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EFFECT OF ORGANICS AND RICE-CROP ESTABLISHMENT METHODS ON SOIL PHYSICAL PROPERTIES OF WINTER MAIZE *(ZEA MAYS L.)* IN CALCIORTHENTS

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ABSTRACT

A field experiment was conducted in South Kisan Vidhyapeeth Block of Crop Research Centre of Rajendra Agricultural University, Bihar, Pusa (Samastipur) during the *rabi* season of 2011-12. The experimental plot was medium land, properly levelled, and well drained with uniform topography. The experiment was conducted in a Split Plot Design with 30 treatments, which were replicated three times. To study the effect of organics and rice-crop establishment methods on soil physical properties of winter maize (*Zea mays* L.) in calciorthents.The main plot treatments consisting of six methods of rice-crop establishment A_1 (ZT), A_2 (DS), A_3 (PDS), A_4 (PT), A_5 (SRI) and A_6 (PT + BM) and the sub plot treatments consisting of five different form of the organic matter enrichment i.e. B_1 (M), B_2 (Vc), B_3(1/3CR), B_4 (M+Vc), and B_5 (control).

Keywords: Winter maize, Physical property, , System of rice-intensification, and Crop residue

INTRODUCTION

Winter maize is an important crop of Bihar covering an area of 0.6 million hectares with an average productivity of 2.67 tons per hectare, respectively during the year 2006-07 (Directorate of statistics and Evaluation, Bihar, 2009). The conventional method of establishment of paddy crop is by puddling and transplanting. Puddled transplanted rice is in practice for two reasons: firstly to increase water retention by complete destruction of soil aggregates and to control weeds. Puddling is a time, labour and water intensive practice, which may benefit rice crop but has detrimental effects on succeeding *rabi* crop in terms of productivity. Therefore, puddling needs to be eliminated by substitution of proper technologies. Direct seeded rice may be the right answer to these problems. However, it would require eco-friendly weedicides (which do not persist for long in soil) to control weeds without impairing the soil. Rabi or winter-maize crops usually suffer from nutritional deficiencies such as phosphorus and zinc due to low soil temperature and resulting in lower productivity. Such problems need to be urgently taken care of. Improvement of soil aggregation and mulching may be of great significance under such situations. In view of the above facts, the present investigation was carried out to evaluate the effect of organics and rice-crop establishment methods on soil physical properties of winter maize (*Zea mays* L.) in calciorthents.

Material and methods

Field experiment was conducted in South KisanVidhyaPeeth Block of Crop Research Centre of Rajendra Agricultural University, Bihar, Pusa (Samastipur) during the *Rabi* season of 2011-12.The soil samples were collected from 0-15 cm depth before and after the experimentation and samples were subjected for analysis with respect to their physical properties. The Experimental soil was sandy loam in texture with 11.50 per cent clay, 28.82 per cent silt and 58.71 per cent sand and having slightly alkaline pH(8.3). Bulk density and Hydraulic conductivity of the soil were 1.46 (Mgm^{-3}) and 4.35 (cm hr^{-1}).The soil fertility status was low in Organic carbon content (0.43 %), low in available N (236.0 Kg ha^{-1}), Medium available P_2O_5 (19.7 kg ha^{1}), andlow in available K_2O (106.92 kg $ha^{1)}$.The experiment was laid out in a Split Plot Design with thirty treatments replicated thrice in plots of 5m x 5 m size. VarietyDeoki was used as a test variety in present study.Treatments details.A: main plot (Methods of rice-crop establishment) includesZero tillage A_1 (ZT), Dry seeded A_2(DS), Puddled dry seeded using drum seeder A_3(PDS), Puddled transplanted A_4 (PT), System of rice-intensification (S.R.I.) and Puddled transplanted + brown manuringA_6 (PT + BM) Note: Brown manuring (30 days *Dhaincha* plants in between the rice crop lines were treated with 2,4 D @ 1 kg ha^{-1}) .B: Sub plot(Organic matter enrichment) includes Mulch @ 10 t ha^{-1} B_1(M), Vermicompost @ 3 t ha^{-1} B_2 (Vc), 1/ 3rd Rice crop residue B_3 (1/ 3 CR), Mulch @ 5t ha^{-1} + Vermicompost @ 1.5 t ha^{-1} B_4 (M + Vc) andWithout organic matter B_5(Control). Recommended dose of N, P, and K was applied at 120kg 75 kg and 50 kg ha^{-1}.

