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Effect of Tillage and Manuring on Some Physical Properties of Old Bramaputra Flood Plain Soil

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Abstract: A field experiment was conducted to study the tillage and manuring effect on soil physical properties. Three tillage treatment were assigned as main plots, T_0, T_1 and T_2 tillage and four manuring treatments such as, M_0 - recommended dose of N, P, K and M_1 -1/2 recommended dose + cow dung @ 5t ha^{-1}, M_2 - cowdung 2.5t ha^{-1} + rice straw @ 2.5t ha^{-1} + ½ recommended dose of N,P,K and M_3 - rice straw @ 5t ha^{-1} +1/2 recommended of N, P, K and assigned in different split plots. Both tillage and manuring had significant effect on soil physical properties like bulk density, air filled porosity, soil moisture and soil organic matter contents. The bulk density was increased with increasing soil depth and the bulk density was influenced more or less similar to tillage by manuring up to 30 cm depth of soil. Highest air-filled porosity 15.28% was recorded at 20-30 cm depth tillage and also in M_2 manuring treatment (12.67%) The interaction effect of tillage and manuring on soil air filled porosity was significant in surface soil but considering the soil depth up to 30cm there was no significant difference and the value ranged from 7.32 to 11.80%. The maximum soil moisture of 48.21 and 48.10% were obtained under deep tillage (T_2) and in M_2 manuring treatment respectively. In no tillage average highest organic matter content was observed.

Key words: Tillage, manuring, Old Bramaputra Flood Plain

Introduction

Tillage improve the physical condition of soil that bring about better nutrient and water relations. It may influences the physical properties of soil such as, soil bulk density, soil moisture, soil porosity, air filled porosity, hydraulic conductivity (Singh and Singh, 1996). Deep tillage facilitates easy uptake of water as well as nutrient by the roots from deeper soil depth. No tillage increase the soil organic matter, cation exchange capacity, exchangeable K, soil hardness and bulk density (Bongki, 1996). Application of organic amendments to light soil increases the soil porosity and water holding capacity but decreases the soil bulk density. Mbagwu (1989) showed in his experiment that organic amendment increases the total porosity, moister content and organic matter content in soil which improve the soil structure and reduce surface run off, erosion loss and salinity of soil. Based on the above view a filed research was undertaken in an Old Bramaputra flood plain soil to evaluate the changes in soil physical properties in rice cropping pattern.

Materials and Methods

An experiment was conducted at the Bangladesh Agricultural University Farm, Mymensingh, during aman season from 5 August to 18 December 1997. The experimental site belongs to the agricultural farm under the Department of Soil Science of BAU, Mymensingh. Geographical position of the land is located approximately between the latitude of 24°26′ and 24°54′ North and between the longitude of 90°15′ and 90°30′ East and lies at the altitude of 7.9 to 9.1 meter above the sea level. The experimental soil belongs to the Sonatala soil series of old Bramaputra flood plain soil.

Table 1: Some physico-chemical properties of the experimental soil

Soil depth (cm)	Particle size fraction %Sand	%silt	%clay	Textural class	Particle density (g/ cm^3)	Soil pH	Soil total N-content (%)
0-10	9.6	72.58	17.82	Silt loam	2.34	6.55	0.09
10-20	20.59	65.56	13.85	Silt loam	2.51	6.76	0.07
20-30	24.30	64.28	11.42	Silt loam	2.48	6.98	0.05

The experiment was laid out in split plot design with the following treatments. Three tillage treatment, were assigned in a main plot such as:- To - (No tillage) T_1 - (0-10 cm depth soil) T_2 -(0-20 cm depth soil) and four manuring treatment were assigned in split plot as follows:- M_0 -recommended dose of N, P, K (40 kg N, 30 kg P and 15 kg K ha^{-1}) M– cow dung @ 5 t/ha + ½ recommended dose of N, P,K M_2 – rice straw @ 2.5 t/ha + cow dung 2.5 t/ha + ½ recommended dose of N, P, K and M_3 - rice straw @ 5 t/ ha + ½ recommended dose of N, P, K.

