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Effect of Tillage on Soil Moisture and Energy Conservation in Production of *Toria* in an Inceptisol of Assam

N.G. Barua[1], P.K. Bora[2], K. Kurmi[1], R.M. Karmakar[1] and P.K. Pathak[1]

[1]Department of Soil Science, Assam Agricultural University, Jorhat-785 013, Assam
[2]School of Natural Resource Management, College of Post Graduate Studies, Central Agricultural University, Umiam-793 103, Meghalaya

Email: pradip66@gmail.com

ABSTRACT: An experiment was conducted with four treatments *viz.* T_1: Minimum tillage (harrowing once by tractor drawn harrow), T_2: Harrowing twice by tractor drawn harrow, T_3: T_2 + pulverization once by tractor drawn rotavator and T_4: Farmers' practice (five times ploughing by country plough + one planking). The soil moisture was reduced during the seasons in the order of $T_4 > T_3 > T_2 > T_1$. The highest seed yield of *toria* was recorded when land preparation was done by tractor drawn harrow twice followed by pulverization by tractor drawn rotavator once (T_3) which remained significantly superior to all other tillage methods. However, the difference in yield was at par between minimum tillage (T_1) and farmers' practice (T_4). The average seed yield of *toria* ranged from 4.19 q/ha in minimum tillage to 7.46 q/ha in T_3 i.e harrowing twice by tractor drawn harrow followed by pulverization once by tractor drawn rotavator. A similar trend was observed with respect to B-C ratio which varied from 2.28 to 3.42 for the same treatments. Results revealed that treatment T_3 recorded the highest energy output (18633 MJ/ha) and T_2 recorded the highest output-input energy ratio (3.46 MJ/MJ). Therefore, in terms of energy coversion T_2 (Two harrowing by tractor drawn harrow) was considered the best treatment which also recorded better moisture conservation and B-C ratio as compared to farmers' practice.

Key words: Tillage, energy conservation, *toria*, economics

Rapeseed and mustard (*toria*) are two major oilseed crops of Assam occupying about 2.45 lakh hectares of cultivable land with an average yield of 528 kg/ha (Annon, 2013) which is much lower than the national average of 1152 kg/ha (Annon, 2012). It is grown mostly on residual soil moisture as a rainfed crop and often suffers from moisture stress in critical growth stages right from the germination thereby reducing the yield considerably. Increasing the productivity and profitability of dryland agriculture depends on achieving more efficient use of precipitation i.e., getting more economic yield per unit of precipitation (Peterson *et al.,* 1996). The existing practice of tillage for production of *toria* is to plough field with repeated ploughing by country plough or pulverization by rotavator to obtain a fine tilth. In dry (*rabi*) season when crops are grown on residual moisture, conventional tillage causes greater loss of soil moisture through evaporation during land preparation (So and Ringrose-Voase, 1996). The primary management option for producers attempting to minimize the loss of soil moisture from the crop field is selection of reduced tillage or no-tillage method (Peterson and Westfall, 2004). Evaluations of energy efficient tillage methods will save farmers' income as tillage is a cost intensive component of crop production. Tillage methods with high energy efficiency and having high soil moisture conservation ability will not only increase the yield of *rabi* crop but also increase farmers' income. Besides, tillage has a direct impact on global warming. So, minimization of tillage operation in crop production without sacrificing the yield of crop is very much essential in the context of present day agriculture.

Materials and Methods

The experiment was conducted in a sandy loam sub-angular blocky soil in the Instructional-cum-Research Farm of Assam Agricultural University for two years (2008-2010). The crop received an amount of 41.9 mm rainfall in 10 rainy days and 33.1 mm in 9 rainy days during its growing period in 2008-09 and 2009-10, respectively; however, the distribution was better in the second season.

