RESEARCH ARTICLE

EFFECT OF TILLAGE AND NITROGEN MANAGEMENT ON, GRAIN QUALITY, PRODUCTIVITY AND SOIL HEALTH OF WHEAT (*TRITICUM AESTIVUM* L)" UNDER SUBTROPICAL CLIMATIC CONDITION

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Abstract: Conservation tillage and nitrogen may improve soil fertility, yield on sustainable basis. The aim of this study was to evaluate the impact of three tillage systems viz. zero (ZT), reduced (RT), and conventional tillage (CT) with or without residue retention/incorporation and five N rates (0, 80, 120, 160, and 200 kg·N·ha^{-1}) on yield and grain quality, soil health i.e. soil organic matter (SOC), bulk density, infiltration rate and microbial biomass carbon of wheat (*Triticum aestivum* L.). Nitrogen rates significantly affected yield and quality with highest values recorded at 200 kg·N·ha^{-1}. Mean maximum grain yield (46.13 and 47.18 q ha^{-1} and protein % 11.1 to 12.1%, gluten 10.6% and starch 63.5 to 67.5%) could be achieved at 160 kg·N·ha^{-1}. The use of ZT with residue retention and RT with residue retention for two crop cycle increased soil organic carbon by 54.68% and 54.22% more than that of conventional tillage (CT), respectively. The SOC, WSOC, POC and MBC were highest in ZT compared to other tillage systems. Though tillage × N interactions were not significant for most of the parameters under study, the overall effect of ZT with 160 kg·N·ha^{-1} appeared to be most favourable compared to RT and CT. The results suggest that ZT with 160 kg·N·ha^{-1} was optimum and sustainable strategy to achieve higher yield and also to improve SOC and MBC on sandy loam soil of subtropical India.

Keywords: Wheat; Tillage, Nitrogen, Grain quality, Soil health, Productivity

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the world's leading cereal crop cultivated over an area of about 651 million tons making it the third most-produced cereal after maize and rice. India achieved remarkable progress in wheat production during the last four decades and is the second largest wheat producer in the world with the production touching a record level of 93.90 mt an area of around 28.40 m ha during 2011-12 (Anonymous, 2012), production has increased tremendously but is still far below the potential yield (11.2 tonnes/ha) (Singh *et al.*, 2010). Although, India is well placed in meeting its needs for food grains the major objective of food and nutritional secretary for its entire population has not been achieved. The demand for food grains is expected to rise not only as a function of population growth but also as more and more people cross the poverty line with economic and social development.

Agricultural practices such as tillage methods are conventionally used for loosening soils to grow crops. But long-term soil disturbance by tillage is believed to be one of the major factors reducing SOC in agriculture Baker *et al*., 2007.Frequent tillage may destroy soil organic matter (SOM) Hernanz *et al*., 2002 and speed up the movement of SOM to deep soil layers Shan et al., 2005. As a consequence, agricultural practices that reduce soil degradation are essential to improve soil quality and agricultural sustainability. Crop residue plays an important role in SOC sequestration, increasing crop yield, improving soil organic matter, and reducing the greenhouse gas (e.g. Zhang, 1998; West and Post, 2002; Liu et al., 2006. As an important agricultural practice, straw return is often implemented with tillage in the production process. Although numerous studies have indicated that tillage methods combined with straw return had a significant effect on labile SOC fractions, the results varied under different soil/climate conditions. For example, both no-tillage and shallow tillage with residue cover had significantly higher SOC than conventional tillage without residue cover in Loess Plateau of China Chen et al., 2009, while Wang et al., 2013 reported that the difference between the treatments of plowing with straw return and no-tillage with straw return on TOC in central China was not significant. Rajan et al., 2012 showed that in Chitwan Valley of Nepal, no-tillage with crop residue application at upper soil depth had distinctly higher SOC sequestration than conventional tillage with crop residue. The effects of tillage on soil labile organic C vary with regional climate Miller et al., 2004, soil condition (e.g. Diekow et al., 2005; Ouédraogo et al., 2006; Yamashita *et al*., 2006, residue management practice, and crop rotation (e.g. Paustian et al.,1997; Puget and Lal , 2005.

