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EFFECT OF DEPTH OF TILLAGE AND MANURING ON SOIL PHYSICAL PROPERTIES, WATER CONSERVATION, AND YIELD OF AMAN RICE (BRRI DHAN49) IN BANGLADESH

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ABSTRACT

The experiment was conducted to study the effect of depth of tillage and manuring on soil physical properties, water conservation, and yield of rice (BRRI dhan49). The experiment was laid out in a split plot design with three tillage treatments in main plot and two manuring treatments in sub-plots. Tillage treatments were: no tillage (T_o), 0-10 cm deep tillage (T_1), and 10-20 cm deep tillage (T_2), and manuring treatments were: recommended dose of fertilizers at 90 kg N, 15 kg P, 40 kg K,10 kg S, and 2 kg Zn ha^{-1} as urea, TSP, MoP, gypsum, and zinc sulphate respectively (F), and 70 % of N plus rest of the recommended dose of fertilizers plus cow dung at 5 t ha^{-1} (FM). Maximum bulk density of 1.68 g cm^{-3} and minimum bulk density of 0.75 g cm^{-3} were recorded under no tillage and deep tillage. In case of manuring, highest bulk density of 1.43 g cm^{-3} and lowest bulk density of 0.86 g cm^{-3} were observed under F and FM treatments respectively. Highest value of 47.62% moisture and 14.45% air-filled porosity were measured in T_2 treatment. Lowest soil moisture (36.30%) and air-filled porosity (8.50%) were found in T_o treatment. In manuring, highest soil moisture (45.62%) and air-filled porosity (11.86%) were recorded in FM. Highest grain yield (4.62 t ha^{-1}) was found under T_2 treatment and lowest yield (3.23 t ha^{-1}) was obtained in control (T_o) treatment. Deep tillage favored better root growth and nutrient uptake resulting higher yield of rice.

INTRODUCTION

Bangladesh is predominantly a rice growing country. Rice is grown in about 77% of total cropped area. The total area and production of rice in Bangladesh is about 11.7 million hectare and 31.98 million metric ton respectively with the average yield around 2.4 ton per hectare (BBS, 2012). Rao *et al.* (2007) observed that rice (*Oryza sativa L*) is a main source of food for more than half of the world population, especially in south and south East Asia. It represents a high value commodity crop. Aman is an important crop in Bangladesh covering area of 5.66 million hectares in 2010 (BBS, 2010). Tillage is considered to be the oldest and the most fundamental farm activity of mankind for crop production. Lal (1997) defined tillage is physical, chemical and biological soil manipulation to optimize conditions for seed germination, emergence and seedling establishment. Khan *et al.* (2010) reported that tillage is a practice which is performed to unite the soil and to bring into being a good tilth.

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Tillage managing practices and farm manure use are among the most important factors affecting soil physical properties and yield of rice crop. The advantages of different tillage systems are moisture conservation, reduced soil erosion, less labor, and energy requirement, more timely planting of crop and increased intensity of land use. No tillage system was inferior to the tillage systems in terms of yield and growth of plants. Soil organic matter is a key factor for sustainable soil fertility and crop productivity. Addition of organic matter to light soil increases porosity and water holding capacity. Cohesion and plasticity of heavy soils are reduced by addition of manures.

Manure acts as a buffer medium for making favorable soil environment to obtain higher yield of crops. The importance of organic manure as a source of humus and plant nutrients to increase the fertility level of tropical soils has been well recognized. Deksissa *et al.* (2008) described that poultry manure is an excellent organic fertilizer as it contains high nitrogen, phosphorus, potassium and other essential nutrients.

Application of organic residues and manures such as poultry manure and sewage sludge improves organic matter content, soil structure, water holding capacity and nutrient status of soil and also increases microbial activity in soil (Mohammad 2004). Use of chemical fertilizers is an essential component of modern farming and about 50% of the world's crop production can be attributed to fertilizer use (Pradhan, 1992). The use of fertilizer nutrients in different countries of Asia has increased considerably with a maximum use of 509 kg ha^{-1} yr^{-1} in the republic of Korea as against only 102 kg ha^{-1} yr^{-1} in Bangladesh (BARC, 2005). Oad *et al.* (2004) stated that continuous use of fertilizers creates potential polluting effect in the environment. A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture.

It is very crucial to consider seriously for the improvement of our soil quality in order to increase crop yield. This can only be done by managing the soil with proper tillage practices and the application of manures periodically following a scientific crop rotation. Nevertheless, sustainable production of crops cannot be maintained by using only chemical fertilizers and similarly it is not possible to obtain higher crop yield by using organic manure alone (Rose *et al.* 2001). Based on the above facts, the present investigation was undertaken to study the changes in soil physical properties as influenced by depth of tillage and manuring treatment, to investigate the effect of depth of tillage and manuring on the yield contributing characters and yield of rice as well as to examine the relationship among physical properties, yield contributing characters and yield of rice.

MATERIALS AND METHODS

Site selection

The experiment was conducted at the Bangladesh Agricultural University Farm, under the Department of Soil Science, during Aman season from August to December. Geographical position of the site was approximately between the latitudes of 24°54″ North and the longitudes of 90°15″ East at a height of 18 m above the mean sea level. The soil belongs to the "Old Brahmaputra Floodplain" and Agro Ecological Zone-9. Morphological characteristics of the experimental field are presented in Table 1.

Morphological characteristics of the experimental field

The general soil type was non-calcareous dark gray floodplain soil. The morphological characteristics of the experimental field are shown in Table 1. The physical characteristics of the initial soil are given in Table 2.