The soil of the experimental site was medium in available N (278.6 kg/ha), low in available P_2O_5 (17.5 kg/ha) and available K_2O (135.0 kg/ha) content. The pH, EC and water holding capacity of the soil were 5.3, 0.20 dS/m and 44.54%, respectively. The experiment was laid out in a randomised block design with four tillage treatments and six replications. The four tillage treatments were T_1: Minimum tillage (Harrowing once by tractor drawn harrow), T_2: Harrowing twice by tractor drawn harrow, T_3: T_2 + pulverization once by tractor drawn rotavator and T_4: Farmers' practice (five times ploughing by country plough + one planking with a local implement called *Moi* or ladder. Individual plot size for each treatment was 500 m^2. The weeds of the experimental plots were killed by spraying of glyphosate before tillage. The seeds of the test crop *toria cv.* TS-38 were sown by broadcasting @ 10 kg/ha in the second fortnight of October in both the years. The crop was fertilized with basal application of 40kg N, 35 kg P_2O_5, 15 kg K_2O and 10 kg borax per hectare. Intercultural operations like thinning and weeding was done at 15-20 days after sowing (DAS). The crop was almost pest free in both the seasons except for aphid at seed setting stage and was controlled by spraying of Chlorpyriphos 20 EC @ 0.5 l/ha with a spray solution of 500 l/ha. The crop was harvested at maturity and recorded the yield.

The soil moisture in different treatments was determined at sowing, flowering, siliqua formation and harvesting with the help of TDR using Theta Probe. Soil moisture was determined in each replication of every treatment at three different locations to the depth of 15 cm and averaged it within the replications. The Theta probe is a three pin probe works in the principle of dielectric properties of soil and water and gives volumetric soil moisture content. In this paper, however, gravimetric moisture content is presented.

Two type of energy inputs were considered for energy assessment in this study. These are direct energy and indirect energy. In the present experiment the inputs are *viz.* adult man (1.96 MJ/h), bullocks (medium 10.10 pair/h), diesel (56.31 MJ/l), chemical fertilizers (N fertilizers = 60.6 MJ/k, P_2O_5 = 11.1 MJ/kg, K_2O = 6.7 MJ/kg), FYM (0.3 MJ/kg), superior chemicals (120.0 MJ/kg) and seeds (Rape and Mustard = 25.0 MJ/kg). The details of equivalent energy for the direct and indirect input in agricultural operation are given in Mittal and Dhawan (1988). The energy output was also calculated based on the total seed yield in each treatment at the rate of 25.0 MJ/kg.

Results and Discussion

Effect of tillage on soil moisture conservation

The initial soil moisture content of surface soil (0-15 cm) after tillage operation but before sowing of *toria* was highest (Table 1 a) in minimum tillage treatment (T_1) and lowest in T_4 (Farmers' practice). The soil moisture content decreased with time in the same trend. Maximum reduction in soil moisture content was observed in farmers' practice (T_4) treatment, where excessive manipulation of soil was done and minimum reduction was observed in minimum tillage treatment in all the stages of crop growth (Table 1 b). Soil moisture reduction with different tillage treatments was observed in the order of $T_4 > T_3 > T_2 > T_1$. Josa and Agnes (2005) also observed that soil moisture storage decreases from no-till to mulch tillage and finally to conventional tillage system. On the other hand, reduced tillage systems without crop residues left on the surface have no particular advantage because much of rainfall is lost as runoff (Suraj Bhan, 2007).

Effect of tillage practices on plant height and yield attributing characters of *toria*

The plant height of *toria* was significantly affected by different tillage systems during 2009-10 only (Table 2 a). Among the yield attributing characters number of plants/m^2, number of branches/plant and number of siliquae/plant varied significantly due to different tillage practices except number of branches/plant during 2008-09. The variation in number of seeds/siliqua due to different tillage practices, on the other hand, was not significant during both the years. The highest values of all these parameters were recorded in tractor drawn harrow twice + pulverisation once by tractor drawn rotavator (T_3) and the lowest in the farmers' practice (T_4) in both the years.