Wheat *(Triticum aestivum* L.) is one of the most important cultivated crops, being grown in a wide range of environments that affect overall performance, particularly grain yield and end-use quality. Wheat yield and end-use quality depend upon the environment, and their interaction. Grain

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yield and quality of winter wheat are affected by several factors, and crop management has a very important role among them. Wheat grains are comparatively better source of protein consumed in India. About 10-12% protein requirement is met by wheat. For achieving high yields and grain quality of wheat it is important to apply all the cultural practices completely and on time and adapt them to cultivars. The correct fertilizer application, particularly N is very important to achieve high yields and good grain quality of wheat. Besides regular nutrition of plants for achieving high yields and good quality, planting techniques play an important role. Nitrogen is the most limiting nutrient in crop production and its efficient use to increase food production is more than any other input; however, much use of N may cause environmental concerns such as nitrate leaching, eutrophication, and greenhouse gases emissions and reduce crop yield Malhi et al., 2001. Therefore, proper use of N is critical to optimize crop yield and minimize environmental damage. It has been estimated that 40% - 60% of N-applied is taken up by wheat, which decreases as the N-input increases, resulting in higher residual soil N that can be readily leached Guarda et al., 2004. The present experiment was designed to evaluate the effect of tillage, N rates and their interaction on wheat grain quality, yield and yield components, and soil health of wheat in subtropical climatic condition.

MATERIAL AND METHOD

Experimental site

The field experiment was established in 2014 at Sardar Vallabhbhai Patel University of Agriculture &Technology, Meerut research farm (29^0 04', N latitude and77^0 42' 'E longitude a height of 237m above mean sea level) U.P., India. The region has a semi-arid sub-tropical climate with an average annual temperature of 16.8^0C. The highest mean monthly temperature (38.9^0C) is recorded in May, and the lowest mean monthly temperature (4.5^0C) is recorded in January. The average annual rainfall is about 665 to 726 mm (constituting 44% of pan evaporation) of which about 80% is received during the monsoon period. The predominant soil at the experimental site is classified as Typic Ustochrept. Soil samples for 0–20 cm depth at the site were collected and tested prior to applying treatments and the basic properties were non-saline (EC 0.42 dS m^{-1}) but mild alkaline in reaction (pH 7.98). The soil initially had 4.1 g kg^{-1} of SOC and 1.29 g kg^{-1} of total N (TN), 1.23 g kg^{-1} of total phosphorus, 17.63 g kg^{-1} of total potassium, 224 mg kg^{-1} of available N, 4.0 mg kg^{-1} of available phosphorus, and 97 mg kg^{-1} of available potassium.

Experimental design and management

A detailed description of different tillage systems is necessary to compare the influence of tillage practices on environmental performance (Derpsch et al., 2014).Six tillage crop establishment methods **T_1-** ZTR; **T_2-**, ZTWR ; **T_3-** RTR ; **T_4-** RTWR, **T_5-** CTR; **T_6-** Conventional tillage (CT) in main plots and five nitrogen management practices were **F_0**-Control; **F_1-** 80 kg Nha^{-1}**;** **F_2**-120 kg Nha^{-1} ; **F_3**-160 kg Nha^{-1}*;* **F_5-** 200 kg Nha^{-1} allotted to sub-plots in a split-plot design and replicated thrice. The gross and net plot sizes were 10 m×2.8 m and 8.0 m×2.1 m, respectively and treatments were superimposed in the same plot every year to study the cumulative effect of treatments.

Soil sampling and processing

Soil samples from each replicated plot were collected randomly from three spots with the help of a core sampler (10 cm internal diameter and 15 cm height) after the harvest of wheat crop in the year 2015 & 16. The soil cores were collected from 0 to 15, 15 to 30, 30 to 45 and 45 to 60 cm soil depth. One composite sample representing each replication was prepared by mixing two cores of respective soil depth. Immediately after collection, the soil samples were brought to the laboratory and stored in a refrigerator for measurement of microbial biomass carbon (MBC). A subset of soil samples was air dried and passed through a 2 mm sieve for determination of pH, SOC and particulate organic carbon (POC). The third core sample was used for the estimation of bulk density. The soil porosity was computed from the relationship between bulk density and particle density using (1). Soil field capacity and permanent wilting point were measured using pressure plate apparatus, while available water content was calculated using (2) [Black, 1965]. Consider

Porosity (%) = $1-\frac{BD}{PD}\,x100$ **(1)**

Where BD is bulk density (g cm^{-3}), PD is particle density (g cm^{-3}), and

d = $\frac{FC-PWP}{100}$ x BD x Soil depth **(2)**

Where d is available water content (cm) at 60 cm depth, FC is field capacity (%), and PWP is permanent wilting point (%)

The double ring infiltrometer method was used to determine the water infiltration and was computed as cumulative infiltration and rate of infiltration in mm h^{-1}.

