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Effect of Tillage Practices and Nitrogen levels on the Physical Properties of Soil

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Abstract: The experiment was conducted to evaluate the impact of tillage and nitrogen on soil physical properties such as bulk density, particle density, soil moisture, porosity, air filled porosity. Soil physical properties were significantly influenced by different tillage practices but in case of nitrogen treatments there were no significant variation. Bulk density was significantly increased with soil depth. The highest bulk density of 1.46 cm^{-3} was recorded under no tillage at 20-30 cm soil depth. Maximum particle density (2.53 g cm^{-3}) was measured by 10 cm deep tillage (T_1) at 10-20 cm soil depth. Soil porosity was statistically influenced by different tillage operations. The maximum soil porosity of 64.68% was observed by 20 cm deep tillage (T_2) at 0-10 cm soil depth. The soil moisture significantly decreased with soil depth. The highest moisture content of 44.43% was recorded under deep tillage (T_2) at 0-10 cm soil depth and lowest 23.53% was found by control (T_0) at 20-30 cm depth. Maximum air filled porosity (15.66%) was recorded in deep tillage (T_2) at 20-30 cm soil depth. High air filled porosity indicated low moisture content in soil.

Key words: Tillage, nitrogen level, physical properties, soil

INTRODUCTION

Tillage is the oldest and most fundamental activity of human being for crop production. Tillage creates improved physical conditions of soil that bring about better water-nutrient and temperature relations. Different tillage operations may influence the physical properties of soil porosity, air-filled porosity, hydraulic conductivity[1]. As a result soil becomes permeable, aerated and having good physical conditions for crop production. Deep tillage decreases soil bulk density. It also removes mechanical impedance of soil which is the hindrance to root penetration and there by accelerate the crop production. Deep tillage breaks the hard layers to help the roots to extend in the deeper layers[2]. Deep tillage loose the soil for easy root penetration horizontally and vertically. It facilitates easy uptake of water as well as nutrients by the roots from different soil layers efficiently which consequently increased the root growth and density. Thus the deep tillage favours for root growth as well as crop yield compared to shallow tillage. No tillage increased soil organic matter, Cation Exchange Capacity (CEC), exchangeable K, soil hardness and bulk density[3]. Nitrogen is one of the essential plant nutrients which can augment the production of rice to a great extent. Nitrogen plays the key role in plant nutrient and its management practices are extremely important aspects for crop production. Out of all nutrients the requirements of N for plant is for more than other elements[4]. With the introduction of HYV of paddy in the country the requirements of nitrogenous fertilizer has tremendously increased. Improper use of fertilizer instead of increasing yield may even reduce the same. Hence a study was carried out to study the effect of tillage practices and nitrogen application on the soil physical properties.

MATERIALS AND METHODS

The experiment was conducted at the Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during aman season, 2002 to study the impact of tillage and nitrogen on the yield and yield contributing characteristics of rice and soil physical properties such as bulk density, particle density, soil moisture, porosity and air-filled porosity. The soil was sandy loam having pH 6.9. The experiment was laid out in a split-plot design with 3 replications. Three tillage treatments arranged to the main plot and four nitrogen

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rates to the sub plots. Three tillage practices in the experiments were: T_0 - no tillage, T_1 and T_2 allowing tillage upto 10 and 20 cm deep, respectively. The four nitrogen levels were: N_0- no nitrogen, N_1, N_2, N_3 application of nitrogen @ 35, 70,105 kg N ha^{-1}, respectively. The unit plot size was 4.0x2.5 m. The experimental aman rice CV. Binashail plots were fertilized @P_2O_5 40 kg ha, K_2O @ 33 kg ha^{-1} with TSP and MP during final land preparation @P_2O_5 45 kg ha^{-1}, K_2O @ 35 kg ha^{-1} with TSP and MP during final land preparation. Urea was top dressed in three installments according to treatment after 10, 25 and 40 days after transplanting. The land was first opened on 1st August 2002 with the help of spade and it was further cultivated on 6 and 13th August, 2002, followed by laddering for breaking the clods and leveling the land. Thirty five-days-old seedlings were transplanted in 20 cm apart rows maintaining 20 cm hill-to-hill distance and 3 seedlings hill.