Test crop

The recommended high yielding T. Aman variety BRRI dhan49 was used as a test crop. This variety was released by the Bangladesh Rice Research Institute, Joydebpur, Gazipur after regional and zonal trials and evaluation. It was recommended as a suitable variety for cultivation under Bangladesh climatic condition. It is a photo-sensitive variety. The life cycle of this variety is 135 days.

Treatments of the experiment

The experiment consisted of three main plot treatments and two sub plot treatments. The treatments were as follows:

Main plot treatments

Treatment code	Tillage treatments applied to the experiment
T_0	No tillage (control)
T_1	0-10 cm deep tillage
T_2	10-20 cm deep tillage

Sub plot treatments

Treatment	Fertilizer and manure applied to the experiment
F	Recommended dose of fertilizers @ 90 kg N, 15 kg P, 40 kg K, 10 kg S, 2 kg Zn ha^{-1} as urea, TSP, MoP, gypsum, and zinc sulfate respectively (BARC, 2005).
FM	70 % of N plus rest of the recommended dose of fertilizers plus cow dung @ 5 t ha^{-1}.

Design of the experiment

The experiment was laid out in a split plot design. There were two sets of experimental treatments viz. (i) three tillage practices arranged as main plot and (ii) two manuring treatments allocated into the sub plots. The treatments were replicated three times. Thus the total number of plot was eighteen. The unit plot size was 4m x 2.5m having spacing of plot to plot 1 m and block to block 1 m.

Table 1. Morphological characteristics of the experimental field

Location	Soil Science field laboratory, Bangladesh Agricultural University, Mymensingh-2202
Agro-ecological zone	Old Brahmaputra Flood Plain (AEZ-9)
Land type	High land
General Soil Type	Non-calcareous Dark Grey Flood Plain
Parent material	Brahmaputra river borne deposits
Taxonomic classification	Order: Inceptisols, Sub-order : Aquept, Sub-group: Acric Haplaquept, Series: Sonatola
Topography	Fairly level
Drainage	Moderately well drained
Flood level	Above flood level

Table 2. Textural class of the soil of the experimental field

Soil depth (cm)	Particle size fractions			Textural class
	% sand (0.2-0.02 mm)	% silt (0.02-0.002 mm)	% clay (<0.002 mm)	
0-10	12.8	73.3	13.9	Silt loam
10-20	13.1	74.5	12.4	Silt loam

Fertilizer and manure application

The manuring was done with well decomposed cow dung (containing 1.2% N, 1% P, 1.6% K and 0.13% S) (BARC, 2005). The cow dung was applied after the first tillage operation and incorporated into the soil thoroughly. The land was fertilized by applying the recommended amount of N, P, K, S and Zn fertilizers i.e. Urea 195.65 kg ha^{-1}, TSP 75 kg ha^{-1}, MoP 80 kg ha^{-1}, Gypsum 55.56 kg ha^{-1}, and $ZnSO_4$ 5.60 kg ha^{-1} as per recommendation of Fertilizer Recommendation Guide[9]. Whole amount of TSP, MoP, Gypsum and Zinc sulphate were applied during final land preparation but the urea was applied in three splits; one third of urea was added at 12 days after transplanting, one third was applied at maximum vegetative growth stage and the rest of the urea was applied before panicle initiation stage of the crop i.e. 45 days after transplanting.

Collection and preparation of soil samples for determining physical properties of soil Initial soil sample

The initial soil sample (0-10 cm and 10-20 cm soil depth) was collected before final land preparation. The samples were taken by means of an auger from 18 different random spots covering the whole experimental plots. The composite sample was air dried and sieved through a 10-mesh sieve. This composite sample was stored in a clean plastic container for subsequent physical analysis. The soil samples were analyzed for the particle size distribution (Sand, silt and clay).

Methods for measuring physical properties of soil Soil texture

Textural classes were determined by hydrometer method as outlined by Bouyoucos (1927). The percentage of sand, silt, and clay were calculated as follows:

% (Silt + Clay) = (C.H.R. after 40 seconds of sedimentation/W) × 100
% Clay = (C.H.R. after 2 hours of sedimentation/W) × 100

Where,

C. H. R. = Corrected hydrometer reading
W = Weight of soil (g)
% Sand = 100 -% (Silt + Clay)
% Silt = % (Silt + Clay) - %Clay

Bulk density

The bulk density was determined with the help of a core sampler made of metal cylinders of known volume. The diameter and the length of the sampler were 4.2 cm and 4.4 cm respectively. Bulk density was calculated by using the following formula:

Bulk density (D_b) = M_S/V_t

Where,

D_b = Bulk density (g cm^{-3})
M_s= Mass of soil solid (g)
V_t = Total volume of soil (cm^3)

Air-filled porosity

Air-filled porosity was calculated by using the following formula:

Air filled porosity (%) = [Volume of the air (cm^3)/ Total volume of the soil (cm^3)] × 100
Volume of air (cm^3) = Total volume of soil (cm^3) – volume of water (cm^3) - volume of soil solids (cm^3).
Volume of water (cm^3) = Mass of water (g)/ Density of water (g cm^{-3})
Volume of solid (cm^3) = Mass of soil/Density of soil solid (g cm^{-3})

Soil moisture

The soil moisture was determined by gravimetric method and was calculated by using the following formula:

Soil moisture (%) = $[(W - W_1)/ W_1] \times 100$ (oven dry basis)

Where,

W = weight of moist soil (g)
W_1 = weight of oven dry soil (g)

Recording of yield contributing characters and yield data Plant height

The height of every plant from five hills was measured randomly in terms of cm with the help of a meter scale. Thus average height of plants (cm) was measured.