Separation of soil aggregates

Aggregate-size separation was performed using a wet sieving method (Elliott, 1986). Soil samples (100-g air-dried <5 mm) were placed on top of a 2.0 mm sieve and submerged for 5 min in deionized water, to allow slaking (Kemper and Rosenau, 1986). Sieving was performed mechanically moving the sieve up and down 3 cm, 50 times in 2 min using a modified

Yoder's apparatus. A series of five sieves (2, 1, 0.5, 0.25 and 0.11 mm) was used to obtain six aggregate fractions (i) >2 (Very large macro-aggregates), (ii) 2-1 (large macro-aggregates), (iii) 1-0.5 (medium macro-aggregates), (iv) 0.5-0.25 (small macro-aggregates) ,(v) 0.25-0.0.106 (micro-aggregates), and (vi) <0.106 (silt- and clay-sized particles).

Soil analysis
The soil pH was measured in soil: water suspension (1:2). The electrical conductivity (E_{Ce}) was determined in soil saturation extract. The bulk density of soil was measured using core sampler method as suggested by Veihmeyer and Hendrickson (1948).

Soil organic carbon
Soil organic carbon was determined by wet digestion with potassium dichromate along with 3:2 H_2SO_4: 85% H_3PO_4 digestion mixture in a digestion block set at 120°C for 2h (Snyder and Trofymow, 1984).A pre-treatment with 3 ml of 1 NHCl g^{-1} of soil was used for removal of carbonate and bicarbonate. By using the bulk density value the SOC for each soil layer was calculated and expressed as Mg ha^{-1}.

Particulate organic carbon
Particulate organic matter (POM) was separated from 2 mm soil following the method described by Camberdella and Elliott (1992). Briefly a 10 g sub-sample of soil was dispersed in 100 ml 0.5% sodium hexa-metaphosphate solution by shaking for 15h on a reciprocal shaker. The soil suspension was poured over a 0.05 mm screen. All material remaining on the screen, defined as the particulate organic fraction within a sand matrix, was transferred to a glass beaker and weighed after oven-drying at 60°C for 24 h. The particulate organic carbon in POM was determined following the method of Snyder and Trofymow (1984).

Water soluble organic carbon
The water soluble organic carbon (WSOC) was successively analyzed according to the method described by Zhang *et al*. (2010). Briefly, the soil samples were first suspended in distilled water at 70±1°C for 60 min. The supernatant was referred to as the water soluble fraction (WSF)

Soil microbial biomass carbon
For the estimation of soil microbial biomass C and N by the chloroform fumigation and incubation method Horwath and Paul, (1994) soil moisture was adjusted to 55% field water capacity, pre-incubated at 25°C for 7 days in the dark, and each soil sample was subdivided into two subsamples for fumigated and non-fumigated treatments. For MBC, soil samples, equivalent to 30 g dry weight, were fumigated with $CHCl_3$ for 24h at 25°C.After removing the $CHCl_3$, each soil sample was incubated at 25°C for a period of 10 days in closed tight Mason jar along with vials containing 1.0 ml 2 M NaOH. The flush of CO_2-C released upon fumigation was determined from titration with HCl.
The MBC was computed using Eq. (2):
MBC (mg kg^{-1}) = (Fc-UFc)/Kc **(3)**
Where, Fc is CO_2 evolved from the fumigated soil,
UFc is CO_2 evolved from the unfumigated soil, and
Kc is a factor with value of 0.41 Anderson and Domsch, (1978).
For MBN, fumigated and non-fumigated soil samples after 10-day incubation were extracted with 2 M KCl (5:1 ratio of extractant: soil) for 1 h and inorganic N was determined by the Kjeldahl distillation as described by Keeney and Nelson (1982). The MBN was computed using Eq. (3):
MBN (mg kg^{-1}) = (Fn-UFn)/Kn **(4)**
Where,
Fn is mineral N from fumigated soil,
UFn is mineral N from unfumigated soil, and
Kn is a factor with value of 0.57 Jekinson, (1988).

