# Tillage and nitrogen management on performance of wheat (Triticum aestivum) under subtropical climatic condition



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# Tillage and nitrogen management on performance of wheat (*Triticum aestivum*) under subtropical climatic condition

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**Abstract**
Soil fertility and yield on sustainable basis may improve by conservation tillage and nitrogen management. This study was aim to appraise impact of 3 tillage viz. zero (ZT), reduced (RT) and conventional tillage (CT) without or with residue retention/incorporation and 5 N rates (0, 80, 120, 160, and 200 kg·N·ha$^{-1}$) on yield, grain quality and soil health i.e. soil organic matter (SOC), bulk density, infiltration rate and microbial biomass carbon of wheat. Nitrogen rates was significantly exaggerated yield and quality where 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 attained 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 under ZT as against reduced (RT) and conventional tillage (CT). Nevertheless, tillage × N interactions were not significant for most of the parameters under this study, the general influence of ZT with 160 kg·N·ha$^{-1}$ on sandy loam soil seemed to be most positive than RT and CT. Thus, results advise that ZT with 160 kg·N·ha$^{-1}$ was finest and sustainable approach to attain more yield and also to improve SOC and MBC of subtropical India.

**Keywords:** Wheat; Grain quality, Nitrogen, productivity, Soil health and Tillage

## 1. Introduction
Globally, wheat is the leading cereal crop which is cultivated over an area of around 651 mt making it third most produced cereal crop after maize and rice. During the preceding four decades India attained remarkable headway in wheat production and is the second major wheat producer in the world with production touching a record level of 93.90 mt an area of about 28.40 m ha during 2011-12 [2], production has augmented tremendously nevertheless still far lower than the potential yield (11.2 tonnes/ha) [24]. Although, the major objective of food and nutritional secretary for its whole population has not been yet achieved. The demand for food grains is probable to increase not only as more and more people cross the poverty line with social and economic development but also as a function of population growth.
Agricultural oriented practices for example tillage methods are conventionally use for loosening the soils to grow the crops. But long-term disturbance of soil by tillage is supposed to be one of the key factors dipping SOC [13]. Repeated tillage may abolish SOM (soil organic matter) [12] and accelerate the drive of SOM to deeper layers of soil [23]. Accordingly, agricultural practices that diminish degradation of soil are crucial to improve quality and sustainability of agricultural soil. Crop residue acting a vital role in soil organic carbon sequestration, increasing yield of crop, improving SOM and dropping greenhouse gas emission [31, 29, 16]. Straw return as an important practice of agricultural, is often executed with tillage in process of production. Even though, several studies have point out that straw return combined with tillage methods had a significant consequence on labile soil organic carbon fractions. Results varied under diverse climate/soil conditions. For instance, both shallow tillage and no-tillage with residue cover had significantly more SOC as against conventional tillage without residue cover in Loess Plateau of China [5], whereas Wang *et al.* [28] conveyed that the variance between the treatments of plowing and no-tillage with straw return on TOC in central China was not significant. Rajan *et al.* [22] displayed that in Chitwan Valley of Nepal, crop residue application with no-tillage at upper depth of soil had definitely more SOC

sequestration compared to crop residue with conventional tillage. The possessions of tillage on labile organic carbon of soil varied with soil condition [8, 19, 30], regional climate Miller *et al.* [18], crop rotation [20, 21] and residue management practice.

Wheat is important cultivated crops, being grown in a wide environments range that affect overall performance, mainly yield and end-use qualities. Wheat end-use quality and yield depend on environment and their interaction. Quality as well as grain yield and of winter wheat are exaggerated by several factors on which crop management has a very significant role among them. In India grains of wheat are relatively better source of protein consumed. Around 10-12% protein requisite is met by wheat. For attaining higher yields and quality of wheat it is important to put on all the cultural practices entirely on time and adjust them to cultivars. The truthful fertilizer application, particularly N is very imperative to realise high yields and good quality of wheat. Besides consistent nutrition of plants for attaining high yields and good grain quality, planting techniques play an essential role. Nitrogen is the utmost limiting nutrient in production of crop and its effectual use increase production of food is over and above any other input; on the other hand, much usage of N may effect environmental concerns for instance eutrophication, nitrate leaching and greenhouse gases emissions in addition to reduce yield [17]. For that reason, proper usage of N is critical to minimize environmental harm and enhance yield of crop. It has been assessed that 40% - 60% of N-applied is in use up by wheat, which declines as N-input upsurges, resulting in more residual soil N that can readily leached [10]. The present study was intended to assess the impact of tillage, nitrogen rates and their interaction on yield and yield components, grain quality of wheat and soil health.

