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Appraisal of changes in bulk density and nitrogen content of a vertisol as affected by land use practices and depth

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Abstract
Field study was conducted at Borlaug Institute for South Asia (BISA) Research Farm, Lakhnwara, Jabalpur to evaluate the changes in bulk density and nitrogen (available and total) contents of a Vertisol as affected by land use practices and depth of soil after harvest of *kharif* and *rabi* seasons of 2015-16. Soil samples were collected with the help of core auger from the fields practiced with different land uses [L_1: Uncultivated, L_2: rice-wheat system with conventional agriculture (CS), L_3: rice-wheat system with conservation agriculture (CA), L_4: soybean-wheat system with CS, L_5: soybean-wheat system with CA, L_6: maize -wheat system with CS and L_7: maize-wheat system with CA] at 0-5 cm, 5-15 cm and 15-30 cm depths. For statistical analysis of data in split plot design land use practices were considered as main plot and depth (0-5 cm, 5-15 cm and 15-30 cm) as sub-plot treatments with three replications. It was found that bulk density was significantly affected by land use practices over soil depths with highest (1.51 and 1.49 Mg m-3) under uncultivated (L_1) and lowest in maize -wheat system with CS (L_6) treatments, respectively for kharif and rabi season. Bulk density of soil in 5-15 cm depth was lowest (1.36 Mg m^{-3}) during both the seasons as compared those in 0-5 cm and 15-30 cm soil depths.

Keywords: Land use practices, soil depth, bulk density, available nitrogen, total nitrogen, conservation agriculture, conventional agriculture

Introduction
Land use practices in any agricultural system primarily regulate the sustainability production system and soil quality. Bulk density is one of the key physical properties of soil and has direct impact on crop emergence, root respiration and availability of nutrients and water. Changes in land use practices have shown significant impact on soil carbon and nitrogen cycling and bulk density (Cao *et al.*, 2009; Jiao *et al.*, 2012) [4, 13]. There is substantial concern about change in land use practise could alter soil carbon (Houghton, 1999) [11] and nitrogen (Potter *et al.*, 1996) [21] cycles. Agricultural practices which enhance organic carbon and N contents in soil play a crucial role in sustaining soil health, crop production and environmental quality (Bauer and Black, 1994; Robinson *et al.*, 1994) [2, 23]. Conservation agriculture is one of such practices which promote buildup of organic carbon in soil and improve soil physical, chemical and biological properties in long term (Sainju and Kalisz, 1990) [24]. C: N ratio is often influenced by many factors such as soil conditions (Yamashita *et al.*, 2006) [27], vegetation types (Puget and Lal, 2005) [22] and agricultural management practices (Zhang *et al.*, 2009; Parras-Alcantara *et al.*, 2013) [28, 18]. It is important to maintain soil aggregate stability to promote soil efficiency, productivity, and to minimize soil losses (Peng *et al.*, 2015) [19]. Loss of soil organic carbon under cultivation is connected to the destruction of macro-aggregates, pore size distribution and connectivity together with bulk density (Elliott, 1986 and Cerda, 1996) [8, 5]. In view of the above facts, the present study was undertaken to evaluate the changes in bulk density and nitrogen content in a Vertisol as influenced by land use practices and depth of soil during kharif and rabi seasons.

Materials and Methods
Study was carried out during kharif and rabi seasons of 2015-16 after harvest of each season crops at BISA Research Farm, Jabalpur (23^0 33' N latitude, 80^0 04' E longitudes and at an altitude of 407.0 metre above mean sea level) having swell-shrink type of soil with dark grayish brown colour and classified as fine, smectitic, hyperthermic family of *Typic Haplusterts* (Vertisols). Study was initiated with seven land use practices [L_1: Uncultivated, L_2: rice-wheat system with conventional agriculture (CS), L_3: rice-wheat system with conservation agriculture (CA), L_4: soybean-wheat system with CS, L_5: soybean-wheat system with CA, L_6: maize -wheat system with CS and L_7: maize-wheat system with CA] as main

plots and three depths (0-5 cm, 5-15 cm and 15-30 cm) of soil as sub plots which were replicated thrice in split plot design. Soil samples were collected as per the treatments with the help of core auger to determine the bulk density of soil following standard procedure. Soil samples were air dried in shade then ground by wooden pastle and mortar, passed through 2.0 mm sieve and analysed for available and total nitrogen contents in soil. Available nitrogen in soil was determined by the alkaline permanganate method (Subbiah and Asija, 1956) [25] and total nitrogen was determined by Kjeldahl method using KEL PLUS as described by (Piper, 1950) [20]. The data obtained on different parameters were analyzed for test of significance using standard statistical procedure given by Gomez and Gomez, (1984) [10].

