J. Soils and Crops 31 (2) 247-250, December 2021

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

EFFECT OF DIFFERENT CROPPING SYSTEM ON SOIL STRENGTH IN CALCAREOUS SOIL

Sanjay Kumar Singh[1], Vivek Kumar[2], Pankaj Singh[3], Sanjay Tiwari[4], A. K. Singh[5], A. K. Pant[6] and Munmun Majhi[7]

ABSTRACT

A significant changing has been observed with soil health under diversification of cropping system to obtain increased yield along with better economic followed the common agricultural practices.The objective of this study was to know the strength of soil on continuous taking different cropping system on same piece of land. In this study, total twenty seven soil samples were collected at harvest from each of nine sites (cropping system) after the end of each cropping cycle. The local coordinates of each sample were recorded with the help of GPS device and the soil samples were brought to the laboratory for analysis.The variation in results obtained with respect to soilbulk density,lowest bulk density (1.21 Mg m^{-3}) was recorded in mustard-mungbean lying on longitude 25^{0}59'37.67'N and latitude 85^{0}36'80.48'E followed by pigeonpea cropping system (1.24 Mg m^{-3}), lying on longitude 25^{0}59'35.68'N and latitude 85^{0}35'43.19'E.The soil strength were assessed at various levels of soil depths. Initially surface soil strength recorded high upto 20 cm in each cropping system might be due to root density and accumulation of clay. However, the higher soil compaction was recorded in soils from 0 to 60 cm depth where cultivating rice-wheat crops since long time which requires crop ration for better maintaining the soil conditions.The consistency of soil strength with conepenitrometer is not recorded steady with soil depth in all cropping systems.

(Key words: Cropping system, conepenitrometer, soil moisture content, bulk density, GPS)

INTRODUCTION

The continuous cropping for many years on same piece of land may influence the physico-chemical characteristics of the soil, where crops grown under different cropping systems may cause changes in soil organic matter content, nutrient cycling and carbon sequestration for soils (Acsosta-Martínez, 2011). The diversification of cropping system is necessary to obtain increased yield along with economic gain along with maintenance of soil quality, optimum utilization of available resources and meet daily requirement of human. A significant changing in soil health has been observed within the soil boundary under variation in cropping system which followed the common agricultural practices. The soil physical conditions are strongly related with the soil structures and aggregates resulting from tillage operation and addition of organic residues into the soil for better growth and yield of crops. Bulk density of soil is a major soil physical factor, affected by tillage operation by the, using of heavy agricultural machineries and implements in the field, causing enhanced soil bulk density which restrict root extension and movement of water and air through the soil (Dexter *et al*., 2008).Traction force in arable soils is also affected by soil physical parameters *viz*., soil moisture and compaction which increases the power consumption (Tim Chamen *et al*., 2015). The impact of cropping system in the study area on calcareous soil, using various management practices may have changed the chemical properties, biological activity and nutrient status that also leave separate impact on soil conditions and strength of soil at various soil depth. The soil cone index a measure of a soil's resistance to penetration (MPa), is a commonly used soil mechanical property to determine soil strength (Lowery and Morrison, 2002). This strength generally increases with the increasing clay content, coarse fragment and soil density found reduced pore space but decreases with the increasing

1. Asstt. Professor-cum-Scientist, Dept. of Soil Science, Tirhut college of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar
2. Laboratory Technician, Dept. of Agronomy, Dr.Rajendra Prasad Central Agricultural University, Pusa, Bihar
3. Asstt. Professor-cum-Scientist, Dept. of Soil Science, Dr.Rajendra Prasad Central Agricultural University, Pusa, Bihar
4. Assoc. Professor-cum- Sr.Scientist, Dept. of Soil Science, Dr.Rajendra Prasad Central Agricultural University, Pusa, Bihar
5. Asstt. Professor-cum-Scientist, Dept. of Soil Science, Dr.Rajendra Prasad Central Agricultural University, Pusa, Bihar
6. Sr. Res. Officer, Dept. of Soil Science, GBPUA&T, Pantnagar, Uttarakhand
7. P.G. Student (Ag.), Dept. of Soil Science, UVKV, Cooch Bihar, West Bengal

soil moisture and organic matter content (Marino-France and Paul, 2017). The instrument cone penetrometer can operated more easily to penetrate in non-cohesive soils *viz.*, sands and sandy loams than clay soils (Kumar *et al.*,2012). The organically enriched soils and moist soils have low penetration resistances, whereas, high for stony and frozen soils (Bronick and Lal, 2005).

The correlations between penetration resistance and measured volumetric water content and bulk density data often display exponential relationships that are known to depend on such soil properties as texture, mineralogy and organic matter content (Carlos *et al.,* 2013). Keeping these facts in view, the objective of the present study was to investigate the physical changes in soil resistance under different cropping system in calcareous soil. The research needs more extensive tests before its general applicability in agricultural field.

MATERIALS AND METHODS

The study was conducted in 2017-18 at research farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar, where, different types of cropping systems had been continued on the same piece of land for more than five years. Each crop cycle was maintained with their normal package of practices that was irrigation scheduled and recommended fertilizer application without any stress condition.