## 2. Materials and methods

### 2.1. *Experimental site*

The experiment on field was established in 2014 at Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut research farm ($29^0$ 04', N latitude and $77^0$ 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 $^0$C. The highest mean monthly temperature (38.9 $^0$C) is recorded in May, and the lowest mean monthly temperature (4.5 $^0$C) is recorded in January. The average annual rainfall is about 665 to 726 mm (constituting 44% of pan evaporation) of which around 80% is acknowledged for the duration of monsoon period. The predominant soil at the experimental site is classified as Typic Ustochrept. Soil samples for 0–20 cm depth were collected at the site and tested previous to put on treatments and basic possessions 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.

### 2.2. Experimental design and management

A comprehensive description of unlike tillage systems is essential to compare effect of tillage on environmental concert (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 replicated thrice in a split-plot design. The net and gross plot sizes were 8.0 m×2.1 m and 10 m×2.8 m, respectively and treatments were superimposed in the same plot every year to study the cumulative effect of treatments.

### 2.3. Soil sampling and processing

Soil samples were collected arbitrarily from three spots with the assistance of a core sampler from each replicated plot (10 cm internal diameter and 15 cm height) after harvest of crop in the year 2015 and 2016. The soil cores were collected from a soil depth of 0 to 15, 15 to 30, 30 to 45 and 45 to 60 cm. One merged sample on behalf of each replication was set by mixing two cores of own depth of soil. Instantly after the collection, soil samples were brought to the laboratory and stored in a refrigerator for measurement of microbial biomass carbon (MBC). A subset of samples was air dried and passed over a 2 mm sieve for determination of pH, SOC and particulate organic carbon (POC). The third core sample was used to appraisal of bulk density. The soil porosity was calculated from the relationship between particle density and bulk density using (1). Permanent wilting point and Soil field capacity were measured using pressure plate apparatus, while available water content was calculated using (2). Consider

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

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

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

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

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

### 2.4. Separation of soil aggregates

A wet sieving method was used to perform aggregate-size separation (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 **[15]**. Sieving was executed mechanically stirring sieve up and down 3 cm, 50 times in 2 min using a modified Yoder's apparatus. A series of 5 sieves (2, 1, 0.5, 0.25 and 0.11 mm) was use to obtained 6 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).

### 2.5. Soil analysis

The electrical conductivity ($E_{Ce}$) of soil was resolute in soil saturation extract. The pH of soil was measured in soil: water suspension (1:2). The soil bulk density was measured using core sampler method as suggested by Veihmeyer and Hendrickson [27].

#### 2.5.1. Soil organic carbon

Wet digestion with potassium dichromate accompanied by 3:2 $H_2SO_4$: 85% $H_3PO_4$ digestion mixture in a digestion block set at 120 °C for 2h was used to determined soil organic carbon **[26]**. Removal of carbonate and bicarbonate was finished by a pre-treatment with 3 ml of 1 NHCl $g^{-1}$ of soil. By using bulk density value the SOC for every soil layer was calculated and expressed as Mg $ha^{-1}$.

### 2.5.2. Particulate organic carbon
Particulate organic matter (POM) was detached from 2 mm soil following method described by Camberdella and Elliott [4]. Briefly a 10 g sub-sample of soil was disseminated in 100 ml 0.5% sodium hexa-metaphosphate solution by shaking for 15h on a reciprocal shaker. The soil suspension was decanted over a 0.05 mm screen. All material left over on the screen, definite as the POM fraction within a sand matrix, was transported to a glass beaker and weighed after oven-drying at 60 °C for 24 h. Snyder and Trofymow [26] was used to determine particulate organic carbon in POM.