RESULT AND DISCUSSION

Bulk Density

Table 1. Effect of tillage crop residue and nitrogen management on bulk density and infiltration rate

Treatments	Bulk density (Mg m^{-3})								Infiltration rate (hr cm^{-1})	
	0-5 cm		5-10 cm		10-20 cm		20-30 cm			
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Tillage Practices										
T_1 ZTR	1.48	1.47	1.60	1.59	1.55	1.53	1.48	1.45	9.4	10.0
T_2 ZTWR	1.52	1.51	1.66	1.66	1.60	1.55	1.51	1.50	9.3	8.8
T_3 RTR	1.45	1.44	1.56	1.55	1.52	1.51	1.50	1.48	9.7	10.5
T_4 RTWR	1.46	1.44	1.57	1.55	1.55	1.52	1.51	1.49	8.5	9.0
T_5 CTR	1.43	1.41	1.53	1.52	1.51	1.49	1.49	1.48	10.2	11.2
T_6 CT)	1.44	1.42	1.54	1.52	1.52	1.50	1.50	1.47	7.3	6.9
S.Em±	0.02	0.02	0.03	0.03	0.017	0.008	0.012	0.019	0.30	0.43
CD at 5%	0.05	0.05	0.08	0.09	0.055	0.026	0.038	0.058	0.91	1.31

Soil organic carbon (SOC)

Results of resource conservation practices after 02 years significantly influenced the water soluble organic carbon (WSOC) and total soil organic carbon (SOC) content of the surface soil is depicted in (Table 2). Data indicate that residue removal have a resulted in highly significant losses of SOC ranging from 9.45 to 16.48% for both the 0–5 and 5–15cm depths. In surface soil (0-5 cm layer) highest soil organic carbon change (35.40%) was found in ZT with residue retention plots followed by RT with residue retention plots (33.52%). The use of ZT with residue retention and RT with residue retention for two crop cycle increased soil organic carbon by 54.68% and 54.22% more than that of conventional tillage (CT), respectively. These treatments were statistically similar and significantly higher from all other treatments. Irrespective of residue retention in 0– 5 cm soil layer ZT with residue retention enhanced 63.9% and 57.9% followed by RT with residue retention 61.1%, and 55.5% WSOC and SOC, respectively, in surface soil as compared to CT. Simultaneously, residue retention caused an increment of 34.3% and 41.9% in WSOC and SOC, respectively over the treatments with no residue management. Similar increasing trends were observed in 5 -15 cm soil layer, however, the magnitude was relatively lower (Table 2).

The distribution of SOC with depth was dependent on the use of nitrogen fertilizers (Table 2). The highest SOC concentration was obtained for 0–5 cm depth and decreased with sub surface depth for all treatments. The SOC concentration in 0–5 and 5– 15 cm depths increased significantly by increased levels of nitrogen application. At the 0–5 and 5–15 cm soil depths, SOC was highest in 200 kg Nha^{-1} (F_4) followed by 160 kg Nha^{-1} (F_3) treatments and the least in Control (unfertilized) F_0 treatment. However, the soil organic C pools directly affect soil physical, chemical and biological properties. Soils under in 200 kg Nha^{-1} (F_4) treated plots contained higher SOC by ~12.5 and 11.4% in the 0–5 and 5–15 cm soil layers, respectively, over 80 kg Nha^{-1} treated plots (Table 2). The total SOC stocks in the 0-15 cm layer was ~35.17 Mgha^{-1} for in 200 kg Nha^{-1} (F_4) treated soils compared with ~28.43 Mgha^{-1} for in 120 kg Nha^{-1} treated plots and 26.45 Mg ha^{-1} for unfertilized control plots. Soil organic C content in the 0–15 cm soil layer in the plots under 50% RDN as CF+50% RDN as FYM treatment was~ 16% higher than that under 75% RDN as CF+25% RDN as FYM-treated plots.

