Journal of Experimental Sciences 2017, 8: 16-20
doi: 10.25081/jes.2017.v8.3430
http://updatepublishing.com/journal/index.php/jes

ISSN: 2218-1768

REGULAR ARTICLE

EFFECT OF TILLAGE, RESIDUE AND NUTRIENT MANAGEMENT ON SOIL QUALITIES AND YIELD PARAMETERS OF RICE

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ABSTRACT

A field experiment was conducted at Rampur, Nepal to see the effect of tillage, residue and nutrient management practices on soil properties and grain yield of rice. Three factors each with two levels i.e. tillage (with or without), residue (with or without) and nutrient management (recommended dose (RD) with 100:60:30 NPK kg ha^{-1} and farmer's doses (FD) with 5Mt ha^{-1} of FYM+50:23:0 NPK kg ha^{-1}. Thus, altogether eight treatment combinations were evaluated under strip-split plot design with three replications. Higher soil organic matter was recorded in residue kept (5.73%) than the residue removed plots. Exchangeable potassium was found higher in no tillage (110.52 kg ha^{-1}) than the conventional tillage (76.77 kg ha^{-1}). Number of effective tillers was higher in no tillage; residue kept and recommended doses of fertilizer. Grain yield was significantly higher in no tillage with 3.66 Mt and residue kept with 3.72 Mt ha^{-1} compared to conventional tillage with 2.28 Mt and residue removed plots having 2.22 Mt ha^{-1}. RD produced significantly higher grain yield of 4.53 Mt ha^{-1} than FD with 1.41 Mt ha^{-1}. Therefore, untilled direct seeded rice with residue and recommend does of nutrients seem promising in Terai region of Nepal.

Keywords: Grain yield, Nutrient management, Residue management, Soil properties, Tillage

INTRODUCTION

Rice is the staple food of Nepal, cultivating in 1.481 mha with a gross production of 4.023 Mt and 2.71 Mt ha^{-1} of rice [1]. Rice occupies about 47.91% of total cultivated area. There was a reduction in production in the past years [1]. It is estimated that, throughout the world, the production of rice should increase around 60% to cope up with the increasing demand [2]. No tillage is nowadays widely used in the cultivation of some plants in many areas, which can save time, water, energy and labour in rice cultivation as well [3]. Therefore, its significance is growing due to receding water table [4], labour intensive rice transplantation [5] and adverse effects of puddling on the soil health [6].

Soil organic matter content is one of the factors responsible for decline in rice yield due to declining soil fertility. Therefore, there is an emphasis on building up soil organic matter the crop residues recycling [7, 8]. In the past chemical fertilizers were in use for rice production, but the use in long run will reduce the yield and thereby sustainability [9]. Nutrient management with crop residues or other organic matter is best way to get sustainable and safe production [10-12].

The present study was conducted with aim of studying effect of tillage, residue and nutrient management practices on the soil properties and yield parameters of rice

MATERIALS AND METHODS

Study material and experimental location

A field experiment was conducted at National Maize Research Program (NMRP) during 2013 from June to November to observe some selected parameters such as, yield attributes, grain yield and soil properties. The NMRP is located at 27 °39'19"N latitude and 84 °21'28"E longitude and 228 masl. The soil type is sandy loam and climatically humid sub-tropical with average total rainfall of 2442.9 mm (June to November) [13]. The tested rice genotype was Ram dhan.

Experimental design and cultural practices

Altogether 8 treatments with two levels of tillage, [conventional tillage (CT) and no tillage (NT)] and two

Received 19 September 2017; Accepted 30 December 2017

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levels of residues management [residue kept (RK) and residue removed (RR)] and two levels of nutrient management [recommended dose of fertilizer (RD) and farmer's dose of fertilizer (FD)] were tested in 3 replications under strip-split plot design. The individual plot size was 5.4 m x 6.3 m (27 rows of 6.3m length) with spacing: 20 cm × 10 cm between row to row and plant to plant respectively.