Results and Discussion

Bulk density (Before panicle initiation): The highest bulk density of 1.45 g cm^{-3} was recorded under no tillage (T_0) at 20 - 30 cm soil depth and the lowest bulk density of 0.95 g cm^{-3} was observed by deep tillage (T_2) at 0 - 10 cm soil depth (Table 1). Bulk density was increased significantly with increasing soil depth. In surface layer, soils were manipulated with different tillage operations there by reduced compactness of soil and increased the number of pore spaces which caused decreased soil bulk density.

The deeper soil (20-30 cm depth) showed significantly higher bulk density which indicated compactness of soil due to formation of a hard pan. Higher bulk density refers to the poor physical conditions of the soil. The present result was supported by Abbas and Al-Rawi (1988), Sharma *et al.* (1988), Chenkual and Acharya (1990) and Matin and Uddin (1994). They stated that the values of soil bulk density were decreased upto the depth of 45 to 60 cm due to deep ploughing.

The bulk density of soil was also significantly influenced by manuring (Table 2). The highest value of 1.03 g cm^{-3} was observed under M_1 treatment at 0 - 10 cm depth where only recommended dose of fertilizer M_1 applied and the lowest bulk density (0.91g cm^{-3}) was recorded in the treatment (M_2) allowing half of the recommended dose of fertilizer along with cowdung 5 t ha^{-1}. It may be due to the application of organic matter. These results were supported by Khaleel *et al.* (1981), Gupta and Larson (1982), Ekwue (1990) and Bhatnagar *et al.* (1992). They described that the organic matter decreased the soil bulk density.

Tillage along with manuring had created an impact on bulk density (Table 3). The highest bulk density (1.16 g cm^{-3}) was observed in the T_0M_1 which was followed by treatment combination T_0M_4 (1.03 g cm^{-3}). The lowest bulk density (0.88 g cm^{-3}) was recorded in the treatment combination of T_2 M_2 . The bulk density was increased with increasing the soil depth and the bulk density was influenced more or less similar to tillage by manuring up to 30 cm depth of soil (Table 3).

Bulk density (After harvest): After harvest the soil bulk density ranged from 1.0 g cm^{-3} to 1.47 g cm^{-3} (Table 2). The highest value of 1.47 g cm^{-3} was recorded under no tillage (T_0) at 20 - 30 cm depth of soil. The lowest value of 1.0 g cm^{-3} was observed in T_1 and T_2 tillage treatments at 0 - 10 cm depth which was significantly different from T_0 treatment.

The bulk density was significantly influenced by manuring (Table 2). The interaction effect of tillage and manuring on soil bulk

Table 2: Effect of tillage practice and manuring on the bulk density of soil

Treatments	Bulk density (g cm^{-3}) before panicle initiation			Bulk density (g cm^{-3}) after harvest		
	Depth of soil			Depth of soil		
	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
Tillage practice						
T_0	1.04a	1.37a	1.45a	1.08a	1.38a	1.47a
T_1	0.96b	1.34b	1.42b	1.03ab	1.35b	1.44b
T_2	0.95b	1.30c	1.43b	1.00b	1.31c	1.44b
$LSD_{0.05}$	0.04	0.01	0.028	0.04	0.01	0.01
CV (%)	4.53	0.66	0.70	4.29	0.93	0.97
Manuring treatment						
M_1	1.03a	1.35a	1.44	1.08a	1.37a	1.45ab
M_2	0.91c	1.31b	1.44	1.00b	1.32b	1.47a
M_3	0.99b	1.34a	1.43	1.03ab	1.35a	1.45b
M_4	1.00ab	1.35a	1.42	1.04ab	1.36a	1.44b
$LSD_{0.05}$	0.03	0.02	NS	0.04	0.01	0.01
CV (%)	2.83	0.99	0.97	4.05	1.02	0.95

Table 3: Interaction effect of tillage practice and manuring treatment on the bulk density of soil

