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Full Length Research Paper

Effect of tillage depths and IPNS on soil physical properties and yield of hybrid maize

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A field experiment was conducted at Central Research Field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh during rabi season of 2008-2009, 2009-2010 and 2010-2011 to study the effect of tillage and Integrated Plant Nutrient System (IPNS) on soil physical properties and yield of hybrid maize. Eighteen treatment combinations comprising 3 tillage practices which are T_0: minimum tillage, T_1: tillage up to 10-12 cm and T_2: tillage up to 20-25 cm depth and 6 levels of fertilizer i.e. F_1: control, F_2: 5 ton cowdung + (*R-M=Recommended dose minus nutrient content in organic manure at 40% mineralization.) (R-M) ha^{-1}, F_3: 10 ton cowdung + *(R-M) ha^{-1}, F_4: 2.5 ton poultry manure + *(R-M) ha^{-1}, F_5: 5 ton poultry manure + *(R-M) ha^{-1} and F_6: recommended dose (RD): N_{255}, P_{55}, K_{100}, S_{40} and B_1 kg ha^{-1} was tested in a split- plot design with three replications. Bulk density, particle density, porosity and field capacity were slightly affected by tillage and IPNS which were non-significant. Yield and yield contributing characters of hybrid maize were significantly influenced by both the treatments singly. The F_3 {10 ton cowdung + *(R-M) ha^{-1}} treatment gave the highest grain yield 9.72 ton ha^{-1} followed by F_5 {5 ton poultry manure + *(R-M) ha^{-1}} treatment (9.40 ton ha^{-1}). Interaction effect of tillage and fertilizer on yield and yield contributing characters was non-significant.

Keywords: Poultry manure, Organic matter, Physical parameters and Yield.

INTRODUCTION

Maize is one of the promising cereal crops and ranks 3rd both in acreage and production in Bangladesh. Maize grains have high nutritive values and used as food, fodder, feed and fuel. Its demand is increasing day by day. Maize is being cultivated all over the country but the yield of maize is low in Bangladesh as compared to other maize growing countries. There are several constrains behind it, such as lack of proper tillage practice and imbalance fertilizer use. These factors play an important role on production of hybrid maize. Tillage management can have a profound impact on soil properties. Tillage influences on aeration, root penetration and microbial activities. On the other hand, organic matter is the major component for physical, chemical and biological productivity of the soils. Organic matter helps sandy soils to hold water and plant nutrients. It makes clay soil easier to work by helping water enter and move more rapidly,

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Table 1a. Physical characteristics of initial soils (initial) at Joydebpur.

Soil depth (cm)	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	Field capacity (%)	Textural class
0-25	1.42	2.65	46.41	28.52	Clay loam

Table 1b. Chemical characteristics of initial soils (initial) at Joydebpur.

Station	pH	OM %	Ca	Mg	K	Total N	P (Olsen)	S	B	Zn
			meq 100 g^{-1}			%		%		
Joydebpur	5.9	1.30	3.5	2.5	0.17	0.066	12	14	0.2	2.1
Critical level			2.0	0.8	0.2	-	14	14	0.2	2

Table 2. Nutrient status of cowdung and poultry manure used in the experiment.

Organic manure	N	P	K	Ca	Mg	S	Mn	Zn
	%					µg g^{-1}		
Cowdung	1.0	0.6	1.20	4.4	1.6	1.4	0.42	1.2
Poultry manure	1.2	1.2	1.3	10	2.7	1.6	0.92	1.5

providing better aeration for plant roots (Robin, 1949). Poultry manure, properly handled, is the most valuable of all manures produced by livestock. Maintenance of soil fertility to obtain constantly good return and adopting intensive cultivation is our imperative. The organic matter content as well as the fertility status of Bangladesh soil is low. Now it is well agreed that depleted soil fertility is a major constrain for higher crop production in Bangladesh and indeed, yield of several crops are declining in some soils (Bhuiyan, 1991). Maintenance of soil fertility is a prerequisite for long term sustainable agriculture and it is certain that organic manure (cowdung and poultry manure) can play a vital role in the stable of soil fertility and crop production. Balanced fertilization is a prerequisite for exploiting optimum yield potentials of high yielding crops. Information on the use of organic manure like cowdung and poultry manure for maize cultivation alone or in combination with inorganic fertilizer under this agro-climatic condition is not adequate. So, for proper growth and development of hybrid maize, appropriate tillage and organic-inorganic fertilizer use is needed. Despite evidences of benefit of tillage and organic-inorganic fertilizer, sporadic works have done in Bangladesh. Therefore, the present study was under taken to study the effect of tillage and organic inorganic fertilizer on soil physical properties and yield of hybrid maize.

