus and potassium was recorded with Pretilachlor 50 % EC 0.75 kg ha^{-1} as PE fb Hand weeding at 20 and 40 DAT/ DAS followed by Farmers method (Hand weeding 20 and 40 DAT/DAS). However no significant difference in available nitrogen, phosphorus and potassium was noticed among the weed management practices.

The soil pH determined for different treatments of rice crop are presented in table 2. The different rice establishment methods *viz* transplanted rice, direct seeded rice and aerobic rice treatments did not affected the soil pH significantly. The pH value was recorded higher in the aerobic rice followed by direct seeded rice and transplanted rice. The rice establishment methods had no significant response on pH. The rice establishment methods have no significance on electrical conductivity. The value of electrical conductivity (dSm^{-1}) was slightly higher under transplanted rice. This may be due to low leaching losses of soil due to soil dispersion. Similar findings were obtained by Sharma and De Datta (1985) [12].

Table 2: Effect of establishment methods and weed management practices on post-harvest soil available N, $P_2O_5$and K_2O (Kg ha^{-1}), pH and EC (dSm^{-1}) in rice

Treatments	N	P_2O_5	K_2O	pH	EC (dSm^{-1})
Establishment methods (Main plots)					
M_1-Transplanted rice	216	33.31	386	7.75	0.83
M_2-Direct seeded rice (in puddled condition)	219	34.84	389	7.81	0.79
M_3-Aerobic rice	215	31.56	374	7.99	0.79
SE(m)±	5.44	1.09	6.51	0.050	0.012
CD (P = 0.05)	NS	NS	NS	NS	NS
Weed management practices (Sub plots)					
S_1- Farmers method (Hand weeding 20 and 40 DAT/DAS)	224	34.95	387	7.84	0.80
S_2-Bispyribac sodium 10% SC 25 g /ha as PE fb fenoxaprop-p-ethyl 9.3% EC 62 g ha^{-1}+ 2, 4-D 80% WP 0.5 kg ha^{-1}	213	32.92	379	7.87	0.78
S_3- Pendimethalin + Penoxsulam25% SE 25 g + 600 g ha^{-1} PE at 4-7 DAS/DAT	219	31.30	385	7.80	0.82
S_4- Pretilachlor 50 % EC 0.75 kg ha^{-1} as PE fb Hand weeding at 20 and 40 DAT/ DAS.	226	37.47	394	7.84	0.79
S_5- Unweeded control	201	29.53	370	7.89	0.82
SE(m)±	7.00	1.40	6.81	0.050	0.011
CD (P = 0.05)	NS	NS	NS	NS	NS
Interaction					
M*S	NS	NS	NS	NS	NS

Data presented in table 3 revealed that all the three rice establishment methods and weed management practices did not affect the status of organic carbon in the soil at harvest of rice however; the values were slightly higher in transplanted rice and among weed management practices unweeded plot recorded slightly higher organic carbon compared to other treatments. The CEC after harvest of crop was found to be non-significant among the establishment methods and weed management practices. Slightly higher CEC was noticed with aerobic rice followed by direct seeded rice and transplanted rice. Among the weed management practices Pretilachlor 50 % EC 0.75 kg ha^{-1} as PE fb Hand weeding at 20 and 40 DAT/ DAS recorded slightly higher CEC compared to other treatments.

Higher value of bulk density was recorded under puddled conditions (transplanted and direct seeded rice under puddled condition) because puddling resulted in destruction of soil aggregates and dispersion of soil particles to form a compact layer with reduced porosity. Gangwar *et al.*, (2008) [4]. Weed management options did not affect the bulk density. After harvest of rice crop hydraulic conductivity of soil did not differ significantly with respect to establishment methods and weed management practices. However, slightly higher value of hydraulic conductivity was noticed with aerobic rice and farmer's method among weed management practices *i.e.*, puddling decreases hydraulic conductivity due to destruction of soil aggregates and reduction of non-capillary pores responsible for rapid transmission of water in soil (Bhattacharyya *et al*., 2008) [1].

Table 3: Effect of establishment methods and weed management practices on post-harvest Soil OC, CEC, Bulk density and Hydraulic Conductivity in rice.

Treatments	OC (%)	CEC (meq $100g^{-1}$)	Bulk density (g cm^{-3})	HC (cm hr^{-1})
Establishment methods (Main plots)				
M_1-Transplanted rice	0.37	22.29	1.47	1.11
M_2-Direct seeded rice (in puddled condition)	0.33	22.71	1.47	1.13
M_3-Aerobic rice	0.34	23.24	1.38	1.18
SE(m)±	0.024	0.262	0.03	0.02
CD (P = 0.05)	NS	NS	NS	NS
Weed management practices (Sub plots)				
S_1- Farmers method (Hand weeding 20 and 40 DAT/DAS)	0.31	22.06	1.40	1.19
S_2-Bispyribac sodium 10% SC 25 g /ha as PE fb fenoxaprop-p-ethyl 9.3% EC 62 g ha^{-1}+ 2, 4-D 80% WP 0.5 kg ha^{-1}	0.35	23.07	1.43	1.17
S_3- Pendimethalin + Penoxsulam 25% SE 25 g + 600 g ha^{-1} PE at 4-7 DAS/DAT	0.34	22.58	1.45	1.14
S_4- Pretilachlor 50 % EC 0.75 kg ha^{-1} as PE fb Hand weeding at 20 and 40 DAT/ DAS.	0.34	22.90	1.44	1.15
S_5- Unweeded control	0.39	23.13	1.48	1.06
SE(m)±	0.019	0.300	0.04	0.03
CD (P = 0.05)	NS	NS	NS	NS
Interaction				
M*S	NS	NS	NS	NS

4. Conclusion

The results in present study has revealed that Soil properties (N, P_2O_5, K_2O, pH, electrical conductivity, OC, bulk density and saturated hydraulic conductivity) measured after harvest of crop during the cropping season did not significantly affected by weed management options but underdifferent establishment methods higher value of bulk density and hydraulic conductivity was recorded under puddled conditions when compared to unpuddled condition because puddling resulted in destruction of soil aggregates and dispersion of soil particles to form a compact layer with reduced porosity. The soil physical and chemical properties does not show any interaction effects between crop establishment methods and weed management practices.

5. References

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