Result and Discussion

Soil moisture content (cm depth)

Data on moisture content (cm depth) of 0-75 cm soil depth after harvest of winter-maize as influenced by rice-crop establishment methods and organics has been presented in Table 1. The data showed that significant variation among different treatments. It varied from 27.98 to 29.54 cm. The highest moisture content (29.54 cm) was registered in A_1 (ZT), while the lowest moisture content was observed in A_4 (PT). Among sub plot treatments maximum moisture content (cm depth) 29.48 cm was obtained with B_2 (Vc), which was at par with B_1 (M) and B_4 (M + Vc) and significantly superior to B_3 & B_5 (control) with values of 28.22 and 27.96 cm, respectively.

Puddling breaks down macro aggregates into micro aggregates, which results in higher percentage of fine pores (microporosity) thus water retention is improved. For this reason main plot treatments involving puddling (A_3, A_4, A_5 & A_6) might have higher content of soil moisture as compared to direct seeded treatments (ZT & DS). Application of organic matter resulted in larger mean weight diameter, higher porosity, lower bulk density, and higher hydraulic conductivity of saturated soil (Bhagat*et. al.*, 1991). Soils under mulch had higher moisture content because mulching plays an important role to control evaporation loss of water and it acts as an insulating material (Samarappuli *et al.*, 1999; Dahiya *et al.*, 2003).

Table1: Moisture content (cm depth) of 0-75 cm soil depth after harvest of winter-maize as influenced by organics and rice-crop establishment methods

Rice crop establishment methods	Organic matter enrichment					Mean
	B_1 (M)	B_2 (Vc)	B_3 (1/3 CR)	B_4 (M + Vc)	B_5 (Control)	
A_1 (ZT)	28.78	29.53	29.86	31.03	28.52	29.54
A_2 (DS)	29.29	29.27	28.91	29.86	29.33	29.33
A_3 (PDS)	29.27	29.86	27.41	29.27	27.77	28.72
A_4 (PT)	29.05	29.29	26.36	28.10	27.12	27.98
A_5 (SRI)	29.27	29.63	28.10	28.69	27.52	28.64
A_6 (PT + BM)	29.86	29.29	28.69	29.27	27.52	28.93
Mean	29.25	29.48	28.22	29.37	27.96	
	SEm±			CD (0.05)		
A	0.05			0.15		
B	0.06			0.16		
A x B	0.14			NS		

Bulk density

The lowest value of 1.43 Mg/ m^3 was obtained in zero tillage (ZT) and at par with dry seeded (DS) and puddled transplanted + brown manuring (PT + BM) treatments, while the highest value of 1.51 Mg/ m^3 was recorded in puddled dry seeded (PDS) treatment. Application of organic matter significantly reduced the soil bulk density over control i.e. treatment receiving no organic matter (control) and the highest reduction of 4.61% over control was due to mulching (M), vermicompost (Vc) and combination of mulching and vermicompost (M + Vc) treatments. Similarly, significant variation in bulk density was recorded due to different treatments after harvest of maize crop and data followed the same trend i.e. ZT treatment recorded the lowest value of 1.42 Mg/ m^3 and the highest value of 1.50 Mg/ m^3in PT treatment, among main plot treatments while among sub plot treatments, M + Vc recorded the lowest value of 1. 43 Mg/ m^3 which was statistically at par with M and Vc treatments. The reduction in bulk density due to application of M + Vc, Vc, and M was by 5.92, 5.26 and 5.26%, respectively.

Reduction in bulk density in ZT and DS treatments as compared to PT might be due to the reason that these treatments maintained higher organic carbon content as the soils were not disturbed which resulted in better aggregation and porosity. Similarly, addition of organic matter in sub plot treatments improved organic carbon content as compared to control and helped in better aggregation and porosity. The results are in conformity of those reported by Ogban *et al.* (2001); Kumar and Pandey (2002) and Sharma and Tomar (2002).Interaction effects were found non-significant.