MATERIALS AND METHODS

A field experiment was conducted at Central Research Field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh during rabi season of 2008-2009, 2009-2010 and 2009-2011 to study the effect of tillage and IPNS (Integrated Plant Nutrient System) on soil physical properties and yield of hybrid maize. Eighteen treatment combinations comprising 3 tillage practices i.e. T_o : minimum tillage, T_1 : tillage up to 10-12 cm and T_2 : tillage up to 20-25 cm depth and 6 levels of fertilizer, F_1: control, F_2 : 5 ton cowdung +*(R-M) ha^{-1}, F_3 : 10 ton cowdung +*(R-M) ha^{-1}, F_4 : 2.5 ton poultry manure +*(R-M) ha^{-1}, F_5 : 5 ton poultry manure +*(R-M) ha^{-1} and F_6 : recommended dose (RD): $N_{250,}$ $P_{80,}$ S_{40} and B_1 kg ha^{-1} were assigned in a split-plot design with three replications. Tillage was assigned in the main plot and fertilizer in the sub-plot. The unit plot size was 4.5m × 3m and maize planting with spacing 75cm × 25cm. One third nitrogen and other fertilizers were applied at the time of final land preparation and remaining nitrogen was applied in two equal splits at 30 and 55 days after sowing. The experiment was sown with variety BARI Hybrid Maize 5 on 20 December, 2010 and harvested on 18 May 2011. Data on physical and chemical properties of soils were collected from 0-25 cm depth and are presented in Table 1a and Table 1b.

All intercultural operations such as weeding, irrigation etc. were done as and when necessary. Data on yield and yield contributing characters were taken and statistically analyzed through analysis of variance and mean separation was done following LSD Test (Steel and Torri, 1960).

RESULTS AND DISCUSSION

Physical properties

Bulk density, particle density and field capacity were not significantly affected by tillage practices. Bulk density and

Table 3. Effect of tillage on physical properties of post harvest soil during 2010-2011.

Treatment	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	Field capacity (%)
T_0	1.440	2.667	46.01	28.20
T_1	1.405	2.639	46.76	28.66
T_2	1.392	2.626	47.00	29.55
CV (%)	5.32	4.45	NA*	7.46
LSD (0.05)	NS	NS	NA*	NS

NA* = not analyzed

Table 4a. Effect of IPNS on physical properties of post harvest soil during 2010-2011.

Treatment	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	Field capacity (%)
F_1	1.450	2.699	46.28	27.50
F_2	1.405	2.631	46.60	29.15
F_3	1.392	2.631	47.10	29.70
F_4	1.405	2.626	46.50	29.16
F_5	1.395	2.617	46.70	29.20
F_6	1.425	2.658	46.38	28.10
CV (%)	5.32	4.45	NA*	7.46
$LSD_{(0.05)}$	NS	NS	NA*	NS

NA* = not analyzed

Table 4b. Chemical characteristics of post harvest soil.

Treatments	pH	OM	Ca	Mg	K	Total	P (Bray)	S	B	Zn
		%	meq 100 g^{-1}			N %		µg g^{-1}		
F_1	5.9	1.20	3.38	1.13	0.100	0.060	2.1	10	0.30	0.74
F_2	5.8	1.49	3.68	1.23	0.150	0.078	9.8	16	0.40	0.94
F_3	5.6	2.00	4.75	1.58	0.171	0.106	12.8	22	0.43	1.13
F_4	5.8	1.35	4.00	1.33	0.148	0.071	13.8	15	0.42	1.30
F_5	5.7	1.95	5.13	1.71	0.153	0.103	18.4	20	0.44	1.83
F_6	6.0	1.11	4.03	1.20	0.113	0.059	7.4	13	0.40	0.72
Critical level	-	-	2.0	0.50	0.12	-	5	14	0.2	0.6
Initial	5.9	1.30	3.5	2.5	0.17	0.066	12	14	0.2	2.1

particle density were the highest in minimum tillage and the lowest in deep tillage treatment (Table 3a). On the other hand, porosity and field capacity were the highest in deep tillage and the lowest in minimum tillage. Meharban and Chaudhury (1998) observed that deep tillage decreases soil bulk density and penetration resistance up to the tilled depth 40 cm and encourages root growth more in the deeper soil layer and increase water holding capacity.

Bulk density, particle density, porosity and field capacity were slightly affected by application of fertilizers which were insignificant are presented in Table 4a. The highest bulk density and particle density were observed in the control plot (F_1). Bulk density and particle density were slightly decreased with the application of cow dung and poultry manure. But soil porosity and field capacity slightly increased due to integration of organic and inorganic fertilizers treated plot than control treated plot. Perhaps that was might be due to improvement of soil health. Bulk density is generally lower in clay soil probably as a result of higher organic matter content and soil dwelling organisms.

The chemical properties of soil were influenced by different combinations of soil nutrients (organic and chemical). Soil pH varied very slightly with the treatments and it decreased with organic manures application and combined application but increased with only chemical fertilizer application and unchanged in control treatment (Table 4b). The result is supported by Yadav *et al.* (2002). The initial organic matter in soil was 1.30%. Soil

Table 5. Effect of tillage on yield and yield contributing characters of maize during 2010-2011.

