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Effect of tillage practices and farmyard manure on rice Oryza sativa L. and water storage capacity of upland inceptisols of Bastar Plateau in India

ABSTRACT. A field experiment was conducted during *Kharif* 2001 and 2002 to find out the response of tillage practices and farmyard manure on water storage capacity of upland inseptisol in a randomized block design with four treatments and seven replications on the farmer's field of Tandpal watershed area, Bastar. The treatments were comprised T_1-conventional tillage (one summer ploughing by country plough farmers' practice), T_2 – conservation tillage (one summer ploughing by mould bold plough + twice disc harrowing), T_3-T_1 + farmyard manure 4 t ha^{-1}, and T_4-T_2 + farmyard manure 4 t ha^{-1}. The soil of the experimental site was moderately acidic in nature, having pH value between, 5.7 and 6.8. The organic carbon content was recorded low. The texture of the soil was sandy clay loam, and the soil was low in nitrogen and phosphorus content, however, medium in potash. In the treatment T_3 and T_4 the FYM was applied 4 t ha^{-1} at the time of ploughing. The rice cultivar Poornima was grown in a line at 20 cm row spacing using 60 kg nitrogen, 40 kg phosphorus and 20 kg potassium per hectare. Nitrogen was applied in three equal split doses at the time of sowing, maximum tillering and panicle initiation of crop. The crop was sown in both years in the last week of June. At the time of rice harvest the moisture content at different depths was recorded and it was noticed that the maximum value of soil water in the profile was under the treatment T_4 followed by T_3. It might have happened because of addition of organic matter, in the amount 4 t ha^{-1}, which enhanced the percentage of microspores in the soil in coarse textured soil and thus helped in retaining higher soil water. The overall moisture content was higher in the treatments of conservational tillage as compared to conventional tillage. Looking at energy expenditure, application of FYM proved best in both conventional and conservational tillage practices.

KEY WORDS: tillage practices, farmyard manure, rice, water storage

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Bastar plateau is geographically situated between $17^0 45'$ to $20^0 34'$ N latitude and $80^0 15'$ to $82^0 15'$ E longitude in the Chhattisgarh state of India. The topography of the region is undulating plateau. The area is mostly upland, which is about 65% of the total cultivated land. In the upland situations, rice grown by the farmers is traditionally with low yields. Tillage practices and application of FYM can play a vital role in increasing the productivity per hectare. Tillage is essential to incorporate the organic sources as well as to mix the fertilizers in the soil. The use of tillage system that left crop residues on the soil surface improves water storage and movement within the soil, increased organic matter concentrations and aggregation of the top soil, and decreases soil, susceptibility to erosion. Different tillage systems may modify soil physical properties depending on factors such as cropping history, soil type, climatic conditions and previous tillage system [Mahboubu et al. 1993; Chagas et al. 1994]. An improved tillage system leads to loosening of the soil, which creates favorable conditions for root growth within the surface soil layers, increases soil aeration and microbial activities resulting in good conditions for crop growth and a consequent increase in yield. On the other hand, nitrogen plays a key role in world food production and one of the most important contributions of soil organic matter (FYM) to soil fertility is that it provides a substantial amount of nitrogen for crop growth and acts as a natural store for this important plant nutrient. Besides, organic matter also improves the soil physico-chemical conditions and increases the biological activities within the soil. These properties ultimately affect the production in a positive way. In the present paper, we discussed the effect of tillage practices with farmyard manure on rice yield, water storage capacity and soil properties through research conducted at farmers fields.

METHODS

A field experiment was conducted during wet seasons of 2001 and 2002 on upland inceptisols of Bastar plateau on rice crop *Oryza sativa* L. cultivar Poornima. The experiment was set in a randomized block design with four treatments and six replications on the farmer field of Tandpal watershed area. The treatments were T_1 – conventional tillage (one summer ploughing by country plough, farmers practice), T_2 –improved tillage (one summer ploughing by mould board plough + twice disc harrowing), $T_3 – T_1$ + farmyard manure 4 t ha^{-1} and $T_4 – T_2$ + farmyard manure 4 t ha^{-1}. The soil of the experimental site was moderately acidic in nature with pH value between 5.7 and 6.8. The organic carbon content was

Table1. Landscape characteristics of study area

S. No.	Particular	Description
1	Elevation	600 m SL
2	Parent material	Granite, sandstone, feld spathic quartzitic schist, gneiss, ferruginous rocks.
3	Physiography	Gently sloping plane undulating plane
4	Slope %	1-15%
5	Present land use	Rice, coarse and minor millet
6	Erosion	Slight (e_1) 25% of 'A' horizon
7	Run off	Slow
8	Drainage	Moderately drained
9	Depth	Deep (up to 90.0 cm)

