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Impact of Tillage on Root Growth and Yield of Rice in Silt Loam Soil

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Abstract: A field experiment was carried out to study the effect of different tillage practices on root growth and yield of rice in silt loam soil. The soil was calcareous gray belonging to Sonatala series of Old Brahmaputra flood plain soil. The treatments comprised of no tillage-(T_0), T_1 (CP_2), T_2 (CP_3), T_3 (CP_4), T_4 (PT_2), T_5 (PT_3) and T_6 (PT_4). The highest root mass density of 2.66 mg cm^{-3} and the lowest root mass density 0.90 mg cm^{-3} were found under T_6 (PT_4) and T_0 (control) respectively. The maximum root mass density (4.22 mg cm^{-3}) was recorded at 0-10 cm depth of soil. The root density drastically reduced at the deeper depth. Tillers number/hill, plant height, panicle length, number of grains/panicle, grain and straw yield at different tillage practices significantly increased over control. The T_3 (CP_4) gave the highest plant height (95.93 cm) among all treatments. The highest grain yield (5969.25 Kg ha^{-1}) was found under T_6 (PT_4) whereas the lowest yield (1451.03) was obtained in control treatment. The grain yield shows a highly positive significant relationship (r = 0.993) with root mass density.

Key words: Tillage, root growth, yield, rice

Introduction

Man spends much time, however, in improving the structure of soil. Tillage is considered to be the oldest and the most effective farm activity of mankind for the purpose of developing a desired soil structure. Tillage improves the physical conditions of soil and favors the rooting characteristics of plants, which lead to a better yield of rice. Grain yield by tillage systems were in the order of conventional tillage (CT) > minimum tillage (MT) > no tillage (NT) with respective yield of 2227, 2167 and 2101 kg ha^{-1} (Ardell *et al.*, 2000). Crop growth and seed yield all increased with an increasing in the intensity of tillage (Pratibha *et al.*, 1996). Whiteley and Dexter (1982) concluded that no tillage treatment restricted seminal root growth remarkably in relation to uniformly tilled treatment in pea, rape and wheat crops grown on a red brown earth. Deep tillage encouraged root growth and water extraction more from deeper soil layers (Meharban *et al.*, 1998). Vars *et al.* (1998) observed that approximately 35% of the maize root length in the 21-100 cm portion of the soil was found below 60 cm depth in the deepest tillage whereas less than 5% was below 60cm in the control. Tillage practices with power tiller increased the root density by breaking the hardpan layer in the soil. The penetrating ability of the root varies among plant spices and its own root growth characters, which can be remarkably modified by the plants environment.

The objective of this experiment was to determine the effect of different tillage practices on root growth and yield of BRRI Dhan 29.

Materials and Methods

The experiment was conducted at the Bangladesh Agricultural University farm, Mymensingh, during the boro season of 2001 to study the effect of tillage practices on root growth and yield of rice in the silt loam soil. The soil belongs to the Sonatola series under the AEZ of Old Bramaputra flood plain. The soil was silt loam in texture having pH 6.01, organic matter 1.57%. The experiment was conducted using two factors such as tillage and depth in a randomized complete block design (RCBD) comprising of seven treatments. The unit plot size was 6 x 5m^2. The treatment was randomly allocated to the unit plot of a block. The treatments were; To (control), country plough with two passes T_1 (CP_2), country plough with three passes T_2 (CP_3), country plough with four passes T_3 (CP_4), power tiller with two passes T_4 (PT_2), power tiller with three passes T_5 (PT_3) and power tiller with four passes T_6 (PT_4). The recommended high yielding boro variety was BRRI Dhan 29 (rice). Urea triple super phosphate (TSP) and muriate of potash (MP) were applied 124.20, 62.4 and 72 kg ha^{-1} respectively. The whole amount of TSP and MP were applied during land preparation. Urea was applied in three splits.

Root mass density was measured before panicle initiation stage using auger like sampler of 7 cm in diameter and 10 cm in length as recommended by Schurman and Goodewaagen (1971). The root mass density was calculated using the following formula:

Root mass density = (Mass of root)/(Total volume of soil) mg cm^{-3}

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

The height (cm) of the plant was measured from the ground level to the top of panicle. From each plots of 5 hills were measured and averaged. Measurement was taken from basal node of the rachis to apex of each panicle (cm). Each observation was a mean of 5 hills and were randomly selected from each plot and the number of grain/panicle from each hill was counted in number. Then the average number of grain/panicle was counted. One thousand grain samples were counted from each plot and recorded their weight (g) with the help of a electrical balance.