Seedbed for transplanted rice was established on the same day of planting direct seeded rice. In order to make the field weed free, glyphosate was applied in all the experimental plots 10 d before the rice seeding @ 1.0 kg a. i. ha^{-1} mixed with 400 liters of water in a hectare of land. Plant protection measures were also taken as per recommendation. Two seeds per hillwere seeded and single plant per hill was maintained by thinning extra plants on 2^{nd} week of planting. Gap filling was done four days after transplanting to maintain the plant population in experimental plots. The fertilizer dose was 100:60:30 Kg NPK ha^{-1} for research based recommendation and 50:23:0 Kg NPK ha^{-1}along with 5 Mt ha^{-1}FYM for farmer's dose. Half dose of nitrogen, full dose of phosphorous (P_2O_5) and potash was applied in planting time as a basal dose whereas remaining half dose of nitrogen was split into two equal halves and top-dressed at tillering and panicle initiation stages, respectively. Two hand-weeding cum inter cultures at 30 and 45 d after seeding (DAS) was given.

Data recording, measurements and its analysis

During the crop season, observations were taken on weather parameters (fig. 1). Soil samples were taken by tube auger from 0 to15 cm depth of soil layer before sowing from each replication and composite sample was made to analyze the initial fertility status of the soil. Soil pH (potentiometric method), organic matter content [Walkley and Black's volumetric method] total N content (Kjeldahl method), available P_2O_5 (Olsen's method) and K_2O (Flame photometeric method) content were determined. Similar soil analysis was done after the harvest of the crop from each treatment. Yield attributing characters such as; effective tillers m^{-2}, thousand grains weight (TGW) or test weight and grain yield were recorded on the selected plants. All the data were analyzed for the variance (ANOVA) by using MSTATC statistical package.

RESULTS AND DISCUSSION

Soil pH

One of the important factors determining soil fertility is pH, which was not significantly influenced by tillage, crop residue management and nutrient management. It might be due to the greater leaching of bases from no tillage and due to the acidifying effect of nitrogen and phosphorus fertilizers which led to a lower pH. The surface soil was more acidic under NT than under CT could be attributed to higher soil organic matter content and increased biological activity in NT than in CT [14].

Soil organic matter content

The SOM% was influenced by residue management having higher SOM% for RK (5.73%) than RR (3.14%). Ploughing helps to accelerate mineralization rate of organic materials. Therefore, when tillage was reduced the process of mineralization might get slow and the carbon concentration on the soil remained high. The reason for increasing the SOM probably resulted from the higher biomass fertilization and the slow rate of decomposition of SOM [15]. Thus, Conservation tillage (NT with RK on the field) helps to increase or maintain soil organic carbon (SOC) levels.

Soil total nitrogen content

The maximum nitrogen concentration from NT as compared to CT might be due to greater pool of liable nitrogen with a slow decomposition rate resulted by minimum disturbances to the soil [9]. There was not so significant N availability in the initial years after switching to zero tillage. Anyhow, the immobilization can occur as a result of residue retention, mainly in initial periods of implementation [16-18].

Soil available phosphorus

Higher extractable P levels from NT plots than CT plots were mainly by the result of low incorporation of P with the soil, leading to lower P-fixation. It is mostly noted under zero tillage [19-24].