Number of Tillers per Hill

Five hills were taken randomly from each plot and the total number of tillers was counted, the average of which were considered as total number of tillers per hill.

Panicle Length

Measurement was taken from basal node of the rachis to apex of each panicle (cm). The panicle length was expressed by averaging the data from 5 plants.

Grains per Panicle

Five hills were randomly selected from each plot and the number of filled and unfilled grains per panicle from each hill was counted in number. Then the average number of grains per panicle was counted in number.

1000-grain weight

The 1000-grain samples were counted from each plot and dried the sample in an oven at 65°C for 24 hours and then recorded their weight in g with the help of an electrical balance.

Grain and straw yields

The harvested crop of each treated plot was bundled separately and brought to the threshing floor for threshing by hand. The separated grains were dried in the sun for 5 days for attaining the moisture up to 14%.

The grains were kept in paper bags plot wise and were recorded in kg. Similarly the straw yield was recorded in kg. Finally, the plot wise yield of grain and straw converted into t ha^{-1}.

Statistical analysis

The mean comparisons of the treatments were calculated and analyses of variance of all the characters studied were performed by F- test. The significance of the difference between the pair of means was evaluated at 5% level of significance by Least Significant Difference (LSD) test using "MSTAT-C" computer package program (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of depth of tillage and manuring on soil physical properties Bulk density (before panicle initiation stage of growth)

The bulk density of soil showed significant results under three tillage treatments along with the manuring. The maximum bulk density of 1.68 g cm^{-3} was recorded under no tillage (T_o) at 10-20 cm soil depth. The minimum bulk density of 0.75 g cm^{-3} was observed by deep tillage (T_2) at 0-10 cm soil depth (Table 3). Bulk density was increased significantly with increasing soil depth. Higher bulk density refers to the poor physical condition of soil. The similar results were also observed from Matin and Uddin (1994), Singh *et al*. (1996), Matin and Hossain (2000) and Molla *et al*. (2000)**.**

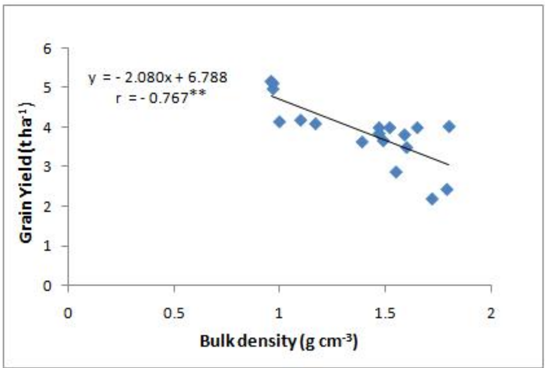

Figure 1. Relationship between grain yield (t ha^{-1}) and bulk density (g cm^{-3})

A negative relationship (r = - 0.767**) was found between bulk density and grain yield (Fig 1). The bulk density of soil was significantly influenced by manuring at 0-10 cm depth, but it was non-significant at 10-20 cm depth (Table 3). The greatest bulk density of 1.43 g cm^{-3} was observed under F treatment at 10-20 cm depth and the lowest bulk density of 0.86 g cm^{-3} was recorded in the treatment FM at 0-10 cm depth. It may be due to the application of organic manures, which improved granulation of soil. The result was also supported by Ekwue (1990) and Bhatnagar *et al.* (1992). The interaction effects of depth of tillage and manuring were significant at 0-10 cm soil depth, but it was non-significant at 10-20 cm depth of soil (Table 3). The highest bulk density of 1.69 g cm^{-3} was observed in the T_oF treatment at 10-20 cm depth. The lowest bulk density of 0.73 g cm^{-3} was recorded in the treatment T_2 FM at 0-10 cm depth.

Bulk density (after harvest)

Depth of tillage influenced soil bulk density significantly. The maximum value of 1.48 g cm^{-3} was recorded under no tillage (T_o) at 10-20 cm depth of soil. The minimum value of 0.87 g cm^{-3} was observed in T_2 treatment at 0-10 cm depth, which was significantly different from T_o and T_1 treatments. Bulk density showed significant result to manuring treatments at 10-20 cm soil depth, but it was non-significant at 0-10 cm depth of soil (Table 3). The highest bulk density of 1.39 g cm^{-3} was found in F manuring treatment at 10-20 cm depth and lowest bulk density was 0.98 g cm^{-3} at FM treatment at 0-10 cm depth. The interaction effect of tillage and manuring was non-significant at both 0-10 cm and 10-20 cm depth of soil. The greatest (1.64 g cm^{-3} at 10-20 cm depth) and the lowest value (0.84 g cm^{-3} at 0-10 cm depth) of bulk density were found in T_oF and T_2FM treatments respectively.

Soil moisture (before panicle initiation stage of growth)

Variable depth of tillage practices influenced soil moisture content significantly (Table 4). The highest value of soil moisture content (47.62%) was found under deep tillage (T_2) at 0-10 cm depth and the lowest value of 36.30% was recorded by no tillage (To) at 10-20 cm depth. All the treatments conserved significantly more soil moisture over control (no tillage). The results indicated that the more loose soil absorbed more soil moisture compared to compacted soil. Fig. 2 showed that bulk density was negatively correlated (r= - 0.752**)** with soil moisture content. The present findings are in agreement with Sarder (1990) and Saltion (1995)**.** They reported that lower moisture content was found in sub soil due to the presence of a hard plough pan. Manuring treatment also influenced soil moisture content significantly. The maximum moisture content of 45.55% was recorded in FM treatment at 0-10 cm depth whereas the minimum value of 37.31% was recorded in F treatment at 10-20 cm soil depth. Addition of cow dung in soil increased the moisture holding capacity as result soil moisture content was increased. Similar result was found by Prihar *et al.* (1985) and Mbagwu-j. Sc (1989).The interaction effect of depth of tillage and manuring was non-significant on soil moisture content (Table 4) at both 0-10 cm and 10-20 cm soil depth. The highest amount of soil moisture (49.37%) was found in T_2FM treatment combination at 0-10 cm soil depth. The lowest amount of soil moisture (35.31%) was found in T_o F treatment at 10-20 cm depth of soil.