The rice crops were harvested at maturity on 25 May 2001. The harvested crop of each treated plot was bundled separately and brought to the threshing floor for threshing by hand. The grains of each plot were dried in the sun for 4-5 days for reducing the moisture up to 14%. The grains were kept into gunny bags and the weights were recorded in kg with the help of a balance. Similarly the weights of straw were recorded. Finally, the yield of grain and straw were converted into kg ha^{-1}.

Results and Discussion

Effect of tillage on root mass density: Tillage practices significantly influenced the root mass density of BRRI Dhan-29 (rice plant) (Table 1). Maximum root mass density (2.66 mg cm^{-3}) was recorded by T_6(PT_4) and the minimum root mass density (0.90 mg cm^{-3}) was recorded under (no tillage) treatment. T_6 (PT_4) was statistically identical with T_5 (PT_3) treatment. But both of

Table 1: Effect of different tillage practices on root mass density of rice during winter season of 2001

Tillage treatments	Root mass density (mg cm^{-3})
T_0 (control)	0.90
T_1 (CP_2)	1.40
T_2 (CP_3)	1.41
T_3 (CP_4)	2.08
T_4 (PT_2)	2.11
T_5 (PT_3)	2.65
T_6 (PT_4)	2.66
$LSD_{(0.05)}$	0.155
Soil depth (cm)	
0-10	4.22
10-20	0.94
20-30	0.50
$LSD_{(0.05)}$	0.104

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Table 2: Yield and yield contributing components of BRRI Dhan (rice) influenced by different tillage practices during winter season of 2001

Tillage treatments	Tillers/plant (No.)	Plant height (cm)	Panicle length (cm)	Grains/panicle (No.)	1000-grain weight	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_0 (control)	8.63	73.74	23.89	90.47	22.44	1451.03	1488.25
T_1 (CP_2)	11.28	90.80	25.90	135.3	22.45	2888.31	2891.35
T_2 (CP_3)	11.92	93.10	25.90	142.8	22.45	2776.33	2841.12
T_3 (CP_4)	13.11	95.93	26.14	155.8	22.50	4597.19	4620.30
T_4 (PT_2)	13.30	92.81	16.15	168.8	22.47	4807.20	4820.20
T_5 (PT_3)	15.23	93.00	28.89	170.4	22.55	5521.10	5561.16
T_6 (PT_4)	15.50	92.60	29.90	178.9	22.54	5969.25	5981.20
LSD $_{(0.05)}$	0.9613	3.786	2.601	9.99	1.082	1.082	201.70

Table 3: Regression among root mass density and grain yield

Dependent variable	Independent variable	Regression equation	r-value
Grain yield	Tillers per plant	GY = 679.38TP-4640.7	0.9733
"	Grains per panicle	GY = 51.484GP- 3680.4	0.9348
"	Root mass density	GY = 2446.6RD-615.32	0.993

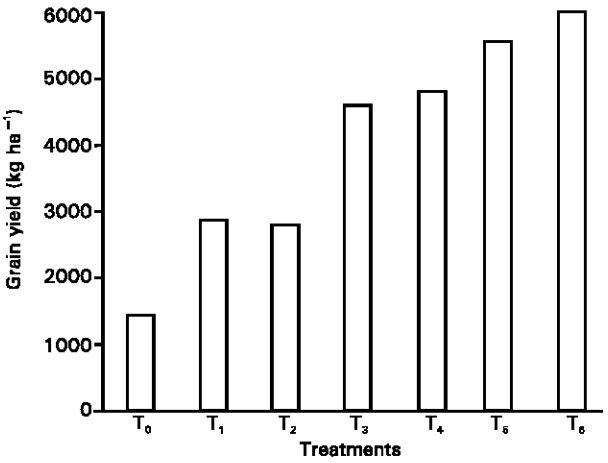

Fig. 1: Grain yield (kg ha^{-1}) of rice under different tillage treatments

them significantly differed from the rest of the treatments. Matin (1996) observed that root mass density of maize increased in general in power tiller treatment which helped in increasing yield of maize. Khan *et al.* (1997) found that below 30 cm depth considerable root growth was noticed in deep tilled plots and lower root weight density was found in minimum tilled plots. The rice root penetrated into the deeper layer under T_6 (PT_4) and absorbed more nutrients from different soil depths which influenced growth and developments. As a result roots became thicker and increased root mass density. On the other hand roots under no tillage (control) could not grow sufficiently and root mass density remained low in relation to other treatments.