Treatment	Plant height (cm)	Cob length (cm)	Grains/ cob (no.)	100-grain wt. (g)	Grain yield (t ha^{-1}) 2010-2011	Grain yield (t ha^{-1}) 2009-2010	Grain yield (t ha^{-1}) 2008-2009
T_o	110.96 c	13.60 b	360.89 c	23.62 c	6.50 c	6.62 b	7.85
T_1	134.64 b	15.75 a	403.59 b	25.17 b	8.16 b	7.75 b	8.22
T_2	154.52 a	16.34 a	465.10 a	25.68 a	8.96 a	8.98 a	8.57
CV (%)	5.62	6.50	6.83	2.74	5.08	14.99	8.06
LSD $_{(0.05)}$	-	-	-	-	-	-	NS

Table 6. Effect of IPNS on yield and yield contributing characters of maize during 2010-2011.

Treatment	Plant height (cm)	Cob length (cm)	Grains/ cob (no.)	100 grain wt. (g)	Grain yield (t ha^{-1}) 2010-2011	Grain yield (t ha^{-1}) 2009-2010	Grain yield (t ha^{-1}) 2008-2009
F_1	86.21 d	9.98 c	260.23 d	21.95 c	3.00 e	3.07 c	3.55 c
F_2	142.36 b	16.08 ab	435.25 b	25.26 ab	8.75 b	8.46 b	9.00 b
F_3	154.55 a	16.87 a	465.37 a	25.94 a	9.72 a	9.75 a	9.83 a
F_4	132.45 c	15.76 b	445.36 a	25.23 ab	8.39 c	8.28 b	8.85 b
F_5	153.12 a	16.25 ab	456.18 ab	25.59 ab	9.40 a	9.26 a	9.29 ab
F_6	131.55 c	15.12 b	396.78 c	25.00 b	7.98 d	7.91 bc	8.76 b
CV (%)	5.62	6.50	6.83	2.74	5.08	14.99	8.06
LSD $_{(0.05)}$	-	-	-	-	-	-	0.57

organic matter was decreased in only chemical fertilizer application and control treatment but increased with all types of organic manures application and that was recorded the highest with combined application of cow dung @ 10 ton ha^{-1} with chemical fertilizers (Table 4b). Maximum organic matter (2.00%) was found in F_3 where 10 ton ha^{-1} cow dung applied followed by F_5, F_2 and F_4 treatment and minimum organic matter was obtained in control treatment. The result is supported by Wells *et al*. (2000). Initially the available N was 0.066% in soil. The result revealed that after Maize harvest, the total N increased in organic manures treated soils. However, this increase was more in F_3 where 10 ton ha^{-1} cow dung applied followed by F_5, F_2 and F_4 treatment and lowest was found in control treatment. All other nutrients showed more or less similar trends.

Effect of tillage on the yield and yield contributing characters of hybrid maize

Effect of tillage on yield and yield contributing characters is presented in Table 5. The yield and yield attributes of maize significantly influenced by the tillage practices. The highest grain yield (8.96 ton ha^{-1}) was observed in T_3 treatment which was statistically different from other tillage treatments and the lowest (6.50 ton ha^{-1}) was recorded in T_0 during 2010-2011. Similar trend was observed in case of plant height, number of grains/cob and 100 grain weights. Previous 2009-2010 year, similar trends were observed but in the 2008-2009 year, tillage had no significant effect on yield and yield contributing characters of maize.

Effect of IPNS

The effect of IPNS on the yield and yield contributing characters of hybrid maize are presented in Table 6. Different fertilizer levels had significant variations in all the studied characters. The highest plant height was found in F_3 treatment which was statistically similar with F_5 treatment and different from other treatments. The highest cob length was observed in F_3 treatment which was statistically identical with F_5 and F_2 treatments and different from other treatments. In case of number of grains/ cob, highest value was recorded from F_3 treatment which was statistically identical with F_4 and F_5 treatment and lowest from control treatment. The 100 grain weight was significantly influenced by different fertilizer treatments and significant higher result was found in F_3 treatment where 10 ton cowdung +*(R-M) ha^{-1} used. The highest grain yield (9.72 ton ha^{-1}) was recorded in F_3 which was statistically similar with F_5 treatment and the lowest grain yield (3.00 t ha^{-1}) was obtained from where no fertilizer used. This result was supported by Madhavi *et al*.(1995). Similar trends were also observed in previous two years.

CONCLUSION

From three year's result of the study, it can be concluded that there was no significant difference among the tillage practices on soil physical properties but maize yield and yield attributes were significantly influenced by tillage practices. The F_3 treatment (10 ton cowdung + *(R-M) ha^{-1}) performed better in respect of soil physical parameters and yield of maize which was statistically identical with F_5 (5 ton poultry manure + *(R-M) ha^{-1}) treatment. Therefore, poultry manure may be used when cow dung is unavailable @ 5 ton ha^{-1} for maize cultivation.

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