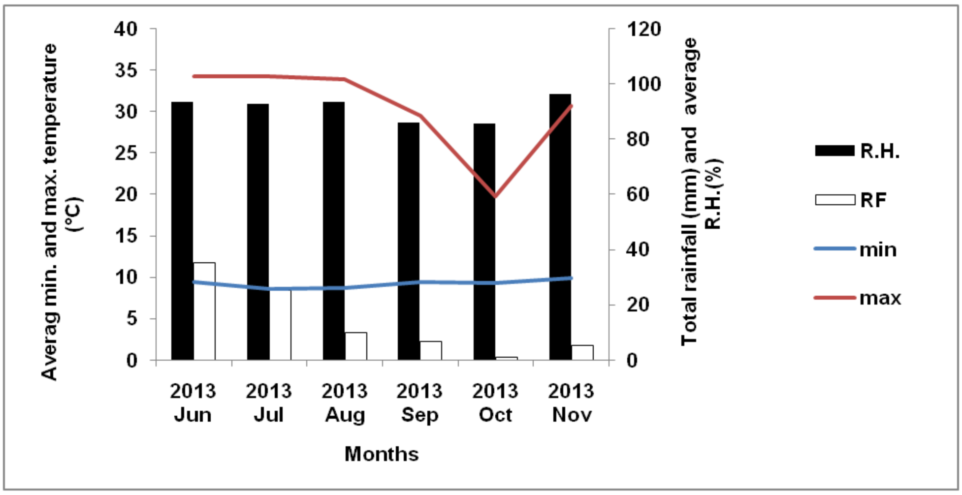

Fig. 1: Weather condition during experimentation at Rampur, Chitwan, Nepal, 2013 (Source NMRP, Rampur, 2013)

Soil exchangeable potassium

Soil exchangeable potassium was obtained significantly ($p \leq 0.05$) higher in NT (110.52 kg ha^{-1}) in comparison with CT (76.77 kg ha^{-1}). We applied 30 kg K_2O at approximately 5 cm below the surface in NT. Therefore, the chance of availability to plants was less and hence more K in the soil was reported [25, 26].

Effective tillers per meter square

Effective tillers $m^{-2}$was significantly influenced by tillage, residue and fertilizer management. Effective tillers from NT was significantly ($p \leq 0.05$) higher (168.33m^{-2}) than CT. Similarly, RK (168.33 m^{-2}) and RD (199.91 m^{-2}) had significantly ($p \leq 0.01$) higher effective tillers m^{-2} in comparison with RR (123.08 m^{-2}) and FD (91.50 m^{-2}), respectively.

The results indicated that the number of total tillers and effective tillers were increased with the increase of nutrient dose up to certain limit and thereafter declined. The improvement in the formation of effective tillers with increasing nutrient level might be due to availability of higher amount of nutrient that enhanced tillers up to specific dose after which the number was decreased.

There was a linear relationship between effective tillers and grain yield with coefficient of determination R^2= 0.949 (fig. 2) meaning 95% of contribution from effective tillers to the grain yield was calculated. This suggests that the treatment which favors effective tiller m^{-2}will definitely favor grain yield.

Table 1: Effects of tillage methods, residue and nutrient management on soil properties at Rampur, Chitwan, Nepal, 2013

Treatments	Soil properties				
	pH	OM (%)	Nitrogen (%)	Available P(kg ha^{-1})	Available K(kg ha^{-1})
Tillage					
CT	5.733	4.310	0.136	55.90	76.77^{b}
NT	5.717	4.570	0.169	64.08	110.52^{a}
LSD	NS	NS	NS	NS	5.01*
SEm±	0.015	0.084	0.006	4.856	4.076
Residue					
RR	5.708	3.149	0.151	59.66	84.49
RK	5.742	5.731	0.154	60.32	102.80
LSD	NS	0.296*	NS	NS	NS
SEm±	0.005	0.078	0.011	1.602	3.255
Nutrient					
FD	5.742	4.361	0.153	59.87	94.45
RD	5.708	4.519	0.152	60.10	92.83
LSD	NS	NS	NS	NS	NS
SEm±	0.014	0.097	0.001	0.356	0.789
CV%	0.87	7.61	3.41	2.06	2.92
Grand mean	5.725	4.44	0.153	59.993	93.647

Means followed by the common letter(s) within each column are not significantly different at 5% level of significance by DMRT.