Treatments combination	Bulk density (g cm^{-3}) before panicle initiation			Bulk density (g cm^{-3}) after harvest		
	Depth of soil			Depth of soil		
	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
T_0M_1	1.16a	1.40a	1.48a	1.21a	1.42a	1.51a
T_0M_2	0.91cd	1.34de	1.44b	1.06bc	1.35cd	1.46bcd
T_0M_3	1.01bc	1.37bc	1.41cd	1.03bcd	1.38b	1.42e
T_0M_4	1.03b	1.38b	1.48a	1.04bcd	1.39b	1.51a
T_1M_1	0.99bc	1.36cd	1.43bc	1.07b	1.38b	1.44cde
T_1M_2	0.91de	1.31fg	1.41d	0.98cd	1.32fg	1.42e
T_1M_3	0.96cd	1.34e	1.42bcd	1.03bcd	1.35de	1.45cd
T_1M_4	0.99bc	1.37bc	1.43bcd	1.04bcd	1.37bc	1.46bc
T_2M_1	0.93de	1.30gh	1.41d	0.96d	1.31gh	1.42e
T_2M_2	0.88e	1.29h	1.42bcd	0.96d	1.30h	1.44de
T_2M_3	0.99bc	1.32f	1.46a	1.04bcd	1.33ef	1.48b
T_2M_4	0.99bc	1.32f	1.43bc	1.04bcd	1.33ef	1.45cd
$LSD_{0.05}$	0.05	0.01	0.02	0.07	0.02	0.02
CV (%)	2.83	0.99	0.97	4.05	1.02	0.95

Table 4: Effect of tillage practice and manuring on the air filled porosity of soil

Treatments	Air filled porosity (%) before panicle initiation			Air filled porosity (%) after harvest		
	Depth of soil			Depth of soil		
	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
Tillage practice						
T_0	7.40c	10.09c	8.17b	7.77c	11.43	9.21b
T_1	8.78b	10.43b	12.59a	9.53b	11.75	15.28a
T_2	9.54a	10.76a	13.54a	10.10a	11.64	14.52a
$LSD_{0.05}$	0.35	0.22	0.99	0.50	0.37	3.87
CV (%)	3.79	1.98	8.00	4.85	2.98	27.31
Manuring treatment						
M_1	8.07bc	9.82c	10.71c	8.69c	10.94c	13.94
M_2	10.05a	11.70a	13.12a	10.53a	12.67a	14.19
M_3	8.30b	10.36b	11.59b	8.91b	11.71b	12.61
M_4	7.87c	9.83c	10.32c	8.40d	11.19c	11.29
$LSD_{0.05}$	0.26	0.43	0.60	0.18	0.36	3.47
CV (%)	3.18	4.21	5.37	2.04	3.20	26.93

density was significant at different level of soil depth (Table 3).

Air-filled porosity (Before panicle initiation): Maximum air-filled porosity (13.54%) was recorded in deep tillage (T_2) at 20 - 30 cm soil depth and the minimum (7.40%) was found in no tillage treatment at(0-10) cm soil depth (Table 4). These results were supported by the findings of Sharma and Datta (1985). In water logged condition the air filled porosity favoured the activity of soil microorganisms and thereby accelerate the growth and development of the crop root. Air filled porosity was significantly decreased up to 20 cm soil depth and it was again increased at 30 cm soil depth. The present result was supported by Matin and Uddin (1994), Rahman (1996) and Rahman (1997). They reported that highest air filled porosity was observed due to deep tillage and the lowest by no tillage treatment. The air-filled porosity of soil was also significantly influenced by manuring.

Table 5: Interaction effect of tillage practice and manuring treatment on the air filled porosity of soil

