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EFFECT OF TILLAGE AND INTEGRATED NUTRIENT MANAGEMENT ON SOIL PHYSICAL PROPERTIES AND YIELD UNDER TOMATO-MUNGBEAN-T. AMAN CROPPING PATTERN

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ABSTRACT

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A field experiment was conducted for three consecutive years to observe the effect of tillage and integrated nutrient management on soil physical properties and yield under tomato-mungbean- T. aman cropping pattern during 2007-08, 2008-09 and 2009-10 at BARI, Gazipur. There were nine treatment combinations comprising three tillage practices i.e. T_1: tillage up to 8 cm depth, T_2: tillage up to 12 cm depth and T_3: tillage up to 20 cm depth and three levels of fertilizers i.e. F_1: recommended dose of chemical fertilizers only, F_2: cowdung @ 5 t ha^{-1} + (Recommended dose of chemical fertilizers-nutrients from cow dung) and F_3: native fertility (no fertilizer used) were tested in a split-plot design with three replications. Soil bulk density, particle density, porosity and field capacity were not significantly affected by tillage and organic and inorganic fertilizers but soil moisture significantly influenced by both treatments. The crop yields were significantly influenced by different treatment combinations of organic and inorganic fertilization but not by tillage practices. The combined effect of tillage and organic and inorganic fertilizers was non-significant in all aspects.

Key words: *tillage, integrated nutrient management, soil physical properties, yield*

INTRODUCTION

In Bangladesh, organic matter status is very low i.e. less than 1% or 1% in maximum soils. It may be reached in severe condition day by day, due to global warming. As because, microbial activity increases with the increasing of soil temperature as well as increase the decomposition rate of organic mater which declining organic matter in soil. Tillage is a practice, which changes the physical properties of soil and enables the plants to attain their full potential. Tillage techniques are used in order to provide a good seedbed, root development, weed control, and manage crop residues, leveling the surface for uniform irrigation and incorporation of fertilizers (Cabeda 1984). It improves water infiltration, decreases bulk density, penetration resistance and increases water holding capacity as compared to no-tillage treatments on sandy loam and loam soil (Joseph *et al.* 2003). Organic matter is the key factor for soil physical, chemical and biological properties. It helps water holding capacity, better aeration, CEC, nutrient absorption, adsorption, microbial activity etc. Undoubtedly, organic matter is good for the sound environment and can not compete solely with fertilizer in the competition of yield. So, it is now essential to increase organic matter content through combined application of organic manures and inorganic fertilizers that improves physical and chemical conditions of soil and soil productivity but the use of inorganic fertilizer alone for a long period deteriorates the physical properties, organic matter status and reduces crop yield. Therefore, considering the above facts, this study was undertaken to observe the changes in soil physical properties and crop yields as influenced by tillage and integrated nutrient management under Tomato-Mungbean-T. aman cropping pattern.

MATERIALS AND METHODS

A field experiment was conducted at Central Research Farm, BARI, Gazipur during 2007-2008, 2008-09 and 2009-10 to study the effect of tillage and integrated nutrient management on soil physical properties and yield under tomato-mungbean-T. aman cropping pattern. There were nine treatments combinations comprising 3 tillage practices i.e. T_1: tillage up to 8 cm depth, maintained by depth control lever of power tiller, T_2: tillage up to 12 cm depth, maintained by power tiller and T_3: deep tillage up to 20 cm depth, maintained by chisel and 3 levels of fertilizers i.e. F_1: recommended dose of chemical fertilizers only, F_2: cow dung @ 5 t ha^{-1} + (Recommended dose of chemical fertilizers- nutrients from cow dung) and F_3: native fertility (control) were assigned in a split-plot design with 3 replications. Tillage was assigned in the main plot and fertilizers in the sub-plot. The unit plot size was 4m x 3m, variety used in the cropping system are tomato (BARI Tomato 9), mungbean (BARI Mung 6) and T. aman (BRRI Dhan 39) with corresponding spacing 60cm x 40cm, 30cm x 10cm and 25cm x 15cm, respectively. The chemical fertilizer N_{230} P_{80} K_{100} S_{20} Zn_4 B_2 kg ha^{-1} for 1st crop, tomato (Recommended dose); only N_{21} for 2nd crop, mungbean and for 3rd crop, T. aman rice N_{70} P_{20} K_{40} S_{15} kg ha^{-1} were applied as reduced amount due to residual effect.