Table 2. Initial morphological properties of the soil

S. No.	Depth cm	Soil properties				
		Color	Texture	Structure	Roots	Effervescence
1	0-14	10 YR 5/3 Brown	SCL	$m_2$sbk	Coarse	Nil
2	14-38	10 YR 5/3 Brown	CL	$m_2$sbk	Few coarse	Nil
3	38-54	10 YR 5/3 Dark brown	CL	$m_2$sbk	Medium fine	Nil
4	54-72	10 YR 3/3 Dark brown	CL	sbk	Fine	Nil
5	72-90	10 YR 5/4 Yellowish brown	*SCL*	sbk	Very fine	Nil

$m_2$sbk – Medium moderate sub-angular blocky

Table 3. Physical and chemical properties of surface soil

S. No.	Physical properties		Chemical properties	
	Particular	Value	Particular	Value
1	Texture	SCL	pH (1:2.5)	5.8
2	Sand %	52.8	EC dS m^{-1}	0.09
3	Silt %	14.6	$CaCO_3$ %	-
4	Clay %	32.6	C %	0.65
5	Bulk density Mg m^{-3}	1.38	Exchangeable Ca cmol (+) kg^{-1}	10.8
6	WHC %	26.4	Exchangeable Mg cmol (+) kg^{-1}	5.3
7	Concretion %	Coarse common	Exchangeable Na cmol (+) kg^{-1}	0.38
8	-	-	Exchangeable K cmol (+) kg^{-1}	0.35
9	-	-	CEC cmol (+) kg^{-1}	22.40

10	-	-	Base saturation %	75.1

Table 4. Initial available nutrient status of the soils

S. No.	Available nutrient	Value kg ha^{-1}		
		0-5 cm	15-30 cm	30-45 cm
1	Nitrogen	233.0	212.5	208.5
2	Phosphorus	9.2	8.7	8.2
3	Potassium	240.6	232.9	227.4

Table 5. Physico-chemical properties of farmyard manure

S. No.	Properties	Value
1	Nitrogen	0.70 %
2	Phosphorus	0.40 %
3	Potassium	0.80 %
4	Organic carbon	35.38 %
5	Moisture	60.0 %
6	C/N	30.62
7	pH	6.4
8	Fe	162 mg kg^{-1}
9	Mn	136 mg kg^{-1}
10	Cu	24 mg kg^{-1}
11	Zn	112 mg kg^{-1}

recorded low (%). The texture of the soil was sandy-clay-loam, the bulk density of soil varied from 1.46 to 1.58 Mg m^{-3}, and the soil was low in nitrogen (233.0 kg ha^{-1}) and phosphorus (9.2 kg ha^{-1}) content however, it was medium in potash (240.6 kg ha^{-1}). In treatments T_3 and T_4 the FYM was applied 4 t/ha at the time of ploughing. The crop was grown in a line at 20cm row spacing using 60 kg nitrogen, 40 kg phosphorus and 20 kg potassium per hectare. Nitrogen was applied in three equal split doses at the time of sowing, maximum tillering and panicle initation stages. The crop was sown in both years in the last week of June. The other packages were given as the recommendations. The landscape characteristics, initial morphological, physico-chemical properties, initial fertility status of soil and physico-chemical properties of farmyard manure are presented in Tables 1, 2 3, 4 and 5, respectively. Nitrogen, phosphorus and potassium content in straw and grain and their availability in soils were determined after harvesting rice with the use standard methods [Jackson 1973; Piper 1966].

RESULTS

The data presented in Table 6 revealed that yield attributes of rice were influenced significantly with tillage practices. However, plant height, panicle weight and 1000-grain weight did not differ significantly due to different tillage practices. The number of effective tillers per m^2 and panicle length (cm) were recorded significantly higher with the application of improved tillage practices, i.e. one summer ploughing by M. B. plough – (T_2), and conventional tillage + FYM 4 t ha^{-1} (T_3) over the conventional tillage (T_1). The highest yield attributing parameters were recorded under treatment T_4 (Improved tillage + FYM 4 t ha^{-1}). The maximum values of grain and straw yields of rice were noted where improved tillage practices coupled with FYM 4 t ha^{-1} were applied over the rest of the treatments (Tab. 7). The maximum cost of cultivation was noticed with treatment T_4 but the maximum net return $rupee^{-1}$ invested was also recorded with the same treatment. A greater response to deep tillage in loamy sand soils was also reported by Singh and Chaudary [1988]. Improved tillage combined with FYM was observed superior; it might be due to the profound effect on water transmission and retention in soil and a higher supply of nutrients to the crop plants.