The WSOC in surface soil were in the order of 200 kg Nha^{-1} (F_4) >160 kg Nha^{-1} (F_3) >120 kg Nha^{-1} (F_2) > 80 kg Nha^{-1} (F_1)> unfertilized control (F_0). However, increase in WSOC was more in surface as compared to sub-surface soil, which indicate that higher accumulation of organic carbon due to application of inorganic fertilizer was confined to surface soil. No significant difference in WSOC in in 200 kg Nha^{-1} (F_4) and in 160 kg Nha^{-1} (F_3) treatments during the study period. This might be due to more turn-over of root biomass in 160 kg Nha^{-1} (F_3) as better and timely availability of nitrogen to plants treatment because of better growth and higher average yields obtained during the study period of the crops in 160 kg Nha^{-1} (F_3) treatment as compared to in 200 kg Nha^{-1} (F_4) treatment.

Table 2. Effect of tillage crop residue and nitrogen management on water soluble organic carbon and total soil organic carbon

Treatments	Water soluble organic carbon (WSOC gkg^{-1})				Total soil organic carbon (SOC gkg^{-1})			
	2014-15		2015-16		2014-15		2015-16	
	0-5 cm	5-15 cm	0-5 cm	5-15 cm	0-5 cm	5-15 cm	0-5 cm	5-15 cm
Tillage Practices								
T_1 ZTR	28.4	21.8	29.2	22.6	22.3	18.6	23.9	19.9
T_2 ZTWR	24.7	17.3	25.9	17.8	17.4	15.3	19.3	14.3
T_3 RTR	26.2	19.4	27.8	20.3	21.7	17.5	23.1	18.9
T_4 RTWR	23.5	16.9	23.9	17.6	17.6	14.1	18.5	14.3
T_5 CTR	25.8	19.2	26.4	19.6	20.9	16.9	22.7	17.9
T_6 CT)	20.9	15.1	22.7	15.7	15.7	12.8	16.3	13.3
CD at 5%	2.63	2.71	2.89	3.11	1.28	1.78	1.09	2.13
Nitrogen Management								
F_0 Control	20.1	14.7	21.9	15.1	16.3	13.4	15.9	12.8
F_1 80 kg N ha^{-1}	26.8	20.4	29.8	21.9	17.8	13.7	17.8	15.6
$F_2$120 kg N ha^{-1}	28.1	21.4	30.9	22.7	18.6	14.9	19.6	17.3
F_3 160 kg N ha^{-1}	28.7	22.6	31.6	23.6	20.2	17.6	21.4	18.8
F_4 200 kg N ha^{-1}	29.6	24.3	32.5	26.4	20.9	18.1	21.7	19.2
CD at 5%	1.82	3.05	3.16	4.62	2.16	3.28	2.36	1.69

Soil Particulate Organic Carbon

After 02 years of the experiment, tillage-induced changes in POC were distinguishable in the surface (0- to 5-cm) and subsurface (5-15 cm) soil layer (Table 3). Plots under ZT had about 32% higher POC than CT plots (620 mgkg^{-1} bulk soil) in the surface soil layer.In 0 - 5 cm soil layer of tillage system, T_1, and T_3 treatments increased POC content from 620 mgkg^{-1} in CT (T_6) to 638 and 779 mgkg^{-1} without residue retention and to 898, 1105, and 1033 1357 mgkg^{-1} in ZT and RT with residue retention (T_1 and T_3), respectively. In subsurface layer (5-15 cm), similar increasing trends were observed, however, the magnitude was relatively lower .It is evident that the POC contents in both surface and sub-surface soil were significantly higher in plots receiving 200 kg Nha^{-1} (F_4) treated plots compared to all other treatments except 160 kg Nha^{-1} (F_3),plots. The values of POC in surface soil varied from 631 mgkg^{-1} in unfertilized control plot to 1381 mg kg^{-1} in 200 kg Nha^{-1} (F_4) plots, respectively; while it varied from 585 mgkg^{-1} (control) to 1032 mgkg^{-1} 160 kg Nha^{-1} (F_3) in sub-surface soil.