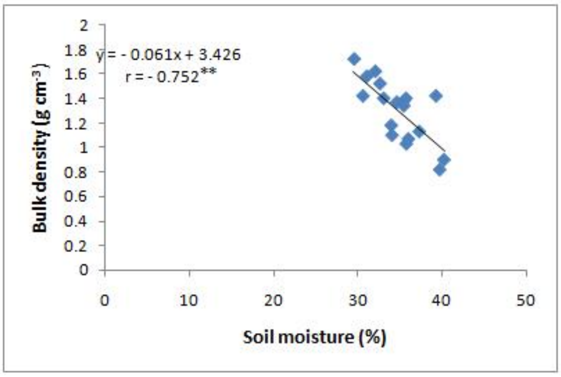

Figure 2. Relationship between bulk density (g cm^{-3}) and soil moisture (%)

Table 3. Effect of depth of tillage and manuring on bulk density (g cm^{-3})

Treatments	Bulk density (g cm^{-3}) before panicle initiation stage		Bulk density (g cm^{-3}) after harvest	
	0-10 cm depth	10-20 cm depth	0-10 cm depth	10-20 cm depth
		Tillage treatment		
T_0	1.14a	1.68a	1.16a	1.48a
T_1	0.87b	1.49ab	1.04ab	1.42ab
T_2	0.75b	1.03b	0.87b	1.01b
LSD	0.059	0.062	0.059	0.041
Level of sig	**	**	*	**
		Manuring treatment		
F	0.98a	1.43	1.07	1.39a
FM	0.86b	1.37	0.98	1.21b
LSD	0.012	0.030	0.044	0.038
Level of sig	**	NS	NS	**
		Tillage × manuring treatment		
T_0 F	1.24a	1.69	1.23	1.64
T_0FM	1.05ab	1.68	1.09	1.31
T_1 F	0.93b	1.52	1.07	1.43
T_1 FM	0.81c	1.46	1.00	1.40
T_2 F	0.77d	1.09	0.91	1.10
T_2 FM	0.73d	0.97	0.84	0.92
LSD	0.036	0.089	0.132	0.115
Level of sig	**	NS	NS	NS

NS= Non significant,
*= Significant at 5% level of probability,
**= Significant at 1% level of probability

Table 4. Effect of depth of tillage and manuring on moisture content (%)

Treatments	Moisture content (%) before panicle initiation stage		Moisture content (%) after harvest	
	0-10 cm depth	10-20 cm depth	0-10 cm depth	10-20 cm depth
		Tillage treatment		
T_0	41.48c	36.30b	43.15c	32.05c
T_1	43.99b	39.39ab	45.15b	35.08b
T_2	47.62a	39.71a	46.42a	37.14a
LSD	1.088	1.285	1.125	1.058
Level of sig	**	*	**	**
		Manuring treatment		
F	43.17b	37.31b	43.92b	33.70b
FM	45.55a	39.62a	45.89a	35.81a
LSD	0.597	0.309	0.447	0.369
Level of sig	*	**	*	**
		Tillage × manuring treatment		
T_0 F	39.86	35.31	42.01	30.82
T_0FM	43.09	37.29	44.29	33.28
T_1 F	43.78	38.36	44.70	34.56
T_1 FM	44.19	40.41	45.60	35.61
T_2 F	45.87	38.25	45.04	35.73
T_2 FM	49.37	41.17	47.80	38.54
LSD	1.792	0.926	1.325	1.077
Level of sig	NS	NS	NS	NS

NS= Non significant
* = Significant at 5% level of probability
** = Significant at 1% level of probability

Soil moisture (after harvesting)

The soil moisture content showed statistically significant results under different tillage treatments (Table 4). Maximum soil moisture content of 46.42% was found in topsoil under deep tillage (T_2) operation. Minimum moisture content of 32.05% was measured under deep tillage (T_o) treatment at 10-20 cm soil depth. After harvest soil moisture content was comparatively lower from the moisture content measured before panicle initiation stage of growth. The moisture content in soil was significantly influenced by manuring (Table 4). The highest moisture content of 45.89 % was observed at 0-10 cm in FM treatment and the lowest moisture content of 33.70 % was found at 10-20 cm depth in F treatment. There was a non-significant effect of tillage and manuring on soil moisture content (Table 4) at both 0-10 cm and 10-20 cm soil depth. The maximum 47.80% and minimum 30.82% moisture content was found at T_2FM and T_0F treatment combination at 0-10 cm and 10-20 cm depth of soil respectively.

Air-filled porosity (before panicle initiation stage of growth)

Different depth of tillage practices significantly changed the soil air-filled porosity. The highest air-filled porosity of 14.45% and the lowest air-filled porosity of 8.50% were found under T_2 treatment at 0-10 cm and T_o treatment at 0-10 cm soil depth respectively (Table 5). Fig. 3 showed that bulk density was negatively correlated (r = - 0.814**) with air-filled porosity. The present results were accorded with the findings of Chan *et al.* (1999), Rahman (1997) and Ball *et al.* (1999)**.** Manuring was significantly influenced the air-filled porosity (Table 5) at 10-20 cm depth but it was non-significant (Table 5) at 0-10 cm depth of soil.