Measurement of some physical properties of soil

Density bulk: After harvest the bulk density was determined with the help of a core sampler made of metal cylinders of known volume[5]. Bulk density was calculated by

$$D_b = \frac{M_s}{V_t} \text{ g cm}^{-3}$$

Where, D_b=Bulk density (g cm^{-3}),
Ms=Weight of soil (g) and V_t=Total volume of soil (cm^{-3}).
Particle density was determined by volumetric flask method[5]. The Particle density was determined by:

$$D_P = \frac{M_s}{V_s} \text{ g cm}^{-3}$$

Where, D_p=Particle density (g cm^{-3}),
M_s=Weight of soil (g) and V_s=Volume of solid in cm^{-3}.

Soil porosity: The soil porosity was calculated by using

$$\text{Soil porosity (\%)} = (1 - \frac{D_b}{D_P}) \text{ X } 100$$

Where, D_b=Bulk density (g cm^{-3}), D_p=Particle density (g cm^{-3})

Air filled porosity: Air filled porosity was calculated by using:

$$\text{Air filled porosity (\%)} = \frac{\text{Volume of air (cm}^3)}{\text{Total volume of soil (cm}^3)} \text{ x } 100$$

Where, volume of air (cm^3)=Total volume of soil (cm^3)-volume of water (cm^3) - volume of soil (cm^3).

$$\textbf{Volume of water (cm}^3) = \frac{\textbf{Mass of water (g)}}{\textbf{Density of water (g cm}^{-3})}$$

$$\textbf{Volume of soil (cm}^3) = \frac{\textbf{Mass of solid (g)}}{\textbf{Density of solid (g cm}^{-3})}$$

Soil moisture: The soil moisture was calculated by using

$$\text{Soil moisture (\%)} = \frac{W - W_1}{W_1} \text{ X } 100$$

Where:
W = Weight of moisture soil (g), $W_1 = \frac{\text{Volumetric}}{\text{Weight}}$ of oven dry soil.

RESULTS AND DISCUSSION

Bulk density: Bulk density was significantly increased with soli depth (Table 1). The highest bulk density of 1.46 g cm^{-3} was recorded under no tillage (T_0) at 20-30 cm soil depth. The lowest bulk density of 0.80 g cm^{-3} was observed by deep tillage (T_2) at 0-10 cm soil depth. This result was supported by Sharma *et al.*[6], Matin and Uddin[7]. They stated that the values of soil bulk density were decreased upto the depth of 45 to 60 cm due to deep ploughing. The effect of nitrogen on soil bulk density was not significant.

Particle density: The particle density of soil was influenced by different tillage practices (Table 1). Maximum particle density (2.53 g cm^{-3}) was measured by shallow tillage (T_1) treatment at 10-20 cm soil depth. Minimum particle density (2.23 g cm^{-3}) was recorded under deep tillage (T_2) treatment at surface layer (0-10 cm depth). Similar result was found by Chowdhury[8], he reported that highest particle density was found in 10-20 cm soil depth and the lowest at 0-10 cm soil depth under traditional tillage operation. The effect of nitrogen on particle density was statistically not significant.

Porosity: Soil porosity was statistically influenced by different tillage operations (Table 2). The maximum soil porosity of 64.68% was observed by deep tillage (T_2) at 0-10 cm soil depth and minimum 41.35% under no tillage (T_0) at 20-30 cm depth. Deep tillage broke the hard plough pan of soil, thereby soils become loose which increased the soil porosity. Low soil porosity indicates high soil bulk density. High soil porosity provided sufficient

Table 1: Effect of tillage practices and nitrogen rates on the bulk density and particle density of soil