The location of study was situated on the southern bank of the river Burhi Gandakat at an elevation of 52.18 meter above mean sea level and intersected by 25.98^{0}N latitude and 85.60^{0}E longitude. The prevailing climate since last five years was dry during summer, moderate rainfall and cool in the winter season. The cropping systems studied were covered at nine different locations with different crops including fallow land depicted in fig. 1.

The research sites represented upland with fairly uniform topography and the soil was deep, well drained alluvial having alkaline in reaction.

A total twenty seven soil samples were collected at harvest from each of nine sites (cropping system) after the end of each cropping cycle. The local coordinates of each sample were recorded with the help of GPS device and the soil samples were brought to the laboratory for analysis. Organic matter of the soils was estimated by chromic acid wet digestion method given by Walkley and Black (Jackson, 1967).The bulk density was determined by core sampler method (Jackson, 1973) and expressed in Mg m^{-3}. Soil moisture content measured in laboratory by using gravimetric method.The soil strength was determined by using a digital cone penetrometer (Model, DIK-5532).

RESULTS AND DISCUSSION

The data obtained from the investigation, on variations in soil properties, strength and soil moisture content recorded under different cropping systems. The changes in soil strength were recorded under cropping system presented in maps and graphs. The soil conditions changed due to the continuous follow of the different cropping systems at fixed land for many years. The data obtained regarding soil organic carbon distribution in soils with nine different cropping systems are presented in Map 2**,** where, less than 0.5% organic carbon content was recorded in soils with cropping systems *viz*., turmeric-mungbean, tuber-mungbean, rice-wheat, onion-garlic and fallow land. However, the rest of cropping systems recorded organic carbon ranging between 0.5-0.75 per cent as depicted in Map 2. The lowest organic carbon (0.33%) was recorded in fallow land site lying on longitude 25^{0}59'30.59'N and latitude 85^{0}35'57.36'E, while the highest OC (0.63%) was recorded in pigeonpea system lying on longitude 25^{0}59'35.68'N and latitude 85^{0}35'43.19'E in the study area. The variation in organic carbon (0.16 to 0.89%) was also reported by (Sweta *et al*., 2017; Potdar *et al*.,2020).

The fallow land recorded higher soil bulk density as compared to the rest of the cropping system. The lowest bulk density (1.21 Mgm^{-3}) was recorded in mustard mungbean lying on longitude 25^{0}59'37.67'N and latitude 85^{0}36'80.48' E followed by pigeonpea cropping system (1.24 Mg m^{-3}), lying on longitude 25^{0}59'35.68' N and latitude 85^0 35' 43.19'E,whereas more than 1.3 Mg m^{-3} bulk density was recorded under tuber-mongbean (1.31), rice-potato (1.31), maize-maize (1.31), rice-wheat (1.35) and turmeric-moongbean (1.36 Mg m^{-3}), cropping systems. The data regarding range of bulk density are given in figure 3 with colour variation. The reduction in bulk density of some cropping system under study might be attributed to the higher soil organic carbon due to more additionof roots and plant biomass as compared to the fallow land (Balpande *et al*., 2020).

The fluctuation in soil moisture content (%) determined in surface and subsurface soil at three soil depths in the study area of different cropping system are depicted in figure 1.The influence of the soil water content is appreciable as the soil compaction decreases.

Variations in soil strength under different cropping systems

The conepenitrometer is commonly used to measure the strength of soil profile when penetrating at a certain speed. Soil compaction begins to inhibit the root growth of most plants when the soil's strength is about 1,500 kPa. Penetrometers can help to identify root penetration and its extension within the rhizospheric zone against soil strength. The soil strength were assessed at various levels of soil depths are shown in Figure 2.The higher soil compaction was recorded in soils from 0 to 60 cm depth where cultivating rice-wheat crops than the other crops.It might be due to more soil compaction found under waterlogged conditions and also due to rigidness of root biomass.However, in pigeonpea cropping system, low soil resistance was found initially upto 20 cm depth and it has also less increased with the soil depth in comparison to other cropping systems. Due to more deposition of leaf litters, it contains high organic matter make soils strength weakens. Root growth is also largely limited to the plough layer or dense layers induced by pedogenetic compaction in the soil profile (Birkás *et al*.,2000). Usually, such layers can be localized at sites with the maximum bulk density and the cone resistance in the soil profile (Lipiec and Nosalewicz, 2000) or aeration parameters in wet soil (Glinski and Stepniewski, 1985).

The surface soil strength initially recorded high upto 20 cm. However, consistency of soil strength was not recorded as usual with soil depths. The data obtained in variation of soil strength under different cropping systems are given in Figure 2.This variation may occur probably due to variation in ground conditions. An increase in subsoil compaction resulted due to higher concentration of roots and accumulation of clay content in the subsoil layer. In general, this effect increased with the increasing depth and thickness of the dense layer (Birkás *et al*.,2000).