Table 5. Effect of depth of tillage and manuring on air-filled porosity (%)

Treatments	Air- filled porosity (%) before panicle initiation stage		Air- filled porosity (%) after harvest	
	0-10 cm depth	10-20 cm depth	0-10 cm depth	10-20 cm depth
		Tillage treatment		
T_0	8.50c	9.34c	10.55b	10.34b
T_1	12.10b	11.01b	11.67a	11.15ab
T_2	14.45a	11.74a	11.63a	11.36a
LSD	0.332	0.249	0.224	0.205
Level of sig	**	**	**	*
		Manuring treatment		
F	11.51	10.33b	11.10b	10.79b
FM	11.86	11.06a	11.47a	11.10a
LSD	0.141	0.094	0.115	0.123
Level of sig	NS	**	*	**
		Tillage × manuring treatment		
T_0 F	8.34	9.23d	10.45	10.09d
T_0FM	8.66	9.44d	10.65	10.58c
T_1 F	11.81	10.26c	11.61	11.06b
T_1 FM	12.38	11.77ab	11.72	11.23ab
T_2 F	14.37	11.49bc	11.23	11.21ab
T_2 FM	14.53	11.98a	12.02	11.50a
LSD	0.422	0.283	0.344	0.370
Level of sig	NS	**	NS	*

NS= Non significant
* = Significant at 5% level of probability,
* * = Significant at 1% level of probability

The maximum value of air -filled porosity 11.86% and the minimum value of air-filled porosity 10.33% were found in FM treatment at 0-10 cm and F treatment at 10-20 cm soil depth respectively. The interaction effect of depth of tillage and manuring on the air-filled porosity was significant (Table 5) at 10-20 cm soil depth but was non-significant at 0-10 cm soil depth. The highest value of 14.53% air-filled porosity was recorded at 0-10 cm depth in the treatment combination T_2FM. The lowest value of 8.34% was recorded at 0-10 cm depth in treatment combination T_0F. Adequate aeration in soil can encourage the activity of microorganisms present in soil that may accelerate the growth and development of a crop by providing nutrient elements available to roots.

Air-filled porosity (after harvesting)

Air-filled porosity was significantly influenced by tillage treatments (Table 5). Maximum value of air-filled porosity 11.67% was found in T_1 treatment at 0-10 cm soil depth and minimum value of 10.34% was found in T_o treatment at 10-20 cm soil depth. After harvest air-filled porosity of soil was slightly increased from the air-filled porosity at before panicle initiation stage of rice probably it occurred due to decrease of soil moisture. Similar results were observed from a study (Rahman, 1997). With respect of manuring, soil air-filled porosity was significantly influenced by different manuring treatments. The maximum value of air-filled porosity 11.47% was recorded in FM treatment at 0-10 cm soil depth and the minimum value of 10.79% were found in F treatment at 10-20 cm soil depth. Interaction effect of tillage and manuring on soil air-filled porosity was significant (Table 5) at 10-20 cm depth of soil, but it was non-significant (Table 5) at 0-10 cm depth. The highest value of air-filled porosity 12.02% was found in T_2FM treatment at 0-10 cm depth and the lowest value of 10.09% was observed in the treatment combination of T_0F at 10-20 cm depth.

Effect of depth of tillage and manuring on yield contributing characters and yield of rice Tillers per hill

Different depth of tillage practices influenced number of tillers per hill of BRRI dhan49 significantly (Table 6). The highest number of tillers per hill (10.92) was recorded in the treatment T_2. The lowest number of tillers per hill (9.69) was found under control (T_0). Tillers hill^{-1} and grain yield was positively correlated (r = 0.628**) (Fig.3) and was statistically significant. It was due to absorption of more water and nutrients from deep soil. Similar result was accorded with Sharma *et al.* (1988) and Basunia (2000).

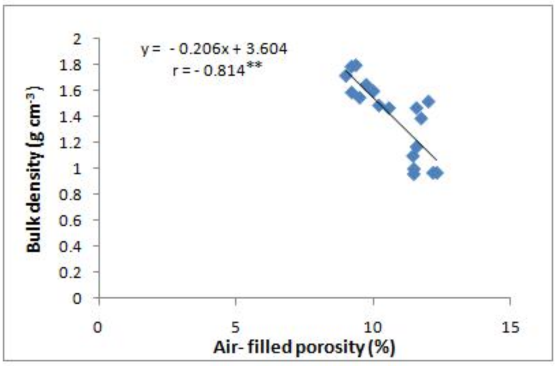

Figure 3. Relationship between bulk density (g cm^{-3}) and air filled porosity (%)

The number of tillers per hill was found to be non-significant by manuring treatment (Table 6). Maximum number of tillers per hill (10.70) was observed in FM treatment. Minimum number of tillers per hill (9.78) was recorded in the treatment combination of F. The interaction effect of depth of tillage and manuring on number of tillers per hill was statistically significant. The treatment combination T_0FM gave the highest number of tillers per hill (11.46). The treatment combination T_0F gave the lowest number of tillers per hill (7.91).