Treatments combination	Air filled porosity (%) before panicle initiation			Air filled porosity (%) after harvest		
	Depth of soil			Depth of soil		
	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
T_0M_1	6.84f	8.80e	7.27f	7.32g	10.40	8.19
T_0M_2	8.43d	11.10b	9.40e	8.73e	12.62	10.44
T_0M_3	7.26f	10.53bcd	8.23f	7.76f	11.63	9.29
T_0M_4	7.06f	9.93cd	7.80f	7.26g	11.10	8.95
T_1M_1	8.23d	10.63bc	12.08cd	8.93de	11.20	19.93
T_1M_2	10.70a	12.02a	14.47ab	11.08b	12.95	15.45
T_1M_3	8.43cd	10.53bcd	12.35cd	9.23d	11.74	13.33
T_1M_4	7.76e	9.86d	11.50d	8.88de	11.14	12.43
T_2M_1	9.13b	10.03cd	12.80c	9.82c	11.22	13.70
T_2M_2	11.03a	11.04a	15.50a	11.80a	12.45	16.68
T_2M_3	9.20b	10.03cd	14.22b	9.73c	11.77	15.22
T_2M_4	8.80bc	9.70d	11.67cd	9.06de	11.11	12.50
$LSD_{0.05}$	0.46	0.75	1.05	0.32	NS	NS
CV (%)	3.18	4.21	5.37	2.04	3.20	26.93

Table 6: Effect of tillage practice and manuring on the moisture content of soil

Treatments	Moisture content (%) before panicle initiation			Moisture content (%) after harvest		
	Depth of soil			Depth of soil		
	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
Tillage practice						
T_0	45.29c	33.25c	28.05b	43.96b	34.63b	28.52b
T_1	47.25b	34.30b	31.45a	45.23a	35.29b	30.60a
T_2	48.21a	36.39a	32.60a	45.46a	37.54a	27.74b
$LSD_{0.05}$	0.453	0.852	1.99	1.06	0.93	1.43
CV (%)	0.85	2.17	5.71	2.18	2.40	4.54
Manuring treatment						
M_1	46.19c	34.11b	28.70b	45.71b	35.30b	27.23c
M_2	48.10a	35.09a	31.98a	48.02a	38.00a	30.95a
M_3	46.98b	34.50ab	30.77a	43.85c	37.49a	29.15b
M_4	46.40c	34.70a	31.34a	41.95d	32.48c	28.56b
$LSD_{0.05}$	0.572	0.609	1.438	1.63	1.30	1.21
CV (%)	1.23	1.78	4.73	3.68	3.68	4.24

Table 7: Interaction effect of tillage practice and manuring treatment on the moisture content of soil

Treatments combination	Moisture content (%) before panicle initiation			Moisture content (%) after harvest		
	Depth of soil			Depth of soil		
	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
T_0M_1	45.00	33.54	26.41	45.33	34.53cd	26.44d
T_0M_2	46.54	33.64	29.57	46.97	39.60a	32.28a
T_0M_3	45.46	32.82	28.29	43.69	36.40c	27.75cd
T_0M_4	44.17	33.00	27.96	39.86	27.99e	27.60cd
T_1M_1	46.44	33.73	29.27	46.30	34.24cd	29.02bc
T_1M_2	48.60	34.93	33.44	48.26	36.36bc	32.94a
T_1M_3	47.06	34.30	30.87	44.19	37.67ab	31.14ab
T_1M_4	46.93	34.26	32.23	43.10	32.88d	29.55bc
T_2M_1	47.14	35.06	30.47	45.50	37.13ab	26.24d
T_2M_2	49.17	36.70	32.93	48.83	38.07ab	27.64cd
T_2M_3	48.43	36.47	33.17	43.69	38.41ab	28.58cd
T_2M_4	48.10	37.07	33.83	42.90	36.56bc	28.53cd
$LSD_{0.05}$	NS	NS	NS	NS	2.26	2.10
CV (%)	1.23	1.78	4.73	3.68	3.68	4.24

The highest value of 13.12% air-filled porosity was recorded in M_2 treatment at 20- 30 cm depth and the lowest (7.87%) was recorded in M_4 treatment at 0 - 10 cm depth (Table 4). It was increased with increasing of soil depth. It may be due to organic matter applied in the soil. The interaction effect of tillage and manuring on the air-filled porosity was highly significant (Table 5). The highest value of 15.5% air filled porosity was recorded at 20 - 30 cm soil depth in the treatment combination of T_2M_2. The lowest value of 6.84% was recorded at 0 - 10 cm soil depth in the treatment combination T_0M_1 which was identical to T_0M_3, T_0M_4 at 0-10 cm soil depth and also identical to T_0M_1, T_0M_3 and T_0M_4 at 20-30 cm soil depth.