Tomato was transplanted on 22, 26 and 28 November 2007, 2008 and 2009, mungbean was sown on 3, 6 and 10 April, 2008, 2009 and 2010 and T. aman was transplanted on 7, 10 and 13 July, 2008, 2009 and 2010, respectively. Tomato harvesting started from first week to last week of March, mungbean from first week to second week of June and T. aman on second week of November in each year. After the harvest, the total biomass of mungbean was incorporated into soil except control plot. Soil samples were collected from 0-25 cm depth and analyzed in the laboratory following standard methods. The initial results of some important soil physical, chemical properties and nutrients status of cow dung used in experimental plots have been shown in Table 1.

Table 1. Physical and chemical properties of the experimental site

a. Initial soil physical properties

Soil depth	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	Soil moisture content (%)	Field capacity (%)	Textural class
0-25 cm	1.40	2.49	43.78	22.71	27.89	Clay loam

b. Chemical properties at initial and post harvest period

Soil (0-25cm)	pH	OM (%)	Total N (%)	P	S	B	Zn	Cu	Fe	Mn	K	Ca	Mg
				µg g^{-1}							meq 100 g^{-1}		
Initial	5.6	1.40	0.070	35	13	0.35	4.88	7.34	590	17.63	0.27	7.01	1.8
Post harvest	5.7	1.98	0.105	73	24	0.40	3.8	3.1	302	6	0.16	6.9	2.5
Critical level		-	-	14	14	0.20	2.0	1.0	10.0	5.0	0.20	2.0	0.8

c. Nutrient status of cow dung used at experimental plots

N (%)	P (%)	K (%)	S (%)	B (%)	Zn (%)
1.0	0.60	0.56	0.20	0.013	0.10

N.B. Cowdung at 40% mineralization

Intercultural operations were done as and when necessary. Data were recorded from ten randomly selected plants from each plot. Total yield per hectare calculated from the yield recorded in each plot. The collected data were analyzed statistically through ANOVA and mean separation following by DMRT (Steel and Torri, 1960).

RESULTS AND DISCUSSION

Effect of tillage on soil physical properties

Data on bulk density, particle density, porosity and field capacity were not significantly affected by tillage practices (Table 2a). Present results are consistent with Blevins *et al.* (1983) and Katsvairo *et al.* (2002) who showed that no differences in soil bulk density among different among tillage treatments.

Table 2a. Effect of tillage practices on physical properties of post harvest soil

Treatment	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	Field capacity (%)	Soil moisture content (%)	Textural class
T_1	1.39	2.48	43.95	28.34	20.42 c	Clay loam
T_2	1.37	2.47	44.53	28.96	21.41 b	Clay loam
T_3	1.36	2.46	44.72	29.18	22.09 a	Clay loam
Lev. of sig.	NS	NS	-	NS	**	-
CV (%)	3.74	3.04	-	2.05	5.91	-

Means followed by common letter are not significantly different at 5% level by DMRT

Soil moisture content was significantly influenced by tillage treatments. Higher soil moisture contents were observed in case of deep tillage (22.09%) and minimum in T_1 treatment (Table 2a). These results are similar to Bonari *et al.* (1994) and Bhatt *et al.* (2004) who stated that soil moisture contents are substantially higher with cheisel plowing than shallow tillage. Meherban and Chaudhury (1998) observed that deep tillage decreased soil bulk density and penetration resistance up to the tilled depth 40 cm and encourage root growth more in the deeper soil layer and increase water holding capacity.

Effect of organic and inorganic fertilizers on soil physical properties

The bulk density, particle density, porosity and field capacity were not significantly affected by organic and inorganic fertilizers. Soil moisture content was significantly influenced by fertilizer treatments. Highest soil moisture content (22.83%) was observed in case of F_2 treatment i.e. integration of organic and inorganic fertilizers and lowest soil moisture content (20.23%) was observed in case of control treatment (Table 2b).