Table 3. Effect of tillage crop residue and nitrogen management on particulate organic carbon and microbial biomass carbon

Treatments	Particulate organic carbon (POC g kg^{-1})				Microbial biomass C (MBC mgkg^{-1})			
	2014-15		2015-16		2014-15		2015-16	
	0-5 cm	5-15 cm	0-5 cm	5-15 cm	0-5 cm	5-15 cm	0-5 cm	5-15 cm
Tillage Practices								
T_1 ZTR	1328.4	961.5	1357.1	974.3	535.8	461.8	589.2	481.5
T_2 ZTWR	963.7	660.1	998.3	674.6	345.2	289.8	355.5	314.3
T_3 RTR	1226.8	831.3	1233.2	842.5	481.7	394.8	498.6	403.7
T_4 RTWR	865.4	599.6	873.4	609.2	311.4	293.9	324.7	305.6
T_5 CTR	1092.6	773.2	1105.5	785.6	398.6	340.9	407.1	367.8
T_6 CT)	614.8	478.3	620.1	485.3	306.5	287.5	309.3	291.5
CD at 5%	116.48	132.46	128.91	133.86	56.91	68.35	93.74	77.81
Nitrogen Management								
F_0 Control	725.2	681.6	694.2	635.6	219.8	206.6	216.8	199.3
F_1 80 kg N ha^{-1}	851.9	781.8	869.4	789.3	239.9	196.8	242.3	201.9
$F_2$120 kg N ha^{-1}	948.3	804.1	956.1	813.6	280.7	219.9	284.7	221.8
F_3 160 kg N ha^{-1}	1096.7	821.4	1102.3	826.2	341.7	260.3	346.2	265.4
F_4 200 kg N ha^{-1}	1149.3	891.6	1156.7	905.1	343.9	267.3	348.6	271.9
CD at 5%	67.31	72.85	58.72	81.36	15.32	8.73	12.78	9.71

Soil microbial biomass carbon

The level of MBC was indistinguishable between the CT and ZT without residue retention regimes and was markedly lower under these regimes than under ZT with residue retention and RT with residue retention (Table 3).Changes in MBC can indicate the effects of management practices on soil biological and biochemical properties. The higher MBC we observed in the ZT and RT with residue retention plots than the CT plot under the wheat crop suggests that abandonment of the cropland had substantial beneficial effects on the activity of microbial organisms probably caused by the accumulation of organic C compounds at the soil surface. A possible reason for this difference is that in the absence of growing plants other labile C fractions may provide food for microbes, and thus maintain MBC. Another possible reason could be related to the soil moisture status. Under the CT treatment, in which biomass production would inevitably deplete much more soil moisture, the microbes in the plot would be stressed at the time of sampling (wheat maturity).

The microbial biomass carbon (MBC) is an important component of the SOM that regulates the transformation and storage of nutrients. The soil MBC regulates all SOM transformations and is considered to be the chief component of the active SOM pool (Table 3). The values of MBC in surface soil varied from 116.8 mgkg^{-1} in unfertilized control plot to 424.1 mgkg^{-1} in 200 kg Nha^{-1} (F_4) plots, respectively; while it varied from 106.6 mgkg^{-1} (control) to 324.9 mgkg^{-1} 160 kg Nha^{-1} (F_3) in sub-surface (5-15 cm) soil layer. The values of MBC increased by 58.4 and 72.5% less than 120 kg Nha^{-1} (F_2) and 160 kg Nha^{-1} (F_3) treatments in surface soil over control, respectively. The highest value of MBC due to 200 kg Nha^{-1} (F_4) use of nitrogen fertilizer might be due to higher turn-over of root biomass produced under 200 kg Nha^{-1} (F_4) treatment. Application of 120 kg Nha^{-1} (F_2) fertilizer is not only required for better growth of the crop but also required for synthesis of cellular components of microorganisms. Therefore, higher root biomass under 200 kg Nha^{-1} (F_4) fertilizer treatments helped in increasing MBC over other treatments.

Table 4. Effect of tillage practices and nitrogen management on grain yield and quality parameters

Treatments	Grain yiekd qha^{-1}		Protein %		Gluten %		Starch %		Hectoliter weight (g)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Tillage Practices										
T_1 ZTR	46.13	48.91	12.0	12.2	10.0	10.0	63.4	67.2	76.2	77.6
T_2 ZTWR	41.92	43.64	11.1	11.5	10.2	10.2	63.5	67.2	74.0	75.5
T_3 RTR	44.29	46.73	11.6	11.8	10.3	10.3	63.5	67.3	76.3	79.8