Effect of tillage on seed yield and economics

There was significant difference in seed yield of *toria* due to application of different tillage treatments (Table 2b). The highest seed yield of *toria* was recorded when land preparation was done by tractor drawn harrow twice followed by pulverization once by tractor drawn rotavator (T_3) which remained significantly superior to all other tillage methods. However, the difference in yield was at par between minimum tillage (T_1) and farmers' practice (T_4). The average seed yield of *toria* ranged from 4.19 q/ha in minimum tillage to 7.46 q/ha in tractor drawn harrow twice followed by pulverization once by tractor drawn rotavator (T_3). A similar trend was observed with respect to net return and B:C ratio which varied from ₹ 5967.11 to 13071.64 and 2.28. to 3.42 for the same treatment, respectively. Dutta and

Table 1 (a) : Moisture content (%) of soil at different growth stages of *toria* (cv. TS-38)

Treatment	2008-2009				2009-2010			
	Sowing	Flowering	Siliqua development	At harvest	Sowing	Flowering	Siliqua development	At harvest
Minimum tillage	19.80	14.30	10.12	8.18	20.59	18.70	13.73	7.58
Tractor drawn harrow twice (TDHT)	19.78	12.04	9.64	6.79	19.18	17.45	12.89	6.82
TDHT + pulverisation once by tractor drawn rotavator	19.49	11.58	9.64	5.54	19.43	17.55	12.91	7.10
Farmers' practice	18.87	11.57	8.13	5.25	18.43	16.91	12.59	5.98
Mean	19.49	12.37	9.38	6.44	19.41	17.65	13.03	6.87
SEm±	0.47	0.33	0.38	0.30	0.55	0.40	0.30	0.29
CD (P=0.05)	NS	0.99	1.14	0.91	NS	1.21	0.90	0.88
C.V (%)	5.92	6.51	9.89	11.53	7.00	5.58	5.61	10.43

Table 1 (b) : Effect of tillage on cumulative soil moisture depletion

Treatment	Soil moisture depletion (%)					
	2008-09			2009-10		
	Up to flowering	Up to siliqua development	Up to harvest	Up to flowering	Up to siliqua development	Up to harvest
Minimum Tillage	27.8	48.9	58.7	9.2	33.3	63.2
Tractor drawn harrow twice (TDHT)	39.1	51.3	65.7	9.0	32.8	64.4
TDHT + pulverisation once by tractor drawn rotavator	40.6	50.5	71.6	9.7	33.6	63.5
Farmers' practice	38.7	56.9	72.2	8.2	31.7	67.6
Mean	36.5	51.9	67.0	9.1	32.9	64.6

Table 2 (a) : Effect of tillage on growth and yield attributes of *toria*

Treatment	Plant height at harvest (cm)			Number of plant/m^2			Number of branches/plant			Number of siliqua/plant			Number of seeds/siliqua		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
Minimum tillage	93.2	99.8	96.5	78.5	89.2	83.8	3.57	4.33	3.95	39.97	44.63	42.30	11.93	12.53	12.23
Tractor drawn harrow twice (TDHT)	91.9	101.1	96.5	91.0	113.5	102.3	3.63	4.65	4.14	40.53	50.87	45.70	12.17	12.67	12.42
TDHT + pulverisation once by tractor drawn rotavator.	94.3	102.8	98.5	96.5	122.8	109.7	3.73	5.17	4.45	42.62	53.17	47.89	13.03	13.08	13.06
Farmers' practice	92.0	93.4	92.7	86.3	112.8	99.6	3.03	3.92	3.48	32.72	40.13	36.43	10.37	12.25	11.31
Mean	92.8	99.2	-	88.1	109.6	-	3.49	4.52	-	38.96	47.20	-	11.88	12.63	-
SEm±	2.89	2.23	-	3.48	6.27	-	0.28	0.19	-	2.37	2.52	-	0.70	0.82	-
CD (P=0.05)	NS	6.7	-	10.5	18.9	-	NS	0.54	-	7.15	7.60	-	NS	NS	-
CV (%)	7.62	5.49	-	9.69	14.01	-	19.88	9.66	-	14.92	13.08	-	14.39	15.95	-