Table 2b. Effect of organic and inorganic fertilizers on physical properties of post harvest soil

Treatment	Bulk density ($g\ cm^{-3}$)	Particle density ($g\ cm^{-3}$)	Porosity (%)	Field capacity (%)	Soil moisture content (%)	Textural class
F_1	1.40	2.49	43.78	28.34	20.86 b	Clay loam
F_2	1.35	2.45	44.90	29.39	22.83 a	Clay loam
F_3	1.41	2.50	43.60	28.14	20.23 b	Clay loam
Lev. of sig.	NS	NS	-	NS	**	-
CV (%)	3.74	3.04	-	2.05	5.91	-

Means followed by common letter are not significantly different at 5% level by DMRT

Interaction effect of tillage and fertilizers on physical properties of post harvest soil

The interaction effect of tillage and organic inorganic fertilizers on bulk density, particle density, soil moisture content and field capacity was non-significant.

Effect of tillage and fertilizers on chemical properties of soil

There was no remarkable change in chemical properties of post harvest soil due to tillage and fertilizer treatments (Table 2c).

Table 2c. Chemical properties of post harvest

Soil depth	pH	OM (%)	Total N (%)	P	S	B	Zn	Cu	Fe	Mn	K	Ca	Mg
				$\mu g\ g^{-1}$							$meq\ 100\ g^{-1}$		
0-25cm	5.7	1.98	0.105	73	24	0.40	2.84	3.1	302	6.24	0.16	6.94	2.53
Critical level		-	-	14	14	0.20	2.0	1.0	10.0	5.0	0.20	2.0	0.8

Tillage on the crop yields under tomato-mungbean–T. aman cropping pattern

There was no statistically significant difference among the tillage treatments on crop yields of tomato, mungbean and T. aman (Table 3a). This result is similar to Adhikari *et al.* (2006) who reported that tillage did not have any significant influence on grain and yield attributes of rice. However, higher crop yields were recorded from deep tillage treatments. This was due to deeper tillage (T_3) depth and favorable soil physical condition for which root was able to proliferate in the deeper soil layer for storing soil water by this tillage method. These findings are in agreement with the findings of Rahman and Islam (1988), Barzegar *et al.* (2004).

Table 3a. Effect of tillage on the crop yields under tomato-mungbean–T. aman cropping pattern

Treatment	Fruit yield of tomato ($t\ ha^{-1}$)			Seed yield of mungbean ($kg\ ha^{-1}$)			Grain yield of T. aman ($t\ ha^{-1}$)		
	2007-08	2008-09	2009-10	2008	2009	2010	2008	2009	2010
T_1	43.02	50.14	42.36	729	755	744	3.84	3.81	3.75
T_2	47.28	52.27	48.23	772	780	768	3.88	4.10	4.13
T_3	48.76	55.78	53.64	816	801	813	4.05	4.15	4.21
Lev. of sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	15.11	12.35	9.33	10.03	9.05	7.54	5.11	7.64	9.65

Means followed by common letter are not significantly different at 5% level by DMRT

Organic and inorganic fertilizers on the tomato, mungbean and T. aman

The yield of Tomato was significantly influenced by the organic and inorganic fertilizer treatments (Table 3b). The highest fruit yield (62.00 $t\ ha^{-1}$) were obtained from the integration of organic and inorganic fertilizers treated plot and the lowest fruit yield (32.67 $t\ ha^{-1}$) from the control plot in 2009-2010 year. In the year of 2007-08, F_1 gave the highest result , this is might be due to first crop tomato got the readily available nutrients from F_1 treatment (chemical fertilizers only) but 2008-09 result showed as similar trend as 2009-10 year. Anwar *et al.* (2001) found that cow dung along with fertilizers produced an optimum fruit of tomato in the grey terrace soil of Bangladesh. This finding is supported by Rahman *et al.* (1998) who reported that cow dung in combination with chemical fertilizers plays an important role with respect to tomato fruit yield.

Seed yield of mungbean increased significantly due to application of organic and inorganic fertilizers (Table 3b). The highest average grain (865 $kg\ ha^{-1}$) was recorded in cow dung @ 5 $t\ ha^{-1}$ + (recommended dose of chemical fertilizers–nutrients from cow dung) treatment and lowest in control treatment where no fertilizer was applied in 2010 year. Although mungbean was not attractive for pod yield, yet growing this crop before T. aman may provide substantial amount of biomass to soil. This is an agreement with the findings of Haque *et al.* (2001), Panaullah *et al*. (1998) and Rokeya (1999). Siag and Prakash (2006) also reported that application of organic and inorganic fertilizer increased the mungbean seed yield significantly over no use of fertilizer. All the years showed similar trends.