T_4 RTWR	40.82	42.82	11.1	11.4	10.5	10.4	63.5	67.3	75.3	76.1
T_5 CTR	44.16	45.90	11.3	11.6	10.5	10.4	63.5	67.2	78.5	80.6
T_6 CT	41.65	43.54	11.0	11.3	10.6	10.5	63.5	67.3	75.8	78.3
CD at 5%	2.98	4.21	0.73	0.68	0.32	0.35	NS	NS	2.81	2.38
Nitrogen Management										
F_0 Control	30.71	29.89	11.0	11.3	9.6	9.5	63.4	67.2	70.5	72.2
F_1 80 kg N ha^{-1}	33.66	32.51	11.3	11.5	9.8	9.8	63.5	67.2	76.6	77.2
$F_2$120 kg N ha^{-1}	39.14	41.83	11.6	11.9	9.9	9.9	63.5	67.3	76.9	77.3
F_3 160 kg N ha^{-1}	46.13	47.18	11.7	12.1	10.6	10.6	63.5	67.3	78.7	80.7
F_4 200 kg N ha^{-1}	43.90	45.69	11.6	11.8	10.7	10.8	63.5	67.3	80.4	81.2
CD at 5%	2.30	1.79	NS	NS	0.85	0.97	NS	NS	3.83	4.56

Quality parameters

Straw retention/return had significant effects on soil protein %, Gluten % and Hectolitre weight under zero and reduced tillage seeding techniques as shown in Table 4. In general, protein % and Gluten % and Hectolitre weight tin the following order: **T_1** ZTR> **T_3** RTR> **T_5** CTR>**T_2** ZTWR> **T_4** RTWR and > **T_6** CT, during experimentation.

Application of 200 kg Nha^{-1} had significantly higher Gluten % and Hectolitre weight as compared to all other treatments except F_3 160 kg Nha^{-1}. However, F_2 and F_1 were at par at with each other and recorded higher Gluten % and Hectolitre weight than F_0 unfertilized "control" plots during both the years of study.).

Grain yield

The wheat yield revealed that the crop responded significantly to different levels of nitrogen application as compared to control. Data generated from the present field study clearly indicated that significant (P=0.05) increase in grain yield of wheat with increasing in N level significantly up to 160 kg Nha^{-1} which was 26.54% over control . Maximum grain yield was recorded (4613 and 47.18) with 160 kg Nha^{-1} and it was significantly superior all over the treatment except F_4 (43.90 and 45.69). The lowest value of grain yield was recorded with unfertilized "control" (F_0) plots (Table-4). The grain yield of wheat was significantly increased by the effect of nitrogen management which increased the fertilizer use efficiency and improved the physical and chemical properties of soil hence making better utilization of nutrients might also be a reason towards increased yield Singh *et al.*, (2009). Similar results were reported by Chuan *et al.* (2013).

CONCLUSION

Soil conservation management improved the quality of the soil by enhancing the SOC and POC and biological status, especially in 0-5cm upper layer. Results of this 02-year field study with wheat crop indicate that the content of SOC, PON, WSOC, MBC and POC decreased with soil depth, and thin surface layer (0 – 5 cm) contained much higher concentration of these pools than 5 - 15 cm subsurface layer. The surface soil layer had substantially higher levels of all soil health parameters than subsurface layer, presumably due to higher retention of crop stubbles, fallen leaves and root biomass. The enhanced proportions of WSC, POC MBC in SOC with the supply of optimum nitrogen and retention of crop residues indicate that the improvement in labile forms of Carbon and N was relatively rapid than control suggesting that active C and N pools reflect changes due to nitrogen management. The macro-aggregates increased by 39% and micro-aggregates decreased by 9% in ZT plots compared with CT plots. Decrease in micro-aggregates and increase in macro-aggregates with application of tillage practices might have enhanced soil aggregation processes and compared to conventional tillage (CT), zero-tillage and reduced tillage could significantly improve the SOC content in cropland and the POC, PON and MBC concentrations were greatly influenced by ZT in the surface (0 - 5 cm) and subsurface (5 - 15 cm) soil layer after 02 cycles of the experiment.

Our results have very significant implications for soil C sequestration potential in semiarid subtropical soils inherently low in organic matter and nutrients of Northern India. SOC concentration in surface soil (0– 15 cm) was sharply increased by the tillage practices and nitrogen management. Thus, returning crop residue to the soil is crucial to improving the SOC level. The large scale implementation of the straw plus inorganic fertilizer amendments will help to enhance the capacity of carbon sequestration and promote food security in the region.

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