Table 2: Bulk density (Mg/ m^3) of soil after harvest of rice as influenced by organics and rice-crop establishment methods

Rice crop establishment methods	Organic matter enrichment					Mean
	B_1 (M)	B_2 (Vc)	B_3 (1/3 CR)	B_4 (M + Vc)	B_5 (Control)	
A_1 (ZT)	1.38	1.38	1.47	1.41	1.51	1.43
A_2 (DS)	1.40	1.45	1.46	1.43	1.55	1.46
A_3 (PDS)	1.49	1.46	1.57	1.56	1.48	1.51
A_4 (PT)	1.50	1.49	1.55	1.39	1.55	1.50
A_5 (SRI)	1.49	1.46	1.52	1.47	1.48	1.48
A_6 (PT + BM)	1.45	1.47	1.47	1.42	1.55	1.47
Mean	1.45	1.45	1.51	1.45	1.52	
	SEm±			CD (0.05)		
A	0.01			0.04		
B	0.02			0.05		
A x B	0.05			NS		

Porosity (%)

The treatment effect on percent pore space after harvest of maize crops have been portrayed in Table 4. The data clearly explained that value of percent pore space of soil varied significantly both due to rice-crop establishment methods and organic matter enrichment. The significant variation in percent pore space was recorded due to different treatments after harvest of maize crop and data followed the same trend. Among main plot treatments, ZT treatment recorded the highest value of 46.64% and the lowest value of 43.55% in PT treatment. While among sub plot treatments, M + Vc treatment recorded the highest value of 45.97% which was statistically at par with M and Vc treatments. The increment in percent pore space due to application of mulch and vermicompost separately was by 7.81% and due to mulch + vermicompost application was by 8.25% over control. Incorporation of compost, vermicompost and crop residue to the soil resulted in improvement of soil structure and puddling deteriorated the soil physical environment for subsequent crops compared to under direct seeded plots followed by zero till plots. These results are comparable with the findings of Sharma and Tomar, (2002). Similar results were reported by number of workers (Ogban *et al.*,(2001); Kumar and Pandey (2002); Sharma and Tomar, 2002) in various soils and climatic conditions.

Table 3: Bulk density (Mg/ m^3) of soil after harvest of winter-maize as influenced by organics and rice-crop establishment methods

Rice crop establishment methods	Organic matter enrichment					Mean
	B_1 (M)	B_2 (Vc)	B_3 (1/3 CR)	B_4 (M + Vc)	B_5 (Control)	
A_1 (ZT)	1.36	1.36	1.45	1.39	1.51	1.42
A_2 (DS)	1.38	1.43	1.44	1.41	1.55	1.45
A_3 (PDS)	1.47	1.44	1.55	1.54	1.48	1.50
A_4 (PT)	1.48	1.47	1.53	1.37	1.55	1.48
A_5 (SRI)	1.47	1.44	1.50	1.45	1.48	1.47
A_6 (PT + BM)	1.43	1.45	1.45	1.40	1.55	1.46
Mean	1.44	1.44	1.49	1.43	1.52	
	SEm±			CD (0.05)		
A	0.01			0.04		
B	0.02			0.05		
A x B	0.05			NS		

Table 4. Porosity (%) of soil after harvest of winter-maize as influenced by organics and rice-crop establishment methods

Rice crop establishment methods	Organic matter enrichment					Mean
	B_1 (M)	B_2 (Vc)	B_3 (1/3 CR)	B_4 (M + Vc)	B_5 (Control)	
A_1 (ZT)	48.68	48.68	45.28	47.55	43.02	46.64
A_2 (DS)	47.92	46.04	45.66	46.79	41.51	45.58
A_3 (PDS)	44.53	45.66	41.51	41.89	44.15	43.55
A_4 (PT)	44.15	44.53	42.26	48.30	41.51	44.15
A_5 (SRI)	44.53	45.66	43.40	45.28	44.15	44.60
A_6 (PT + BM)	46.04	45.28	45.28	47.17	41.51	45.06
Mean	45.97	45.97	43.90	46.16	42.64	
	SEm±			CD (0.05)		
A	0.56			1.76		
B	0.69			1.97		
A x B	1.70			NS		

Conclusion

Results of the present investigation indicate that zero tillage and dry seeded methods of rice crop establishment favourably influenced the soil physical properties such as higher porosity, and lower bulk density, while, puddled transplanted rice adversely affected the soil physical properties. However, brown manuring with *Dhaincha* in puddled transplanted rice mitigated the ill effects of puddling on winter maize. Application of paddy straw mulch @ 10 t/ ha, vermicompost @ 3 t/ ha and combination of the two (paddy straw mulch @ 5 t/ ha + vermicompost @ 1.5 t/ ha) improved the soil moisture,soil physical properties,and to control evaporational loss of water.

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