Table 2 (b) : Effect of tillage on seed yield and B-C ratio of *toria* cv.TS-38

Treatment	Yield(q/ha)			Cost of cultivation (₹/ha)			Net return (₹/ha)			B-C ratio		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
Minimum tillage	4.11	4.28	4.19	4356.00	4770.00	4563.00	3863.95	8070.27	5967.11	1.88	2.69	2.28
Tractor drawn harrow twice (TDHT)	6.21	6.80	6.51	5022.00	5020.00	5021.00	7398.00	15380.27	11389.14	2.47	4.06	3.26
TDHT + pulverisation once by tractor drawn rotavator	7.80	7.13	7.46	5577.00	5270.00	5424.00	10023.00	16120.27	13071.64	2.79	4.06	3.42
Farmers' practice	4.83	5.54	5.18	7802.00	4946.00	6374.00	1858.00	11674.27	6766.14	1.24	3.36	2.30
Mean	5.74	5.94	-				-	-	-	-	-	-
CD (P=0.05)	1.12	1.16	0.82				-	-	-	-	-	-
CV (%)	15.8	17.9	11.24				-	-	-	-	-	-

Price of *Toria* in 2008-09 was ₹ 2000/q whereas in 2009-10, it was ₹ 3000/q

Table 3 : Effect of tillage on energy output and output-input ratio

Treatment	Energy input (MJ/ ha)	Energy output (MJ/ha)			Energy output-input ratio		
		2008-09	2009-10	Mean	2008-09	2009-10	Mean
Minimum tillage	3845	10275	10700	10488	2.67	2.78	2.73
Tractor drawn harrow twice (TDHT)	4695	15525	17000	16263	3.31	3.62	3.46
TDHT + pulverisation once by tractor drawn rotavator	5544	19500	17825	18663	3.52	3.22	3.37
Farmers' practice	8558	12075	13850	12963	1.41	1.62	1.51

Sarma (1995) also reported that the residual soil moisture can be utilized in better way to increase productivity by adopting suitable practices like minimum tillage which is also beneficial for soil conservation.

Effect of tillage on energy output and output-input ratio

Two energy parameters *viz.*, energy output (MJ/ha) and energy output-input ratio were worked out for different tillage treatments (Mittal and Dhawan, 1988) are presented in Table 3. Results revealed that treatment T_3 recorded the highest energy output (18633 MJ/ha) and T_2 recorded the highest energy output-input ratio (3.46). The farmers' practice produced lower energy conversion (1.51). Therefore, in terms of energy output-input ratio, T_2 (Two harrowings by tractor drawn harrow) was considered the best treatment which also recorded better moisture conservation and B-C ratio as compared to farmers' practice.

Conclusion

Tillage is important for water conservation, aggregation and protection of soil surface from wind and water erosion. Under rainfed farming especially during *rabi* season, different types of tillage practices affect conservation of moisture in soil. Therefore, the tillage practices those are to be followed in a particular soil for growing specific *rabi* crops need standardization for which the present investigation has been formulated.

References

Anonymous. 2012. Economic Survey, Government of Assam, GoI, 2011-12 (website: www.indiabudget.nic.in.)

Anonymous. 2013. Economic Survey, Government of Assam, GoA, 2012-13: (website: www.assambudget.nic.in.)

Dutta TC and Sarma NN. 1995. Enhancing water availability for crop production during post monsoon season in Assam. In: *Proceedings of the seminar of Agricultural Science Society of NE India*. AAU, Jorhat, pp 100-108.

Josa R and Agnes H. 2005. Effect of tillage systems in dryland farming on near surface water content during later winter period. *Soil and Tillage Research*, 82 (2): 173-184.

Mittal JP and Dhawan KC. 1988. Research Manual of Energy Requirement in Agriculture Sector. AICRP on Energy Requrement in Agriculture Sector, PAU, Ludhiana. pp 19-23.

Peterson GA, Schlegel AJ, Tanaka DL and Jones OR. 1996. Precipitation use efficiency as affected by cropping and tillage systems. *Journal of Production Agriculture*, 9: 180-186.

Peterson GA and Westfall DG. 2004. Managing precipitation use in sustainable dryland ecosystems. *Annals of Applied Biology*, 144: 127-138.

So HB and Ringrose-Voase AJ. 1996. Management of clay soils for lowland rice based cropping systems. An overview of AICAR Project 8938, AICAR *Proceeding No.* 70: 13-24.

Suraj Bhan. 2007. Conservation agriculture as strategy for enhancing the integrity of natural sources and productivity in South Asia. *Journal of Soils and Water Conservation*, 6 (4): 153.

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