International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 2997-3000

Received: 21-03-2018
Accepted: 22-04-2018

Usha Kaushik
Ph.D. Scholar, UAS, GKVK, Bangalore, Karnataka, India

Dev Raj
Department of Soil Science, CCS Haryana Agricultural University Hisar, Haryana, India

Pooja Rani
Department of Soil Science, CCS Haryana Agricultural University Hisar, Haryana, India

RS Antil
Amity Food and Agriculture Foundation, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India

Correspondence
Usha Kaushik
Ph.D. Scholar, UAS, GKVK, Bangalore, Karnataka, India

Impact of zero tillage on available nutrients status on pearlmillet wheat cropping system

Usha Kaushik, Dev Raj, Pooja Rani and RS Antil

Abstract
This study was conducted by collecting the surface soil samples from prominent pearlmillet-wheat cropping system of Haryana state locating in similar agro ecological regions under two different tillage system with same soil types. The samples are collected from two different depth considered as surface and subsurface. The results revealed that the organic carbon content of soil was higher under zero tillage system soil than conventional soil conditions. The organic carbon content and available N, P, S was found higher under zero tillage system as compared to conventional tillage system. Similarly, micronutrients were found higher under zero tillage system. The available potassium was found higher under conventional tillage condition. Zinc, iron and manganese micronutrients content was found higher under zero tillage system soils than conventional tillage soils while copper content was noticed higher under conventional tillage soils. Available nutrient status of soils was observed higher where higher amount of manures and crop residues are in practices and no tillage practice increased the organic carbon content of soil and found highly correlated with the availability of nutrients in soil.

Keywords: Tillage system, zero tillage, organic carbon, available nutrients

Introduction
Globally 60-90 Pg of soil organic carbon has been lost during several decades due to continuous and intensive tillage practices [1]. Adoption of traditional management practices including deep tillage and inversion combined with the removal of crop residues has resulted in SOC depletion which has exacerbated soil degradation and diminished the physical, chemical and biological properties of the soil [2]. In rainfed arid and semiarid conditions apart from the scanty rainfall problem, low organic carbon stock hence poor nutrient content causes poor physical, chemical and biological properties of the soil thereby low productivity. Excessive loss of nutrients in these soils due to poor holding of nutrients by the low organic matter contended soil leads to soil degradation [3]. The benefits associated with reducing the tillage intensity are limited in the absence of retention of crop residues particularly under rainfed conditions where the soil is exposed without any vegetative cover for up to 9 months a year. Small holder farmers in developing countries generally manage intensive, mixed crop-livestock systems where animals are extremely important components and contribute to food security of the household, provide for system diversification, generate cash, spread risk, provide draft power, and transportation and are important assets for investment and savings [4].
Frequent tillage usually destroys SOM and speed up the movement of SOM to deeper soil layers [5] Therefore, agricultural practices such as reduced tillage (RT) that reduce soil disturbance are essential to improve soil quality and health and agricultural sustainability. Likewise, retention or incorporation of crop residues can also play an important role in increasing SOC sequestration, increasing crop yield, improving SOM/SOC, and reducing the greenhouse gases [6-9].
Tillage can affect crop production and thereby the quantity of residue inputs to the soil, which is one of the major factors determining SOM levels. Tillage practices can alter the vertical distribution and quantity of SOM in soils through several processes. Incorporation of crop residues under conventional tillage (e.g. autumn mouldboard ploughing) enhances the rate and extent of decomposition by placing the residues closer to nutrients and decomposers, and in an environment with more favourable temperature and moisture conditions than on the soil surface.

Materials and Methods

Study site

The experiment has been carried out in the CCS Haryana Agricultural University hisar, Haryana. The soil samples were collected from the Research Farm, Dept. Of Agronomy (Latitude: 29° 10' N, Longitude: 75° 46' E). The samples were collected from pearlmillet-wheat cropping system. The field are managed under zero tillage since long time and another plot besides was managed by regular cultivation practices of tillage operations. All these systems were located in same agro ecological zones, with similar atmospheric conditions. The texture of the soil is sandy loam and annual rainfall of the area is 450 mm with average temperature range of 1.9-46 °C.

Soil sampling

Surface soil samples from two different depth (0-5 & 5-15) were collected each from the two fields of continuous tillage and zero tillage system in June, 2015. Soil samples were collected after removing the litter layer then air dried, grounded and sieved (2mm) for carrying out the chemical analysis.