### 2.5.3. Water soluble organic carbon
The water soluble organic carbon (WSOC) was consecutively analyzed conferring to the method defined by Zhang *et al.* [32]. Briefly, the soil samples were first suspended in distilled water at 70±1 °C for 60 min. The supernatant was mentioned to as the water soluble fraction (WSF)

### 2.5.4. Soil microbial biomass carbon
For the estimation of soil microbial biomass C and N by the chloroform fumigation and incubation method Horwath and Paul [11] soil moisture was attuned to 55% field water capacity and pre-incubated at 25 °C for the 7 days in dark, and each soil sample was then 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 the removing $CHCl_3$, each soil sample was incubated at 25°C for the 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):

$$\text{MBC (mg kg}^{-1}\text{)} = (Fc-UFc)/Kc \quad (3)$$

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 [1].
For MBN, non-fumigated and fumigated soil samples after 10-day incubation were extracted with 2 M KCl (5:1 ratio of extractant: soil) for 1 h and the inorganic N was determined by the Kjeldahl distillation as described by Keeney and Nelson [14]. The MBN was computed using Eq. (3):

$$\text{MBN (mg kg}^{-1}\text{)} = (Fn-UFn)/Kn \quad (4)$$

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 [13].

## 3. Results and discussion
### 3.1 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 |

### 3.2. 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 caused in highly losses of SOC extending from 9.44 to 16.47% for both 0–5 and 5–15cm soil 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. Alike increasing trend was also noted in 5 -15 cm soil layer, however, greatness was comparatively lower (Table 2).
The SOC distribution with depth was reliant on use of nitrogen fertilizers (Table 2). The maximum SOC concentration was gained for 0–5 cm soil depth and diminished with sub surface soil depth for all the treatments. Significantly the SOC concentration in 0–5 and 5– 15 cm soil depths increased with increased nitrogen application levels. At the 0–5 and 5–15 cm depths, SOC was maximum 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 SOC pools directly affect physical, biological and chemical properties of soil. Soils under in 200 kg $Nha^{-1}$ ($F_4$) preserved plots confined maximum SOC by ~12.5 and 11.4% in 0–5 and 5–15 cm soil layers, respectively, above 80 kg $Nha^{-1}$ preserved plots (Table 2). The total stocks of SOC in 0-15 cm soil 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 plots. SOC content in 0–15 cm soil layer in plots underneath 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 ($F_0$). Nevertheless, increases in WSOC were more in surface soil against sub-surface soil that indicated higher organic carbon accumulation due to inorganic fertilizer application were confined to soil surface. 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 may be more root biomass turn-over in 160 kg Nha$^{-1}$ ($F_3$) as better and timely availability of nitrogen to plants treatment for the reason that better progress and higher yields attained during study age of crops in 160 kg Nha$^{-1}$ ($F_3$) treatment than 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 |

### 3.3 Soil Particulate Organic Carbon

After 02 years of the experiment, tillage-induced changes in POC were distinguishable in surface (0- to 5-cm) and sub-surface (5-15 cm) soil layer (Table 3). Plots under ZT had about 32% more POC than CT plots (620 mgkg$^{-1}$ bulk soil) in surface soil layer. In 0 - 5 cm soil layer of tillage system, $T_1$, and $T_3$ treatments augmented POC content by 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 increase trend was also observed, but, magnitude was comparatively lower. It is apparent that POC contents in surface soil and sub-surface soil was significantly more in the plots receipt of 200 kg Nha$^{-1}$ ($F_4$) treated plots compared to all other treatments except 160 kg Nha$^{-1}$ ($F_3$), plots. The POC values in surface soil ranged from 631 mgkg$^{-1}$ in unfertilized plot to 1381 mg kg$^{-1}$ in 200 kg Nha$^{-1}$ ($F_4$) plots, respectively; whereas 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 |

### 3.4 Soil microbial biomass carbon

The MBC level was vague between CT and ZT without residue retention systems and was markedly less under these system than under with residue retention of RT and ZT (Table 3). Fluctuations in MBC can show the possessions of management practices on the biochemical and biological properties of soil. The greater MBC observed in the RT and ZT by residue holding plots than the CT plot under wheat crop advises that the abandonment of cropland had considerable beneficial possessions on activity of microbial probably caused by the accumulation of organic carbon compounds at the surface of soil. A possible intention for this modification is that in the absence of growing plants other labile carbon fractions might be provide food for the microbes, and thus sustain MBC. One more possible aim could be related to moisture status of soil. Under CT treatment, in which biomass production would unavoidably deplete much more moisture of soil, the microbes in plot would be harassed at the sampling time (wheat maturity).