In terms of depths, root mass density was significantly influenced in three soil depths under different tillage treatments (Table 1). The root mass density (4.22 mg cm^{-3}) was found maximum in the top soil (0-10 cm soil depth) and the lowest (0.50 mg cm^{-3}) was measured at 20-30 cm soil depth. The root mass density drastically reduced downward and significantly decreased from the top layer (Table 1). Dense or compact layer in the soil profile obstructs root proliferation or extensibility.

Effect of tillage on yield and yield contributing characters

Number of tillers: Different tillage practices influenced significantly number of tillers per plant of BRRI Dhan 29 (Table 2). The tillers per plant ranged from 8.63 to 15.50. All the treatments gave higher number of tillers compared with control. The highest number of tillers per plant was recorded in T_6 (PT_4). The lowest number of tillers per plant was found under control. T_5 (PT_3) did not statistically differ from T_6 (PT_4). Tillers per plant and grain yield were positively correlated (Table 3) and was statistically significant. The positive relationship indicates that the increase of grain yield is associated with the increase of tillers per plant.

Plant height: The plant height of BRRI Dhan 29 was significantly changed by the impact of different tillage treatments (Table 2). The plant height ranged from 73.74 to 95.93 cm. The maximum height was obtained by the T_3(CP_4) which was significantly different from T_0 (no tillage) and T_1 (CP_2). The lowest plant height was in control. All the treatments gave significantly higher plant heights over control. Olofintoye (1989) mentioned that plant height and tillering at early crop stage were lower under reduced tillage in relation to minimum or conventional tillage. Basunia (2000) found that maximum plant height was found by country plough with 4 passes.

Panicle length: Different tillage treatments significantly influenced panicle length (Table 2). The T_6 (PT_4) produced the highest panicle length (29.90 cm) which was identical to T_5 (PT_3). The lowest panicle length (23.89 cm) recorded in control treatment, which was statistically identical to T_1 (CP_2) and T_2 (CP_3). T_3 (CP_4) and T_4 (PT_2) are statistically identical.

Number of grains per panicle: Different tillage treatments influenced significantly the number of grains per panicle (Table 2). The number of grains per panicle ranged from 90.47 to 178.9 (Table 2). The highest number was obtained in T_6 (PT_4) which was identical to T_5 (PT_3) but was different from the rest of treatments. All the treatments gave higher number of grains per panicle over no tillage treatment. A grain per panicle was positively correlated with grain yield and the relationship was significant (Table 3).

1000-grain weight: The analysis of variance indicates that the tillage treatments showed insignificant result on 1000-grains weight. The 1000-grain weight of BRRI Dhan 29 did not significantly change due to different tillage treatments. Although they were statistically identical, there was difference among the treatments (Table 2). The highest 1000-grain weight 22.55g was found in T_5 (PT_3). The lowest 1000-grain weight (22.44 g) was found under T_0 (control).

Grain yield: Different tillage treatments significantly influenced the rice yield of BRRI Dhan 29 (Table 2). The highest grain yield of (5969.25 kg ha^{-1}) was found under T_6 (PT_4). The lowest yield was obtained in control treatment. The highest grain yield was identical to T_5 (PT_3) but significantly differed from all other treatments. T_1 (CP_2) and T_2 (CP_3) gave statistically similar grain yield per hectare but significantly different from the rest of the treatments. Matin and Uddin (1994) reported that significant better grain and straw yield of rice in power tiller treatments over country plough treatment. The highest grain yield was produced when the land was prepared with two ploughing followed by two laddering and the lowest yield was obtained in the plots with no land preparation (Rezaul and Ahmed, 1997). Rice yield depends largely on

tillers/plant, grain/panicle and root density. Grain yield has a positive relationship with tillers/plant, grains/panicle and root mass density and the relationship was positive (Table 3).
A bar graph for the yield under different treatments is showing the increase of yield with the increase of tillage intensity (Fig.1).

Straw yield: Different tillage treatments significantly influenced the straw yield of BRRI Dhan 29 (Table 2). The straw yield ranged from 1488.25 to 5981.20 kg ha^{-1}. The highest straw yield was recorded in the T_6 (PT_4) and the lowest was obtained under T_0 (control). Like grain yields all the treatments gave higher straw yield over the control treatment. The T_6 (PT_4) was statistically significant over all other treatments. The second highest straw yield 5561.16 kg ha^{-1} was found in the T_5 (PT_3) which was dissimilar to other treatments. Under T_6 (PT_4), soil were more loose compared to other tillage treatments which permits the entrance of the roots into the deeper layer for up taking water and mineral nutrients. Positive physiological and metabolic activities of rice were perhaps influenced by tillage practices, hence grain and straw yields of rice were increased.

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