Sample analysis for various parameters

Available nutrients content and other parameters:

Parameter	Method	Reference
pH (1:2::Soil:water suspension)	Potentiometric method	[10]
EC (1:2::Soil:water suspension)	Conductometric method	[10]
Organic Carbon	Wet oxidation method	[11]
Available N	Kjeldahl-distillation	[12]
Available P	$NaHCO_3$ extraction method	[13]
Available K	Flame photometry	[10]
Available S	Spectrophotometry	[14]
DTPA extractable Micronutrients	Atomic Absorption Spectrophotometer	[15]
Cation exchange capacity	Flame photometry	[16]

Data Analysis

All results are reported as mean ± standard error. Data were analyzed by two-way ANOVA with soil depth and tillage system as the factors. Least significant difference ($p < 0.05$) was used to separate the means when differences were significant. Statistical analysis was performed by using [17].

Results

Soil physic-chemical properties

Soil pH varies in both the system of tillage system under different depth of soil at 0-5 cm and 5-15 cm. Conventional tillage (7.70) system has been found with slightly lower pH as compared to zero tillage (7.88). Under two different depth lower depth of 5-15 cm (7.63) was reported as lower pH than upper depth of 0-15 cm (7.70).

EC (electrical conductivity) was observed in reverse order than the pH while depth wise EC was decreases. Zero tillage was reported with 0.31 dS/m while conventional tillage was reported higher EC 0.38 dS/m.

Available nutrients

Available Nitrogen

Nitrogen content was observed higher under zero tillage than the conventional tillage. The mean value obtained was 156.8 kgha^{-1} under zero tillage system and 140 kgha^{-1} under conventional tillage system. Depth wise the available nitrogen content decreases with higher (168.94 kgha^{-1}) under surface (0-5 cm) than subsurface (5-15 cm) (142.63 kgha^{-1}).

Available phosphorus

Available phosphorus was observed higher under zero tillage system with mean value of 60.24 kgha^{-1} as compared to conventional tillage system which was recorded with 52.79 kgha^{-1} of available phosphorus.

Depth wise availability of phosphorus decreases in both of the tillage system. Maximum reduction was observed under zero tillage than conventional tillage system. The mean observed value of surface available phosphorus under zero tillage system is 78.37 kgha^{-1} while for the conventional tillage system was 42.98 kgha^{-1}.

Available potassium

Available potassium was recorded higher under conventional tillage system with mean value 301.31 kgha^{-1}.On the other hand the content of potassium under zero tillage was found 242.30 kgha^{-1}. The amount of available potassium was found more in upper soil layer than the lower at 5-15 cm depth. However, the difference among the two tillage systems at two different depths widened in conventional tillage system as compared to the zero tillage system.

Available sulphur

The trend of sulphur availability was found similar as of nitrogen and higher content was observed under zero tillage system as compared to conventional tillage. The mean value at two different depths at 0-5cm and 5-15 cm under zero tillage and conventional tillage was observed 211.45 kgha^{-1} and 191.56 kgha^{-1} & 100.41 kgha^{-1} and 88.62 kgha^{-1} respectively.

Available micronutrients

The micronutrients availability was found higher under zero tillage system. Available zinc, copper, manganese, and iron reported 3.67, 1.21, 9.43, 17.56 mgkg $^{-1}$under zero tillage system. Copper was found on par in both the system however slightly higher content under conventional tillage was observed. The depth wise distribution of micronutrients follow the same trends and content of all the nutrients are found lower under deeper depth (5-15 cm). The available content of zinc, iron, manganese was recorded 3.62, 18.69, 9.98 mgkg^{-1} respectively in 0-5 cm under zero tillage system which is higher than the subsurface layer. But copper recorded higher content under conventional tillage with upper surface value of 1.18 mgkg^{-1} and 1.28 mgkg^{-1} under lower depth. Similar tend followed under conventional tillage system and surface layer has been recorded with higher availability of micronutrients.

Discussion

Soil physic-chemical properties

Zero tillage condition was found to have lower pH due to higher amount of organic matter and higher leaching of bases in comparison to conventional tillage. This may be attributed to higher addition of organic matter whose decomposition leads to release of organic acids which reduces the pH of the zero tilled soil. These results are in accordance the findings of [18] who reported decrease in pH with the addition of organic residue and manure due to production of organic acid in fertilized plot over control. The EC of conventional field was found to have higher EC than zero tillage system. This may be due to higher pore size and porosity under zero tillage leads to leaching of the basic cations and reduces EC.