Table 6. Effect of depth of tillage and manuring on yield contributing characters of BRRI dhan49

Treatment	Number of tillers hill^{-1}	Plant height (cm)	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain weight (g)
			Tillage treatment		
T_0	9.69b	104.34	22.14	90.60	22.40
T_1	10.12ab	102.75	21.80	89.72	22.26
T_2	10.92a	103.91	21.95	90.84	22.56
LSD	0.353	1.277	0.521	0.697	0.124
Level of sig	*	NS	NS	NS	NS
			Manuring treatment		
F	9.78	102.56b	22.15	90.83	22.32
FM	10.70	104.77a	21.77	89.94	22.50
LSD	0.354	0.458	0.342	1.049	0.243
Level of sig	NS	**	NS	NS	NS
			Tillage × manuring treatment		
T_0 F	7.91c	101.88b	22.78	92.83	22.54
T_0FM	11.46a	106.79a	21.49	88.37	22.26
T_1 F	10.17bc	101.85b	21.68	89.12	22.21
T_1 FM	10.06bc	103.66ab	21.92	90.31	22.31
T_2 F	11.25ab	103.96ab	21.99	90.53	22.20
T_2 FM	10.58b	103.86ab	21.90	91.14	22.92
LSD	1.061	1.373	1.027	3.147	0.729
Level of sig	*	*	NS	NS	NS

NS = Non significant
* = Significant at 5% level of probability
* * = Significant at 1% level of probability

Plant height (cm)

The plant height of BRRI dhan49 was non-significantly changed by the impact of different tillage treatments (Table 6). Maximum plant height of 104.34 cm was recorded in no tillage (T_0) and the minimum plant height of 102.75 cm was found under T_1 treatment. Plant height was also highly influenced by the application of manures (Table 6). The recommended dose of fertilizers along with manure (FM) produced the tallest plant (104.77 cm). The shortest plant of 102.56 cm was found under F manuring treatment. The interaction effect of depth of tillage and manuring showed significant impact on plant height (Table 6). From the Table, it was clear that the tallest plant of 106.79 cm was produced by T_0FM and the shortest plant of 101.85 cm was recorded under T_1F treatment combination.

Panicle length (cm)

Different depth of tillage treatments had a non-significant impact on panicle length (Table 6). The treatment T_0 generated the highest panicle length (22.14 cm) which was not identical to T1 and T_2 treatments. The lowest panicle length (21.80 cm) was recorded in T_1 treatment. Application of manures had non-significant impact on panicle length of rice (Table 6). From the Table it was observed that the tallest plant of 22.15 cm was recorded under the plots which received the recommended dose of fertilizers (F) and the shortest panicle (21.77 cm) was observed in the treatment FM. The combined effect of depth of tillage and manuring on panicle length was non-significant (Table 6). The tallest panicle of 22.78 cm was found under no tillage with recommended dose of fertilizers (T_2M_1). The shortest panicle of 21.49 cm was found under T_oFM treatment combination.

Number of grains per panicle

Different depth of tillage treatments influenced the number of grains per panicle non-significantly (Table 6).

The highest number of grains per panicle (90.84) was obtained in T_2 treatment which was identical to T_0 but was different from the rest. The lowest number of grains per panicle (89.72) was observed under T_1 tillage treatment. Considering the manuring treatments, addition of manure had a non-significant impact on the number of grains per panicle. The highest number of grains per panicle (90.83) was observed in F treatment which was significantly different from other treatments. The lowest number of grain per panicle (89.94) was observed in FM treatment (Table 6). Similar results were recorded by Sharma *et al.* (1988) and Basunia (2000). The interaction **e**ffect of depth of tillage and manuring was also non-significant (Table 6). The maximum number of grains panicle^{-1} was observed in T_0F. The minimum grains per panicle (88.37) were found in the treatment combination of T_0FM.

1000- grain weight

The thousand grain weight of BRRI dhan49 was not significantly changed due to different depth of tillage treatments. Although they were statistically identical, there was difference among the treatments (Table 6). The highest 1000-grain weight (22.56 g) was found in T_2 treatment. The lowest 1000-grain weight of (22.26 g) was found under T_1 treatment. Manuring did not affect 1000-grain weight significantly (Table 6). The maximum weight of 1000-grain (22.50g) was found under FM treatment. The minimum weight of 1000-grain (22.32g) was found under F treatment. Combined effect of depth of tillage and manuring on thousand grain weight was also non-insignificant (Table 6). They were statistically identical, but there was difference among the treatments. The highest weight of 1000-grain (22.92g) was found in the T_2FM treatment. The lowest weight of 1000-grain (22.20g) was found in the treatment combination of T_2F.

Grain yield

The grain yield of BRRI dhan49 gave significant results due to different tillage and manuring treatments (Table 7).

Table 7. Effect of depth of tillage and manuring on grain and straw yields of Aman rice var. BRRI dhan49

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Tillage treatment		
T_0	3.23b	4.23b
T_1	3.78ab	4.80ab
T_2	4.62a	5.32a
LSD	0.129	0.155
Level of sig	**	**
Manuring treatment		
F	3.44b	4.35b
FM	4.31a	5.21a
LSD	0.050	0.070
Level of sig	**	**
Tillage × manuring treatment		
T_0 F	2.51d	3.38c
T_0FM	3.95bc	5.07ab
T_1 F	3.67c	4.59b
T_1 FM	3.88bc	5.02ab
T_2 F	4.15b	5.10ab
T_2 FM	5.09a	5.54a
LSD	0.150	0.210
Level of sig	**	**

NS = Non significant,
* = Significant at 5% level of probability,
* * = Significant at 1% level of probability

Table 8. Correlation and regression analysis among soil physical properties, yield contributing characters and grain yield of rice