Table 6. Effect of tillage practices and farmyard manure on growth and yield attributes of rice

Treatment	Plant height cm	Effective tillers No./m^{-2}	Panicle length cm	Panicle weight g	1000 grain weight g	Sterility %
T_1	67.53	311.73	20.33	1.69	26.17	12.86
T_2	68.81	342.29	20.66	1.78	25.91	15.09
T_3	69.79	345.20	20.35	1.78	26.46	13.13
T_4	71.09	355.01	21.47	1.86	26.74	11.80
CD 5%	ns	26.94	0.84	NS	NS	3.24

Table 7. Effect of tillage practices and farmyard manure FYM on yields and economics of rice

Treatment	Grain yield dt ha^{-1}	Straw yield dt ha^{-1}	Cost of cultivation Rs	Gross return Rs	Net return Rs	Net return/rupee invested
T_1	30.59	43.43	11302	17306	5974	0.52
T_2	33.51	48.92	11812	18876	7096	0.61
T_3	36.12	53.45	12402	20399	7977	0.64
T_4	38.05	57.07	12932	21491	8559	0.66
CD 5%	4.42	2.64	--	--	--	--

Table 8. Effect of tillage practices and farmyard manure FYM on N-content and N uptake

Treatment	Straw		Grain		Total uptake kg ha^{-1}
	N-content %	N uptake kg ha^{-1}	N-content %	N uptake kg ha^{-1}	
T_1	0.38	16.50	0.85	26.00	42.50
T_2	0.46	22.25	0.90	30.15	52.40
T_3	0.52	27.79	1.02	36.84	64.63
T_4	0.61	34.81	1.14	43.37	78.18
CD 5%	0.04	5.17	0.08	3.86	

Table 9. Effect of tillage practices and farmyard manure on moisture content of soil at rice harvest

Treatment	Moisture content %			
	0-15 cm	15-30 cm	30-45 cm	45-65 cm
T_1	11.82	13.82	12.20	14.00
T_2	12.74	16.15	17.51	19.30
T_3	14.34	18.35	20.24	22.43
T_4	16.78	18.82	22.05	23.45
CD 5 %	1.96	1.25	1.91	2.00

At the time of rice harvest, the moisture content at different depths was recorded and it was noticed that the maximum value of soil water in the profile was under treatment T_4, followed by T_3 (Tab. 9). It might be because of an addition of organic matter in the amount of 4 t ha^{-1}, which enhanced the percentage of microspores in the soil in coarse textured soil and thus helped in retaining higher soil water. The overall moisture content was higher in the treatments of conservational tillage as compared to conventional tillage. Looking at the energy use pattern, application of FYM proved best in both conventional and conservational tillage practices. These results are in agreement with the findings of Bhagat et al. [1999] and Masand et al. [1993].

The study showed that the cost of cultivation was increased in the case of T_3 and T_4 due to application of FYM, whereas the mean gross return (Rs. 21491.00/-) as well as mean net return (Rs. 8559.00/-) were the highest in the case of T_4 (conservational tillage + FYM 4 t ha^{-1}) followed by T_3 (conventional tillage + FYM 4 t ha^{-1}). The average net return rupee invested was maximum in the case of T_4 (0.66), followed by T_3 (0.64).

The treatment effect on N-uptake in grain and straw (Tab. 8) showed that significantly higher N-content and uptake were recorded with T_4 (improved tillage practices + FYM 4 tha^{-1}) over the other treatments. This might have happened due to proper root growth and vigorous plant growth. The maximum grain and straw yields of rice favoured a higher uptake of nitrogen under treatment T_4. The minimum total uptake of nitrogen was recorded with treatment T_1 (conventional tillage), which was observed to be significantly lower as compared with the rest of the treatment. Similar findings were reported by Sharma et al. [1995] and Vasanthi and Kumaraswamy [2000].

REFERENCES

Bhagat R.M., Mantotra M., Sharma P.K. 1999. Tillage Effect on Soil Physical Properties and Yield of Ranfed Rice (*Oryza sativa* L.). J. Indian Soc. Soil Sci. 47, 3; 415-421.

Chagas C.I., Mavell H.J., Santanatoglia O.J. 1994. Propiedades fisicas Y contendido hidrico de un Argiudol tipico bajo tres sistemas de labranza. Ciencia del Suclo. 12, 1-16.

Jackson M.L. [1973]. Soil Chemical Analysis. Printice Hall of India Pvt. Ltd. New Delhi.

Mahboubi A.A., Lal R. Faussey N.R. 1993. Twenty-eight years of tillage-effect on two soils in Ohio. Soil Sci. Soc. Am. J. 57. 506-512.

Masand S.S., Kapur O.C., Jaggi R.C. 1993. Effect of tillage and nitrogen fertilizer on water use and yield of rainfed maize on sloping and level lands. J. Indian Soc. Soil Sci. 41, 3, 426-429.

Piper C.S. 1966. Soil and Plant Analysis. Hans Publishers, Bombay.

Sharma R.S., Thakur C.L., Agrawal K.K. 1995. Comparison of transplanted and direct-seeded rice for productivity, profitability and physical properties of soil. Oryza 32, 3, 183.

Singh M., Chaudhary M.R. 1988. Effect of deep tillage on growth and yield of maize under water stressed condition at different physiological stages on coarse textured soils. J. Indian Soc. Soil Sci. 46, 4, 557-562.

Vasanthi D., Kumaraswamy K. 2000. Effect of manure fertilizer schedules on the yield and uptake of nutrient by cereal fodder crops and on soil fertility J. Indian Soc. Soil Sci. 48, 3, 510-575.