Available nutrients

Soil organic carbon content in the soil increased with increasing the input of organic matter in the form of plant residue, leaf litter and with application of manure. The higher SOC content was observed under zero tillage than conventional tillage system under pearl millet-wheat cropping system. Tillage affects the equilibrium of soil carbon balance through the physical disturbance and mixing of soil and exposure of disrupted aggregates, and through the incorporation of plant residues in the soil [19]. Soil organic carbon has been noticed to decrease with increase in intensive cultivation and under conventional tillage system compared to zero tillage system. When land use is converted to intensive management system, soil carbon is lost most rapidly than it accumulates [20, 21].

Significantly higher amount of available N was found under zero tillage pearl millet-wheat cropping system as compared to their conventional tillage due to more addition of crop residue and less disturbances of soil. These results are in agreement with [22] who reported that the increased soil temperature and tillage practices made the soils susceptible to erosion of nitrogen in the arable land. The increase in available N in soils of Haryana under different cropping system with the application of fertilizers and manures was also reported by several workers [23-25].

The amount of available phosphorus was found higher under zero tillage as compared to conventional tillage. This is attributed to larger addition of crop residue in former which increases the P solubilisation and reduces P fixation of applied phosphorus. These results are on same line as reported by with [26] who observed the increase in available of P in the soil with incorporation of crop residue along with chemical fertilizers.

In contrast to other macronutrients availability, content of available K was found lower under zero tillage system than conventional tillage system. This is may be due to more leaching and removal of potash by the crops in the zero tillage system. The zero tillage system was found to have higher content of available S as compared to conventional tillage system because of higher addition of crop residue in zero tillage which results in more build up of organic carbon therefore, more available sulphur was observed in zero tillage than conventional tillage.

Available micronutrients

The content of micronutrients was found higher under zero tillage system as compared to conventional tillage system because of higher addition of crop residue under former which directly enhances the content of these micronutrients. Copper was found higher under conventional tillage system due to higher affinity of copper with the organic matter and hence lower content of organic matter in conventional tillage system. Similar results were also recorded by [27].

Conclusions

Tillage system plays important role in the availability of the nutrients. Zero tillage system has been recorded with higher amount of organic carbon and available macronutrients and micronutrients.

Table 1: Soil physic-chemical properties

Tillage system/ depth	Soil organic carbon	pH	EC dS/m
ZT (0-5 cm)	8.192	7.97	0.26
ZT(5-15 cm)	4.448	7.86	0.22
CT (0-5 cm)	7.958	7.92	0.42
CT(5-15 cm)	7.374	7.88	0.38

Table 2: Tillage system and available micronutrients

Tillage system/ depth	Available Fe ($mgkg^{-1}$)	Available Mn ($mgkg^{-1}$)	Available Zn ($mgkg^{-1}$)	Available Cu ($mgkg^{-1}$)
ZT (0-5 cm)	18.69	9.98	3.62	1.18
ZT(5-15 cm)	15.65	8.89	2.58	1.28
CT (0-5 cm)	5.45	6.28	4.07	1.65
CT(5-15 cm)	3.86	5.36	1.98	1.58

Table 3: Tillage system and available macronutrients

Tillage system/ depth	Available N ($kgha^{-1}$)	Available P ($kgha^{-1}$)	Available K ($kgha^{-1}$)	Available S ($kgha^{-1}$)
ZT (0-5 cm)	168.94	78.37	254.34	211.45
ZT(5-15 cm)	142.63	42.12	230.26	191.56
CT (0-5 cm)	148.23	58.63	327.65	100.41
CT(5-15 cm)	132.28	46.98	274.98	88.62

