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RESEARCH PAPER

Comparative study of physical properties with organics and rice-crop establishment methods of winter maize (*Zea mays* L.) in calciorthents

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Abstract : An experiment was conducted during the *Rabi* season of 2011-12 at south Kisan Vidhya Peeth block of Crop Research Centre of Rajendra Agricultural University, Bihar, Pusa (Samastipur). The experiment was conducted in a Split Plot Design with 30 treatments, which were replicated three times to the comparative study of physical properties with organics and rice-crop establishment methods 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).

Key Words : Winter maize, Physical property, Zero tillage, Dry seeded, Drum seeder, Puddled transplanted, System of rice-intensification, Brown manuring, Mulching, Vermi compost, Crop residue

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INTRODUCTION

Maize is called "King of cereals" because of its productivity potential compared to any other cereal crop. The sustainable crop production needs proper management of nutrient resources and conservation of soil fertility. Application of organic manure combined with rice-crop establishment methods in soil is considered as a good management practice for sustainability of soil fertility and crop productivity. The soil degradation causes loss of organic matter, nutrient imbalance, reduces crop yield and finally soil becomes unsuitable for cropping. A combined application of balance inorganic fertilizer and supplementary dose of organic matter sustains the crop productivity and maintain the soil fertility. For improvement of soil condition and maintenance of soil for a few decades we have been realizing the deleterious impact of continuous use of chemical fertilizers alone in agriculture. Chemical fertilizers indeed boost up crop production initially and gradually it causes decrease in fertilizer use efficiency. Application of chemical fertilizer as such without conservation of soil fertility, not only results in depletion of soil nutrient reserves but it also disrupt the biological eco balance of soil - plant system. Integrated plant nutrient supply not only sustains the soil and crop productivity but also ensures environmental and ecological security. Application of nutrients through organic sources stimulates the activity of soil micro-organisms, improves the structure/texture of soil, plant nutrients holding capacity and increases the availability of plant nutrients. In view of the above facts, the present investigation was carried out to comparative study of physical properties with organics

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and rice-crop establishment methods of winter maize (*Zea mays* L.) in calciorthents.

MATERIAL AND METHODS

Field experiment was conducted in South Kisan Vidhya Peeth 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}), and low 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 5×5 m size. Variety Deoki was used as a test variety in present study. Treatments details A: main plot (methods of rice-crop establishment) includes zero 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 A_5 (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) and without organic matter B_5(Control). Recommended dose of N, P, and K was applied at 120kg 75 kg and 50 kg ha^{-1}.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

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 and 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 and A_6) might have higher content of soil moisture as compared to direct seeded treatments (ZT and DS). Application of organic matter resulted in larger mean weight diameter, higher porosity, lower bulk density, and higher hydraulic conductivity of saturated soil (Bhagat and Verma, 1991). Soils under mulch had higher moisture content because mulching plays an important role to control evaporational loss of water and it acts as an insulating material (Samarappuli *et al.*, 1999; Dahiya *et al.*, 2003).

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 puddle transplanted + brown manuring (PT + BM) treatments, while the highest value of 1.51 mg/ m^3 was recorded in puddle dry seeded (PDS) treatment has been recorded in Table 2.

Table 1 : 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	
	S.E. ±	C.D. (P=0.05)				
A	0.05	0.15				
B	0.06	0.16				
A × B	0.14	NS				

NS=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	
	S.E.±	C.D. (P=0.5)				
A	0.01	0.04				
B	0.02	0.05				
A × B	0.05	NS				

NS=Non-significant

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	
	S.E.±	C.D. (P=0.5)				
A	0.01	0.04				
B	0.02	0.05				
A × B	0.05	NS				

NS=Non-significant

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	
	S.E.±	C.D. (P=0.5)				
A	0.56	1.76				
B	0.69	1.97				
A × B	1.70	NS				

NS=Non-significant

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 per cent 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 in Table 3 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^3 in 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 per cent, 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.

Porosity (%) :

The treatment effect on per cent pore space after harvest of maize crops have been portrayed in Table 4. The data clearly explained that value of per cent pore space of soil varied significantly both due to rice-crop establishment methods and organic matter enrichment. The significant variation in per cent 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 per cent and the lowest value of 43.55 per cent in PT treatment. While among sub plot treatments, M + Vc treatment recorded the highest value of 45.97 per cent which was statistically at par with M and Vc treatments. The increment in per cent pore space due to application of mulch and vermicompost separately was by 7.81 per cent and due to mulch + vermicompost application was by 8.25 per cent 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 *et al.,* 2005) in various soils and climatic conditions. Similar related to the present topic was also done by Kumar (2006); Nanjappa (2001); Prasad *et al.* (1987); Reddy and Reddy (2003); Sujatha *et al.* (2008); Tripathi and Tomar (2002).

Conclusion :

Results of the present investigation indicate that zero tillage and dry seeded methods of rice crop establishment favorably influenced the soil physical properties such as higher porosity, and lower bulk density, while, puddle transplanted rice adversely affected the soil physical properties. However, brown manuring with *Dhaincha* in puddle 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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