Air-filled porosity (After harvest): Maximum value of 15.28% air filled porosity was recorded in the treatment T_1 at 20 - 30 cm soil depth and the minimum value of 7.77% air filled porosity was

Table 8: Effect of tillage practice and manuring on the organic matter (%) and N (%) content in soil

	Organic matter content (%)			Nitrogen content (%)		
	Depth of soil			Depth of soil		
Treatments	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
Tillage practice						
T_0	1.73a	0.85a	0.39a	0.10	0.07b	0.05
T_1	1.53b	0.82a	0.39a	0.10	0.06b	0.05
T_2	1.50c	0.53b	0.34b	0.09	0.09a	0.06
$LSD_{0.05}$	0.01	0.05	0.03	NS	0.008	NS
CV (%)	0.63	7.45	8.47	13.86	12.42	9.78
Manuring treatment						
M_1	1.59b	0.63c	0.36b	0.10	0.07	0.05
M_2	1.60a	0.89a	0.41a	0.11	0.06	0.05
M_3	1.58bc	0.73b	0.36b	0.10	0.07	0.05
M_4	1.57c	0.69b	0.35b	0.09	0.07	0.05
$LSD_{0.05}$	0.009	0.04	0.03	NS	NS	NS
CV (%)	0.68	5.82	6.16	8.36	6.07	6.92

Table 9: Interaction effect of tillage practice and manuring treatment on the organic matter content and nitrogen content of soil.

	Organic matter content (%)			Nitrogen content (%)		
	Depth of soil			Depth of soil		
Treatments combination	0 - 10 cm	10 - 20 cm	20 - 30 cm	0 - 10 cm	10 - 20 cm	20 - 30 cm
T_0M_1	1.73	0.54e	0.33	0.10	0.08abc	0.06
T_0M_2	1.75	0.56e	0.38	0.11	0.07bc	0.05
T_0M_3	1.73	0.51e	0.32	0.11	0.09ab	0.06
T_0M_4	1.72	0.52e	0.33	0.09	0.09a	0.06
T_1M_1	1.52	0.67d	0.36	0.10	0.07abc	0.05
T_1M_2	1.55	1.05a	0.43	0.11	0.06bc	0.05
T_1M_3	1.52	0.87b	0.39	0.09	0.06bc	0.05
T_1M_4	1.51	0.80c	0.37	0.09	0.06bc	0.05
T_2M_1	1.51	0.69d	0.39	0.10	0.06c	0.05
T_2M_2	1.52	1.05a	0.42	0.09	0.06bc	0.05
T_2M_3	1.50	0.79c	0.38	0.10	0.06c	0.05
T_2M_4	1.49	0.74cd	0.34	0.10	0.06c	0.05
$LSD_{0.05}$	0.13	0.07	NS	NS	0.02	NS
CV (%)	6.28	5.82	6.16	8.36	6.07	6.92

Means followed by common letters within tillage or manuring treatments do not differ significantly at 5% level of DMRT

found in T_0 treatment at 0 - 10 cm depth of soil (Table 4). From the above discussion, it is clear that soil porosity was significantly influenced due to different tillage operations. After harvest air-filled porosity of soil was slightly increased from the air filled porosity at before panicle initiation stage of rice growth. Probably, it occurred due to decreases of soil moisture. Air-filled porosity gradually decreased up to 20 cm soil depth and then increased up to 30 cm soil depth. Similar results were observed from the study of Rahman (1996). The air-filled porosity of soil was significantly influenced by manuring and the highest value of 10.53% air filled porosity was observed in the M_2 treatments at 0 - 10 cm soil depth and the lowest was 8.40% in M_4 treatment. In 10 - 20 cm depth of soil profile the highest air filled porosity (12.67%) was observed in M_2 treatment where the lowest value of 10.94% was recorded in M_1 treatment. However, there was no significant variation of the air-filled porosity in deeper soil (20 - 30 cm depth) due to manuring (Table 4).