Dependent variable	Independent variable	Regression equation	Correlation coefficient (r)
Grain yield	Bulk density	y = -2.080x + 6.788	-0.767**
Grain yield	Tiller $hill^{-1}$	y = 0.362x + 0.164	0.628**
Bulk density	Soil moisture	y = -0.061x + 3.426	-0.752**
Bulk density	Air-filled porosity	y = -0.206x + 3.604	-0.814**

The highest grain yield of 4.62 t ha^{-1} was found under T_2 treatment and the lowest yield (3.23 t ha^{-1}) was obtained in control (T_o) treatment. This finding was supported by Rezaul and Ahmed (1997) and Ardell *et al.* (2000)**.** Deep tillage increased grain yield by 43.03% more than control. Application of manuring had a significant result for producing grain yield (Table 7). The highest yield of 4.31 t ha^{-1} was recorded while applying the different fertilizers as a recommended dose (FM). The lowest grain yield of 3.44 t ha^{-1} was recorded under F treatment. The interaction effect of depth of tillage and manuring showed significant result for producing rice yield (Table 7). The maximum yield 5.09 t ha^{-1} was observed in the treatment combination of T_2FM and the minimum yield of 2.51 t ha^{-1} was observed in the treatment combination of T_0F. Rice yield depends largely on tillers per hill. Grain yield has a positive relationship with tillers per hill (r = 0.628**) (Fig 4).

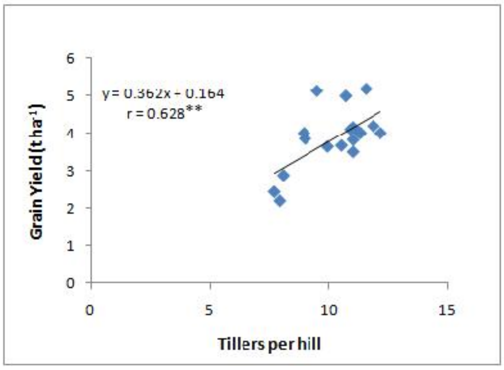

Figure 4. Relationship between grain yield (t ha^{-1}) and tillers $hill^{-1}$

Positive relationship indicates the increase of grain yield was dependent on tillers $hill^{-1}$. Grain yield showed a highly negative significant relationship with bulk density (r = -0.767**) (Fig 1). Negative relationship indicates that grain yield will decrease with the increase of bulk density. Because high bulk density restricted root growth that affected the yield contributing characters of rice. Similar result was also reported by Sharma *et al.* (1988).

Straw yield

Different depth of tillage treatments significantly influenced the straw yield of BRRI dhan49 (Table 7). The highest straw yield (5.32 t ha^{-1}) was recorded in the T_2 treatment. The lowest straw yield (4.23 t ha^{-1}) was obtained under T_o treatment. Like grain yield, all the treatments gave higher straw yield over the control (T_0) treatment. The second highest yield (4.80 t ha^{-1}) was obtained in the T_1 treatment. Under T_2 treatment soil were more loose which permits the penetration of the roots into the deeper layer for uptaking water and mineral nutrients. Deep tillage increased straw yield by 25.76% more than control. Addition of manuring showed significant result on straw yield (Table 7). The greatest value of 5.21 t ha^{-1} was recorded under application of recommended dose of different fertilizers (FM). The lowest straw yield 4.35 t.ha^{-1} was recorded in F treatment. The interaction effect of depth of tillage and manuring showed significant result on straw yield (Table 7). The highest straw yield of 5.54 t ha^{-1} was observed under T_2FM treatment combination and it was statistically identical to T_0FM, T_1FM and T_2F treatment combination. The lowest straw yield of 3.38 t ha^{-1} was obtained in the treatment combination of T_0F

Correlation and regression analysis among soil physical properties and grain yield of rice

Table 8 shows that bulk density of soil had a significant negative correlation with grain yield (r = -0.767**) and also with soil moisture content (r = -0.752**) and air-filled porosity (r = -0.814**). It appears from the correlation study that when bulk density increases then the grain yield decreases. Correlation and regression equation (Table 8) shows that grain yield had a significant positive correlation with number of tillers per hills (r = 0.628**).

Conclusion

For the improvement and sustenance of soil fertility and productivity manuring needs to be practiced along with chemical fertilizers which would reduce the farmer's initial cost of production and also help to sustain the soil ecosystem. No tillage practices should be discouraged for the farmers of Bangladesh. Because it gave downgraded soil physical and chemical conditions as well as poor yield of rice.

The following conclusions might be drawn from the investigation

- The depth of tillage and manuring treatments improve the physical properties of soil i.e. reduce the bulk density and increase the air-filled porosity and moisture content of soil.
- Deep tillage and recommended dose of fertilizers along with manuring gave the highest yield of rice.
- Manuring with chemical fertilizers showed a positive impact on soil physical properties and considerably increased the yield of rice.