References

1. Lal R. Soil management and restoration for C sequestration to mitigate the accelerated greenhouse effect. Progress in Environmental Science. 1999; 1:307-326.
2. Lal R. Soil carbon sequestration impacts on global climate change and food security. *Science* 2004; 304:1623–1627.
3. Srinivasarao C, Venkateswarlu B, Rattan Lal, Singh AK, Sumanta Kundu. Sustainable management of soils of dryland ecosystems of India for enhancing agronomic productivity and sequestering carbon. Advances in Agronomy, Academic Press, Burlington. 2013; 121:253-329.
4. Ahuja Vinod, Umali-Deininger D, de Haan C. Agricultural Support Services and the Poor: Case of Livestock Health and Breeding Services in India. World Bank Technical Report (in press), 2000.
5. Hernanz JL, Lopez R, Navarrete L, Sanchez-Giron V. Long-term effects of tillage systems and rotations on soil structural stability and organic carbon stratification in semiarid central Spain. Soil and Tillage Research, 2002; 66(2):129-141.
6. Liu SP, Nie XT, Zhang HC, Dai QG, Huo ZY. Effects of tillage and straw returning on soil fertility and grain yield in a wheat-rice double cropping system. Transactions of the CSAE. 2006; 22(7):48-51.

7. Sun X, Liu Q, Wang DJ, Zhang B. Effect of long-term application of straw on soil fertility. Chinese Journal of Ecology and Agriculture 2007; 16(3):587-592.
8. West TO, Post WM. Soil organic carbon sequestration rates by tillage and crop rotation. Soil Science Society of America Journal. 2002; 66:1930-1946.
9. Yadvinder-Singh BS, Timsina J. Crop residue management for nutrient cycling and improving soil productivity in rice-based cropping systems in the tropics. Advances in Agronomy. 2005; 85:269-407.
10. Jackson ML. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi, 1973.
11. Walkley AJ, Black CA. Estimation of soil organic carbon by the chromic acid titration method. Soil Science, 1934; 37:29-38.
12. Subbaiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soil. Current Science. 1956; 25:259-260.
13. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circulation from United States Department of Agriculture. 939. USDA, Washington, D.C, 1954.
14. Chesnin L, Yien CH. Turbiditric determination of available sulphates. Proceedings of the Soil Science Society of America. 1950; 14:149-151.
15. Lindsay WL, Norvell WA. Development of a DTPA soil test for Zinc, iron, manganese and copper. Soil Science Society of American Journal, 1978; 42:421-428.
16. Hesse PR. A textbook of soil chemical analysis. CBS Publishers and Distributors, Delhi, 1971.
17. Pense VG, Sukhatme PV. Statistical methods for agricultural workers. IInd Ed. I.C.A.R. Agric. Circ. No. 843, 1961.
18. Wong, Vanessa, Dalal NL, Greene RC, Richard SB. Salinity and sodicity effects on respiration microbial biomass of soil. Biology and Fertility of Soils. 2008; 44:943-953.
19. Paustian K, Collins HP, Paul EA. Management controls on soil carbon. (eds. Paul E.A., Elliott E.T, Paustian K., Cole C.V.), Soil organic matter in temperate agroecosystems: long-term experiments in North America. CRC Press, Boca Raton, FL, 1997, 15-49.
20. Freibauer A, Rounsevell MDA, Smith P, Verhagen J. Carbon sequestration in the agricultural soils of Europe. Geoderma. 2004; 122:1-23.
21. Matos ES, Freese D, Mendonca ES, Slazak A, Huttl RF. Carbon, nitrogen and organic C fractions in topsoil affected by conversion from silvopastoral to different land use systems. Agroforestry Systems. 2011; 81:203-211.
22. Carter MR, Gregorich EG, Angers DA, Donald RG, Bolinder MA. Organic C and N storage and organic C fractional in adjacent cultivated and forested soils of eastern Canada. Soil and Tillage Research. 1998; 47:253-261.
23. Antil RS, Singh Mandeep. Effect of organic manures and fertilizers on organic matter and nutrient status of the soil. Archives of Agronomy and Soil Science. 2007; 53(5):519-528.
24. Dev Raj, Antil RS, Khokhar KK. Effect of nutrient management practices on yield, uptake and changes in soil fertility under cotton-wheat cropping system. Indian Journal of Fertilisers, 2013; 9(7):46-50.
25. Kaur J, Singh JP. Long-term effect of continuous cropping and different nutrient management practices on the distribution of organic nitrogen in soil under rice-wheat system. Plant Soil and Environment. 2014; 60(2):63-68.
26. Kumar B, Gupta RK, Bhandari AL. Soil fertility changes after long-term application of organic manures and crop residues under rice-wheat system. Journal of the Indian Society of Soil Science. 2008; 56:80-85.
27. Walters DT, Aulakh MS, Doran JW. Effects of soil aeration, legume residue, and soi] texture on transformations of macro- and micronutrients in soils. Soil Sciences. 1992; 153:100-107.