In surface soil (0-10 cm) the interaction effect of tillage and manuring on soil air filled porosity was significant. But considering the soil depth up to 30 cm there was no significant difference of air-filled porosity and the value ranged from 7.32 to 11.80% (Table 5).

Moisture content (Before panicle initiation): The moisture content of soil was significantly influenced by different tillage practices and the highest moisture content of 48.21% was found under deep tillage (T_2) at 0 - 10 cm soil depth and the lowest of 28.05% was recorded by no tillage (T_0) at 20 - 30 cm depth. All the treatments conserved significantly higher soil moisture over control (no tillage). It was observed that tillage had significantly positive effect on soil moisture. The results indicated that the more loosen soil absorbed more soil moisture compared to compacted soil as was observed in control plot. A similar effect of tillage treatment was obtained by Negi *et al.* (1982), Sarder (1990), Saltion and Mielniczeuk (1995). They reported that the lower moisture content was found in sub soil due to the presence of a hard plough pan. The moisture content of soil was significantly influenced by manuring and the highest value of 48.10% moisture was recorded in M_2 treatment at 0 - 10 cm soil depth whereas the lowest value of 28.7 was recorded in M_1 treatment at 20 - 30 cm soil depth where cowdung was applied 5 t ha^{-1} with half recommended dose of fertilizer. Addition of organic matter (cow dung) in soil increased the water holding capacity as a result soil moisture content in soil was increased. Similar results were found by Prithar *et al.* (1985) and Mbagwu (1989). They stated that organic amendments or organic matter increased water holding capacity. The interaction effect on soil moisture content was not significant due to tillage and manuring (Table 7).

Moisture content (After harvest): After harvest of rice the maximum soil moisture content of 45.46% was found in top soil (0-10 cm) under deep tillage (T_2) operation. Minimum moisture content was measured under deep tillage (T_2) treatment at 20 - 30 cm soil depth. From our data it was observed that the soil moisture decreased with the increase of soil depth, probably due to the absence of low fragipan. After harvest soil moisture content in soil was comparatively lower from the moisture content measured before panicle initiation stage of growth. Due to manuring practices the highest moisture content of 48.02%

was observed at 0 - 10 cm soil depth in M_2 treatment and the lowest 27.23% was found at 20 - 30 cm soil depth in M_1 treatment. The interaction effect of moisture content was statistically significant by tillage and manuring at 10- 20 cm and 20- 30 cm soil depths (Table 7). The maximum moisture content of 39.6% was recorded in T_0M_2 treatment combination and the minimum was 26.24% which was identical to T_0M_1.

Organic matter content: The highest amount of organic matter content (1.73%) was found under no tillage (T_0) at surface soil (0-10 cm depth) and the lowest value of (0.34 %) was observed in deep tillage (T_2) at 20 - 30 cm depth. Deep tillage favored for rapid decomposition of organic matter and no tillage favoured improvement of organic matter status. These results are in agreement with the findings of Agenbag and Maree (1989), Hussain *et al.* (1990), Boyle *et al.* (1989). They reported that no tillage and to a lesser extent shallow fine tillage tended to increase organic carbon content at 0-10 cm soil depth. The organic matter content of top soil (0-10 cm) depth was also significantly influenced by manuring and the highest (1.6%) amount was obtained in the treatment M_2 allowing cow dung incorporation (5t ha^{-1}) with half recommended dose of fertilizer and the lowest value of 1.57 % organic matter was recorded in the M_4 treatment (Table 8). The treatment M_2 recorded the highest organic matter content at all soil depths (0-10, 10-20 and 20-30 cm). Like tillage effects organic matter level due to manuring tended to decrease with soil depths. The interaction effect of tillage and manuring on the soil organic matter content was found statistically significant (Table 9). The amount ranged between 1.49 and 1.75% and the highest amount of organic matter was recorded in the treatment combination T_0M_2 and the lowest amount in the T_2M_4 treatment combination.

Both tillage and manuring improve the soil physical properties i.e., reduces the bulk density, increases the air filled porosity and water holding capacity of the soil. Deep tillage up to 0-20 cm improve the soil physical charactertics which increases the yield. However further investigation was needed to confirm the study.

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