Table 3b. Effect of organic and inorganic fertilizers on the yield of tomato, mungbean and T. aman

Treatment	Fruit yield of tomato (t ha^{-1})			Seed yield of mungbean (kg ha^{-1})			Grain yield of T. aman (t ha^{-1})		
	2007-08	2008-09	2009-10	2008	2009	2010	2008	2009	2010
F_1	57.98 a	58.32a	49.56b	832 b	835 a	828 b	4.21 a	4.25 a	4.31 a
F_2	49.22 a	62.17a	62.00a	882 a	858 a	865 a	4.27 a	4.31 a	4.40 a
F_3	31.86 b	37.70 b	32.67c	603 c	663 b	635 c	3.29 b	3.50 b	3.02 b
Lev. of sig.	**	**	**	**	*	*	**	*	*
CV (%)	15.11	12.35	9.33	10.03	9.05	7.54	5.11	7.64	9.65

Means followed by common letter are not significantly different at 5% level by DMRT

Organic and inorganic fertilizers significantly increased the rice grain yield. The highest 4.40 t ha^{-1} grain was recorded from cow dung @ 5 t ha^{-1} + (recommended dose of chemical fertilizers–nutrients from cow dung) treatment and as expected the lowest grain 3.02 t ha^{-1} was obtained from the control plot in 2010 year (Table 3b). Like recent year, the grain yield followed the same trends in previous two years. The residual effect of cow dung and mungbean stover as brown manure along with inorganic fertilizer was distinct. Spectacular response of residual effect of cow dung and mungbean stores as brown manure along with inorganic fertilizer to the following rice have been reported by Panaullah *et al.* (1998).

Tillage practices on the biomass and straw yield of mungbean and T. aman

There was no significant effect on the biomass of mungbean and straw yield of T. aman due to different tillage practices (Table 4a).

Table 4a. Effect of tillage on biomass/straw yield of mungbean and T. aman

Treatment	Biomass yield of mungbean (t ha^{-1})			Straw yield of T. aman (t ha^{-1})		
	2008	2009	2010	2008	2009	2010
T_1	6.38	7.01	6.75	4.16	4.33	4.01
T_2	7.29	7.54	7.40	4.31	4.37	4.25
T_3	7.60	8.25	7.94	4.32	4.47	4.36
Lev. of sig.	NS	NS	NS	NS	NS	NS
CV (%)	9.93	6.09	8.67	7.49	8.83	11.49

Means followed by common letter are not significantly different at 5% level by DMRT

Integrated nutrient management on the biomass and straw yield of mungbean and T. aman

The integration of organic and inorganic fertilizers gave the significant role on biomass production of mungbean and straw yield of rice under tomato-mungbean–T. aman cropping pattern (Table 4b). The cow dung @ 5 t ha^{-1} + (recommended dose of chemical fertilizers–nutrients from cow dung) treated plots produced highest biomass and straw of mungbean and T. aman, respectively in all the growing seasons.

Table 4b. Effect of organic and inorganic fertilizers on the biomass/straw yield of mungbean and T. aman

Treatment	Biomass yield of mungbean (t ha^{-1})			Straw yield of T. aman (t ha^{-1})		
	2008	2009	2010	2008	2009	2010
F_1	7.28 a	7.57 b	7.48 a	4.49 a	4.47 a	4.50 a
F_2	8.27 a	8.73 a	8.56 a	4.79 a	4.70 a	4.72 a
F_3	5.72 b	6.50 c	6.05 b	3.51 b	3.80 b	3.70 b
Lev. of sig.	**	**	**	**	**	*
CV (%)	9.93	6.09	8.67	7.49	8.83	11.49

Means followed by common letter are not significantly different at 5% level by DMRT

Interaction effect of tillage and fertilizers on the yield of tomato, mungbean and T. aman

The combined effect of tillage practices and fertilizer treatments on the yield of tomato, mungbean and T. aman was non-significant.

CONCLUSION

From the experimental result, it can be concluded that bulk density, particle density, porosity and field capacity were not significantly affected by tillage and organic and inorganic fertilizers, however, soil moisture significantly influenced by both treatments. Results also showed that there was a considerable effect of integrated nutrient management on the crop yields as well as soil physical properties.

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