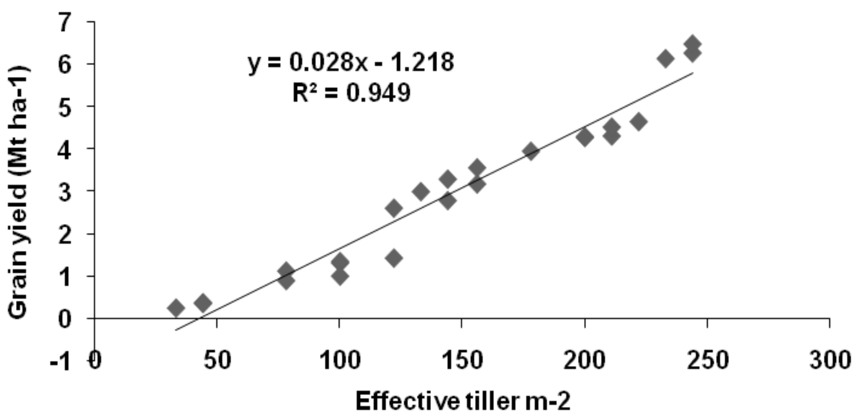

Fig. 2: Relationship between effective tiller $m^{-2}$and grain yield kg ha^{-1} of rice at Rampur, Chitwan, Nepal, 2013

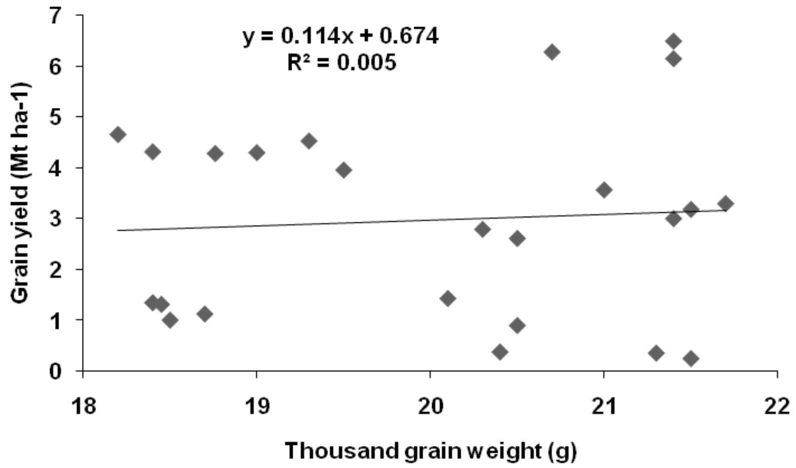

Fig. 3: Relationship between TGW and grain yield of rice at Rampur, Chitwan, Nepal, 2013

Thousand grain weight

There were no significant changes in TGW under tillage methods. TGW remained stable in previous reports [27, 28]. Grain weight was least affected by the environment. [29, 32, 30]

There was non-linear relationship between TGW and grain yield (fig. 3) with coefficient of determination (R^2= 0.005).

Grain yield

Grain yield was obtained significantly ($p \leq 0.05$) higher in NT (3.66 Mt ha^{-1}) and RK (3.72 Mg ha^{-1}) in comparison with CT (2.28 Mt ha^{-1}) and RR level (2.22 Mt ha^{-1}) respectively. Plots applied with RD obtained significantly ($p \leq 0.01$) higher grain yield (4.53 Mt ha^{-1}) than that with FD (1.41 Mt ha^{-1}). Soil quality parameters were significantly improved in NT than CT [31,32].

CONCLUSION

The findings of this study revealed that no tillage with residues kept and recommended dose of fertilizers were more efficient for improving soil properties and rice yield than other tested treatments. Therefore, farmers are suggested to adopt conservation agriculture for profitable and sustainable agriculture farming in the country.

ACKNOWLEDGEMENT

Authors are grateful to Institute of Agriculture and Animal Science (IAAS), Tribhuvan University and Agriculture and Forestry University (AFU) for their support in carrying out the research and producing this manuscript. We are also thankful to National Maize Research Program (NMRP), Rampur for every support to carry-out the field experiment.

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