Results and Discussion

Bulk density of soil

Data pertaining to the effect of land use practices and soil depths on bulk density after harvest of kharif and rabi season crops in 2015-16 has been presented in Table 1. It was found that bulk density of soil was significantly affected by land use practices and highest (1.51 and 1.49 Mg m^{-3}) values have been recorded under L_1: uncultivated land and lowest (1.32 and 1.32 Mg m^{-3}) in L_6: maize -wheat system with conventional agriculture for both the respective season. The data further revealed that bulk density of soil at 5-15 cm was lowest (1.36 and 1.36 Mg m^{-3}) as compared to those recorded for 0-5 cm (1.37 and 1.37 Mg m^{-3}) and 15-30 cm (1.38 and 1.40 Mg m^{-3}) soil depths after harvest of kharif and rabi season crops, respectively. Similar finding have also been reported by Mengistu *et al.*, (2017); Neris, (2012) and Brady and Weil, (2008) [15, 17, 3] which revealed that pore spaces and organic matter in soils have been inversely related to bulk density and directly affected due to land use practices. Higher bulk density at lower soil depth under conventional tillage was might be due to the formation of a traffic pan (Jat *et al.*, 2017) [12]. The interactive effect of land use practices and soil depth on bulk density was found non-significant.

Available nitrogen

The data on available N content in soil after harvest of the kharif and rabi season crops of 2015-16 (Table-2) exhibited significant variation due to land use practices and different depths. It is evident from the data that available N content under conservation agriculture (CA) was higher than conventional system (CS) in respective of cropping system but significant difference exist only for rice-wheat system. Highest available N content (166.8 kg ha^{-1}) was recorded under L_3: rice-wheat system with CA and lowest (130.8 kg N ha^{-1}) under the L_1: Uncultivated in after harvest of kharif crop. However, after harvest of rabi season crops, available N content was recorded highest (199.3 kg ha^{-1}) under L_5: soybean-wheat system with CA and lowest (160 kg N ha^{-1}) under the L_6: maize -wheat system with CS. It was also found that available N content was significantly affected by soil depth after both the seasons and surface soil (0-5 and 5-15 cm) had higher content of available N as compared to sub-surface (15-30 cm) soil. It was also found that available N content in soil after harvest of rabi season crops was higher than those of kharif season crops at every depth. Similar findings were also reported by Jat *et al.*, (2017) [12] and Kaur and Bhat, (2017) [14] which reflected that available N was significantly influenced by different CA based practices at both the surface and sub-surface soil depths. Available N concentration decreased with increase in soil depth. CA-based practices are reported to cause greater accumulation of nutrients in surface layer as compared to conventional tillage. The interactive effect of land use practices and soil depth was also found significant.

Total nitrogen

Land use practices and soil depth significantly affected the total nitrogen content in soil but interactive effect was not significant after harvest of kharif rabi crops during 2015-16 (Table-2). Highest total N content (0.129% and 0.137%) was obtained under L_3 (rice-wheat system with CA) followed by L_5 (soybean-wheat system with CA) and lowest (0.102% and 0.105%) under the L_1 (Uncultivated) followed by L_6 (maize-wheat system with CS) treatments. Higher quantity of residue additions and their slow decomposition due to less soil disturbance might have caused higher total N concentrations in CA system (Du *et al.*, 2010 and Dikgwatlhe *et al.*, 2014) [7, 6]. Total N content in upper soil layer (0-5 cm) was significantly higher than those in 5-15 cm and 15-30 cm soil depth. Maximum total N (0.150 and 0.147%) content was found in 0-5 cm depth and minimum (0.091 and 0.099%) in 15-30 cm soil depth, respectively during both the seasons. The result of the present study agrees with the findings of Adugna and Abegaz, (2015) and Gbadegesin *et al.*, (2012) [1, 9] who attributed the decrease in total nitrogen with increasing depth to declining humus with depth. In consent with the trends found in this study, various studies reported lower total nitrogen content in soils of cultivated lands as compared to soils of natural forest lands or without tillage practices and N mineralization levels were also higher in NT than under conventional tillage by Nahusenay and Kibebew (2016) and Taye, (2011) [16, 26]. The interaction effect of land use practices and depths on total N was found to be statistically non-significant.