The microbial biomass carbon is a significant component of SOM that controls the storage and transformation of nutrients. The soil MBC is reflected to be chief component of active SOM pool and controls all SOM transformations (Table 3). The values of MBC in soil surface varied from 116.8 mgkg$^{-1}$ in control plot to 424.1 mgkg$^{-1}$ in 200 kg Nha$^{-1}$ ($F_4$) plots, respectively; whereas it varied from 106.6 mgkg$^{-1}$ (control) to 324.9 mgkg$^{-1}$ 160 kg Nha$^{-1}$ ($F_3$) in sub-surface layer of soil (5-15 cm). The values of MBC augmented by 58.4 and 72.5% fewer than 120 kg Nha$^{-1}$ ($F_2$) and 160 kg Nha$^{-1}$ ($F_3$) treatments in soil surface over control plot, respectively. The uppermost value of MBC by reason of 200 kg Nha$^{-1}$ ($F_4$) use of fertilizer nitrogen might be owing to higher root biomass turn-over produced under 200 kg Nha$^{-1}$ ($F_4$). Application of 120 kg Nha$^{-1}$ ($F_2$) fertilizer was not only obligatory for better crop growth but also requisite for cellular components of microorganisms synthesis. As a result, higher root biomass under 200 kg Nha$^{-1}$ ($F_4$) fertilizer plot helped in raising MBC overall another 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 yield of wheat exposed that significantly crop responded to different nitrogen levels of as against control treatment. Data produced from present field study obviously showed that significant (P=0.05) upsurge in wheat grain yield with cumulative in N level significantly able to 160 kg Nha$^{-1}$ which was 26.54% more over control plot. Higher grain yield was logged (4613 and 47.18) with 160 kg Nha$^{-1}$ and it was superior to all over the treatment, except $F_4$ (43.90 and 45.69). The lowermost value of yield was obtained with control plots (Table-4). The wheat grain yield was significantly augmented by nitrogen management effect which improved the chemical and physical properties of soil and also increased the fertilizer use efficiency hereafter making healthier nutrients utilization might be a reason on the way to increased yield Singh *et al.* [25]. Similar consequences were also stated by Chuan *et al.* [6].

## 4. Conclusion

Soil conservation enhanced the quality of soil by augmenting SOC and POC and biological status, particularly in 0-5cm soil upper layer. Results of this 02-year field trial with wheat crop revealed that the content of SOC, PON, WSOC, MBC and POC diminished with depth of soil, and thin layer of soil surface (0–5 cm) contained much greater concentration of these pools as against 5-15 cm subsurface soil layer. The soil surface layer had significantly higher levels of the all parameters of soil health than subsurface soil layer, seemingly because of higher crop stubbles retention, fallen root biomass and leaves. The boosted proportions of WSC, POC MBC in SOC with supply of optimum nitrogen and residues of crop retention specify that improvement in labile forms of C and N was quite rapid than unfertilized plot signifying that active N and C pools imitate changes owing to management of nitrogen. The macro-aggregates augmented by 39% and micro-aggregates reduced by 9% in ZT treatment compared to CT plots. Reduction in micro-aggregates and upsurge in macro-aggregates with tillage practices application might have been boosted processes of soil aggregation as compared to conventional tillage (CT), reduced tillage and zero-tillage could significantly expand the content of SOC in cropland and the concentrations of POC, PON and MBC were prominently influenced by ZT in the surface soil layer (0 - 5 cm) and subsurface soil layer (5 - 15 cm) after 02 cycles of field experiment.

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

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