REFERENCES

Ardell, D., Halvorson, A. L., Black, J. M., Krupingley, S. D., Merril, B. J., Wienhold, D. L. and Tonaka. 2001. Spring wheat response to tillage system and nitrogen fertilization within a crop tallow system, *Journal of Agronomy*, 92:151

Ball, B. C., Scott, J. P., Parker, M. A. and Arshad. 1999. Field N_20, CO_2 and CH_4 fluxes in relation to tillage compaction and soil quality in Scotland, Soil and Tillage Research 53 (1):29-39

BARC. 2005. (Bangladesh Agricultural Research Council), Fertilizer Recommendation Guide. Soils publication no, 41, Bangladesh Agricultural Research Council, Farmgate, Dhaka

Basunia M. S. H. 2000. Effect of land tilling by country plough and power tiller on some soil properties and yield of transplant Aman rice (C.V. BR 11), MS Thesis, Department of Agronomy, BAU, Mymensingh

BBS. 2010. (Bangladesh Bureau of Statistics), Statistical Yearbook of Bangladesh, Statistics Division, Ministry of Planning Government of the people's republic of Bangladesh, pp. 136-140

BBS. 2012. (Bangladesh Bureau of Statistics), Yearbook of agricultural statistics, Ministry of Planning Government of the people's republic of Bangladesh, pp. 45-99

Bhatnagar V. K., Kundu, S. and Ved-Prokash. 1992. Effect of longterm manuring and fertilization on soil physical properties under a soybean (Glycine max.) wheat (Trnicinn aestivum) cropping sequence

Bouyoucos G. J. 1927. The hydrometer as a method for the mechanical analysis of soils, *Journal of Soil Science*, 23, 343-353

Chan K. Y., Hallugalle, N. R. and Arshad, M. A. 1999. Changes in some in soil properties due to tillage practices in rain fed hard setting alfisols and irrigated vertisols of eastern Australia, *Soil Tillage and Research*, 53(1):49-57

Deksissa T. I., Short, J. and Allen. 2008. Effect of soil amendment with compost on growth and water use efficiency of Amaranth, Proceeding of the UCOWR/NIWR annual conference: International water resources, challenges for the 21st century and water resources education Durham. NC.DOC/C9.pdf.

Ekwue E. I. 1990. Organic matter effects soil strength properties, *Soil and Tillage Research*, 16, 289-297

Gomez K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research 2nd edition IRRI., Los Banos, Languna, The Philippines, pp. 62-74

Khan N. I., Malik, A. U., Umer, F. and Bodla, M. I. 2010. Effect of tillage and farm yard manure on physical properties of soil, *International Research Journal of Plant Science*, 1:75-82

Lal, R. 1997. Soil degreadative effects of slop length and tillage method on alfisols in Western Nigeria, Soil chemical properties, plant nutrient loss and water quality, 8(3):221-244

Matin, M. A. and Hossain, M. A. 2000. Impact of tillage and manure on soil physico-chemical properties, water conservation, root growth and the yield of rice, ISTRO-2000 conference, Book of abstracts, Texas, USA, pp. 34

Matin, M. A. and Uddin, M. S. 1994. Effect of different tillage operations on soil physical properties, root growth and yield of rice, Proceedings of 13th ISTRO (International Soil Tillage Research Organization) conference, Denmark, pp. 1087-1092

Mbagwu J. S. 1989. Effects of organic amendments on some physical properties of a tropical alfisols, Biological wastes, 28 (1), 1-13

Mohammad, A. K., Mansoor, K. K. and Massod, U. R. R. 2004. Effect of different tillage operation on emergence and yield of wheat, Agricultural Mechanizaton in of Asia, Africa and Latin America (AMA), 26(2):62-64

Molla, M. R., Sattar, M. A. and Talukder, M. S. U. 2000. Impact of ploughing on soil moisture conservation in rice field, Bangladesh Journal of Agricultural Science, 27(2):287-291

Oad, F. C., Buriro, U. A. and Agha, S. K., 2004. Effect of organic and inorganic fertilizer application on Maize fodder production, *Asian journal of Plant Science*, 3:375-377

Pradhan S.B. 1992. Status of fertilizers use in developing countries of Asia and the Pacific Region. In: Proc. Regional FADINAP Seminar, Chinag Mai. Thailand, pp 37-47

Prithar, S.S., Guildyal, B. P., Painuli, D. K. and Sur, H. S. 1985. Physical properties of mineral soils affecting rice based cropping system, International Soil Physics and Rice, IRRI, Los, Banos, Laguna, Philippines, pp. 57-68

Rahman, M. S. 1997. Different tillage methods on soil properties, root growth and yield of BRRI Rice-29, MS Thesis Department of Soil Science, BAU, Mymensingh

Rao, An., Johnson, D. E. and Ladha, J. K. 2007. Weed management in direct seeded rice, Advance Agronomy, 14:27-30

Rezaul, S. M. K. and Ahmed, S. 1997. Effect of degree of land preparation and spacing on weed growth and yield of transplant aman rice, *Bangladesh Journal of Agricultural Science*, 24(1):40-42

Rose, E., Barthes, B., Martias, C. and Tiessen, H. 2001. Organic matter management for soil conservation and productivity restoration in Abrica, Managing organic matter in tropical soils; scope and limitations, Proceeding of a workshop organized by the Centre of Development Research, University Bonn, Germany, 61(12):159-170

Saltion, J. C. and Mielniczeuk, J. 1995. Relationship between tillage, temperature and moisture in a dark red podzokic soil of eldoradosul, Revista brasileia de Cienciadoslo, 19(2):313-319

Sarder, N. N. 1990. Establishment technique of mungbean (Vigna radiata L.) and sesame (Sesamum indicum L.) after rainfed wetland rice, Ph.D. Thesis in Agronomy, Graduate School University of the Philippines at Los Banos, p. 125

Sharma, P. K., De Datta, S. K. and Redulla, C. A. 1988. Tillage effects on soil physical properties and wet land rice, *Journal of Agronomy*, 80(1):34-40

Singh, P. K. and Singh, Y. 1996. Effect of reduced tillage on soil properties, root growth and grain yield in rice-wheat system. *Indian Journal of Agricultural Research*, 30(8):179-185

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