Conclusion

Findings of the present study revealed that bulk density of soil under uncultivated land was significantly higher than cropping systems under conservation or conventional practices. Different cropping systems under conservation agriculture practice improved bulk density and nitrogen (available and total) content of soil. Available and total nitrogen content in surface soil increased under conservation agriculture practice irrespective of cropping systems. It has been concluded that land use practices reflects significant impact on soil properties (bulk density and nitrogen content at different depth of soil.

Table 1: Effect of land use practices on bulk density of soil in different depths

Main Plot (Land use practices)	Bulk density (Mg m^{-3})	
	After harvest of kharif crops	After harvest of rabi crops
L_1:Uncultivated	1.51	1.49
L_2:R-W system-CT	1.40	1.41
L_3:R-W system-CA	1.36	1.36
L_4:S-W system-CT	1.35	1.34
L_5:S-W system-CA	1.33	1.34
L_6:M-W system-CT	1.32	1.32
L_7:M-W system-CA	1.34	1.36
SEm ±	0.010	0.032
C.D. ($p=0.05$)	0.032	0.097
Sub-Plot (Soil depth)		
D_1: 0-5 cm	1.37	1.37
D_2: 5-15 cm	1.36	1.36
D_3: 15-30 cm	1.38	1.40
SEm ±	0.006	0.016
C.D. ($p=0.05$)	0.019	0.046

Table 2: Effect of land use practices on available nitrogen and total nitrogen content of soil in different depths

Main Plot (Land uses practices)	Available nitrogen (kg N ha^{-1})		Total nitrogen (%)	
	After harvest of kharif crops	After harvest of rabi crops	After harvest of kharif crops	After harvest of Rabi crops
L_1:Uncultivated	130.8	172.0	0.102	0.105
L_2:R-W system-CT	147.0	168.3	0.106	0.106
L_3:R-W system-CA	166.8	194.7	0.129	0.137
L_4:S-W system-CT	155.7	185.0	0.114	0.114
L_5:S-W system-CA	163.1	199.3	0.126	0.129
L_6:M-W system-CT	146.8	160.0	0.111	0.111
L_7:M-W system-CA	150.3	174.7	0.124	0.125
SEm ±	4.97	7.8	0.0054	0.0050
C.D. ($p=0.05$)	15.33	24.2	0.0161	0.0154
Sub-Plot (Soil depth)				
D_1: 0-5 cm	88.7	121.3	0.150	0.147
D_2: 5-15 cm	151.0	160.6	0.108	0.109
D_3: 15-30 cm	214.8	255.6	0.091	0.099
SEm ±	3.33	4.70	0.0042	0.003
C.D. ($p=0.05$)	9.66	13.6	0.0122	0.009
Main x Sub treatment				
SEm±	8.82	12.4	0.0111	0.0079
CD(p=0.05)	25.57	35.9	NS	NS