	Bulk density (g cm^{-3}) depth of soil			Particle density (g cm^{-3}) 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	0.90a	1.38a	1.46a	2.23b	2.51a	2.49b
T_1	0.89a	1.29b	1.35b	2.31a	2.53a	2.51a
T_2	0.80b	1.20c	1.35b	2.23b	2.44b	2.42c
$S\bar{x}$	0.02	0.02	0.01	0.01	0.02	0.003
CV (%)	0.82	4.25	0.23	1.40	2.19	0.36
Nitrogen rate						
N_0	0.86	1.27	1.39	2.26	2.49	2.46
N_1	0.86	1.32	1.39	2.26	2.49	2.50
N_2	0.86	1.27	1.39	2.26	2.49	2.43
N_3	0.86	1.30	1.39	2.25	2.49	2.51
$S\bar{x}$	-	-	-	-	-	-
CV (%)	1.71	4.09	1.53	1.46	2.76	2.51

In a column, means having similar letter (s) do not differ significantly at 5% level of probability

Table 2: Effect of tillage practice and nitrogen rates on the porosity, moisture content and filled porosity of soil

	Porosity (%) depth of soil			Moisture (%) depth of soil			Air filled porosity (%) depth of soil		
Treatments	0-10 cm	10-20 cm	20-30 cm	0-10 cm	10-20 cm	20-30 cm	0-10 cm	10-20 cm	20-30 cm
Tillage practice									
T_0	59.57c	45.30c	41.35c	40.36c	29.41c	23.53b	7.28b	12.07a	7.88c
T_1	61.58b	48.85b	46.21a	42.34b	31.45b	25.26a	9.46a	5.35c	13.28b
T_2	64.68a	50.61a	44.59b	44.43a	32.36a	26.46a	9.55a	7.92b	15.66a
$S\bar{x}$	0.09	0.25	0.21	0.41	0.22	0.33	0.07	0.04	0.12
CV (%)	0.49	1.80	1.63	3.34	2.41	4.55	5.22	1.67	3.45
Nitrogen rate									
N_0	62.03	48.67	43.99	42.12	30.85	24.86	8.77	8.45	12.24
N_1	61.89	48.07	44.01	42.25	30.99	25.00	8.76	8.45	12.04
N_2	61.88	48.22	44.08	42.43	31.09	25.16	8.77	8.44	12.47
N_3	61.97	48.05	44.12	42.72	31.34	25.33	8.77	8.44	12.35
$S\bar{x}$	-	-	-	-	-	-	-	-	-
CV (%)	0.44	4.20	2.59	3.08	2.74	2.72	1.71	2.15	9.47

In a column, means having similar letter do not differ significantly at 5% level of probability

acration, permeability and water holding capacity that help to attain good physical conditions of the soil. The results were supported by Sharma and De Datta[9], Lal[10]. They reported that total porosity was high in plough layer than ploughpan layer. The effect of nitrogen or porosity was not significant.

Moisture content: The moisture content of soil was significantly influenced by different tillage practices (Table 2). Soil moisture significantly decreased with soil depth. The highest moisture content of 44.43% was recorded under deep tillage (T_2) at 0-10 cm soil depth and lowest 23.53% was found by control (T_0) at 20-30 cm depth. Surface layer (0-10 cm depth) with deep tillage (T_2) having maximum moisture content than no tillage. Deep tillage loosed the soil thereby absorbed maximum soil moisture compared to hand pan soil. Similar results were described by Sharma *et al.*[6].

Air filled porosity: Maximum air filled porosity (15.66%) was recorded in deep tillage (T_2) at 20-30 cm soil depth and minimum (5.35%) was found under shallow tillage (T_1) treatment at 10-20 cm depth. High air filled porosity indicated low moisture content in soil. Air filled porosity was significantly decreased upto 20 cm soil depth and it was again increased at 30 cm soil depth. This results was supported by Rahman[11].

So it was concluded that bulk-density, particle-density, air filled porosity and moisture content of soil were statistically significant due to different tillage practices but not significant due to different levels of nitrogen application.

It also concluded that soil physical properties were significantly influenced by different tillage practices but in case of nitrogen treatments there were no significant variation.

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