References

1. Adugna A, Abegaz A. Effects of soil depth on the dynamics of selected soil properties among the highlands resources of Northeast Wollega, Ethiopia: are these sign of degradation? Solid Earth Discuss. 2015; 7:2011-2035.
2. Bauer A, Black AL. Quantification of the effect of soil organic matter content on soils productivity. Soil Science Society of America Journal. 1994; 58:186-193.
3. Brady NC, Weil RR. The nature and properties of soil, ed. Prentice-Hall, Upper Saddle River, New Jersey, 2008, 14.
4. Cao SX, Zhong BL, Yue H, Zeng HH, Zeng JH. Development and testing ofa sustainable environmental restoration policy on eradicating the poverty trapin China’s Changting county. PNAS. 2009; 106(26):10712-10716.
5. Cerda A. Soil aggregate stability in three Mediterranean environments. Soil Technol. 1996; 9:133-140.
6. Dikgwatlhe SB, Chen Z, Lal R, Zhang H, Chen F. Changes in soil organic carbon and nitrogen as affected by tillage and residue management under wheat–maize cropping system in the North China Plain. Soil Tillage Res. 2014; 144:110-118.
7. Du Z, Ren T, Hu C. Tillage and residue removal effects on soil carbon and nitrogen storage in the North China Plain. Soil Sci Soc Am J. 2010; 74:196-202.
8. Elliott ET. Aggregate structure and carbon, nitrogen, and phosphorus in native and cultivated soils. Soil Sci. Soc. Am. J. 1986; 50:627-633.
9. Gbadegesin AS, Abugiam TA, Ata JE. Variation in Soil Properties on Cassava production in Southern Nigeria. Journal of Geography and Geology. Canada Center of Science and Edu. 2012; 3(1):94-103.
10. Gomez AA, Gomez KA. Statistical procedures for Agricultural research.2nd Edn. John Wiley and Sons, New York, 1984.
11. Houghton RA. The annual net flux of carbon to the atmosphere from changes in land use 1850-1990. Tellus. 1999; 51B:298-313.
12. Jat HS, Datta Ashim, Sharma PC, Kumar Virender, Yadav AK, Choudhary Madhu *et al*. Assessing soil properties and nutrient availability under conservation agriculture practices in a reclaimed sodic soil in cereal-based systems of North-West India, Archives of Agronomy and Soil Science, 2017; DOI: 10.1080/03650340. 1359415.
13. Jiao Y, Zhu X, Zhao JH, Yang WZ. Changes in soil carbon stocks and relatedsoil properties along a 50-year grassland-to-cropland conversion chronose-quence in an agro-pastoral ecotone of Inner Mongolia, China. J Arid Land. 2012; 4(4):420-430.
14. Kaur Rajwinder, Bhat ZA. Effect of different agricultural land use systems on physico-chemical properties of soil in sub-mountainous districts of Punjab, North-West India. Journal of Pharmacognosy and Phytochemistry. 2017; 6(3):226-233.
15. Mengistu C, Kibebew K, Tarekegn F. Influence of Different Land Use Types and Soil Depths on Selected Soil Properties Related to Soil Fertility in Warandhab Area, Horo Guduru Wallaga Zone, Oromiya, Ethiopia. Int J Environ Sci Nat Res. 2017; 4(2):555634.
16. Nahusenay Abate, Kibebew Kibret. Effects of Land Use, Soil Depth and Topography on Soil Physicochemical Properties along the Topo-sequence at the Wadla Delanta Massif, North central Highlands of Ethiopia. Environment and Pollution. 2016; 5(2).
17. Neris Jimenez. Vegetation and land-use effects on soil properties and water infiltration of Andisols in Tenerife. 2012; 98:55-62.
18. Parras-Alcantara L, Martin-Carrillo M, Lozano-Garcia B. Impacts of land use change in soil carbon and nitrogen in a Mediterranean agricultural area (Southern Spain). Solid Earth. 2013; 4:167-177.
19. Peng X, Yan X, Zhou H, Zhang YZ, Sun H. Assessing the contributions of sesquioxides and soil organic matter to aggregation in an Ultisol under long-term fertilization. Soil Tillage Res. 2015; 146:89-98.
20. Piper CS. Soil and Plant Analysis. Intel Science Publishers. Inc. New York, 1950.
21. Potter CS, Matson PA, Vitousek PM, Davidson EA. Process modeling of controls on nitrogen trace gas emissions from soils worldwide. Journal of Geophysical Research. 1996; 101(D1):1361-1377.
22. Puget P, Lal R. Soil organic carbon and nitrogen in a Mollisol in central Ohio as affected by tillage and land use, Soil Till. Res. 2005; 80:201-213.

23. Robinson CA, Cruse RM, Kohler KA. Soil management. In: Hatfield, J.L. and D.L. Karlen (Eds.), Sustainable Agricultural Systems. CRC Press, Boca Raton, FL, 1994; 109-134.
24. Sainju UM, Kalisz PJ. Characteristics of “coal bloom” horizons in undisturbed forest soils in eastern Kentucky. Soil Science Society of America Journal. 1990; 54:879-882.
25. Subbiah BV, Asija EC. A rapid procedure for estimation of available nitrogen in soil. Curr. Sci. 1956; 25:259-260.
26. Taye K. Chemical properties of wild coffee forest soils in Ethiopia and management implications. Agricultural Sciences. 2011; 2(4):443-450.
27. Yamashita T, Feiner H, Bettina J, Helfrich G, Ludwig B. Organic matter in density fractions of water-stable aggregates in silty soils: effect of land use, Soil Biol. Biochem. 2006; 38:3222-3234.
28. Zhang T, Wang Y, Wang X, Wang Q, Han J. Organic carbon and nitrogen stocks in reed meadow soils converted to alfalfa fields, Soil Till. Res. 2009; 105:143-148.