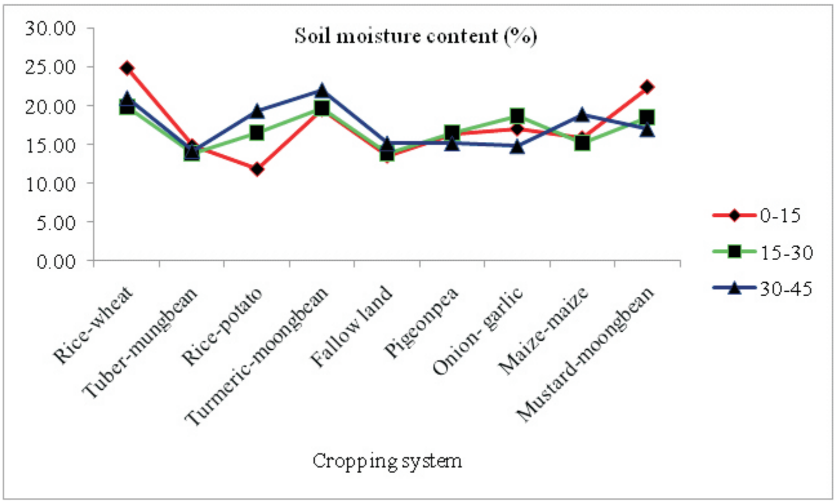


Figure1.The fluctuation in soil moisture content under different cropping systems

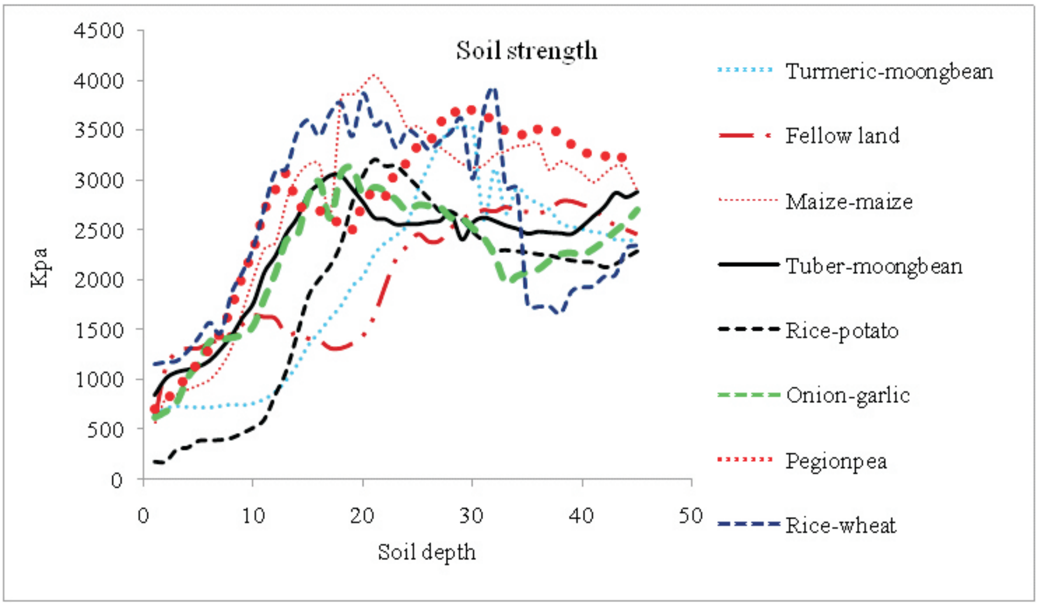
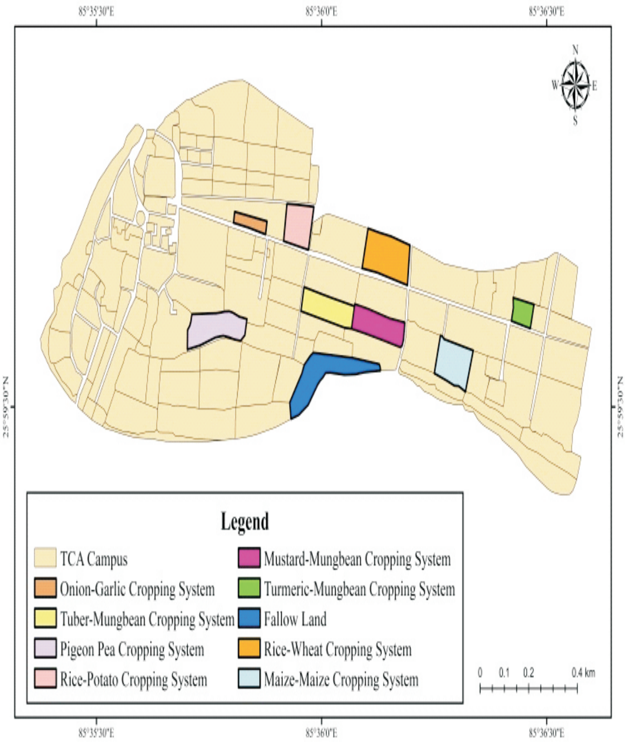
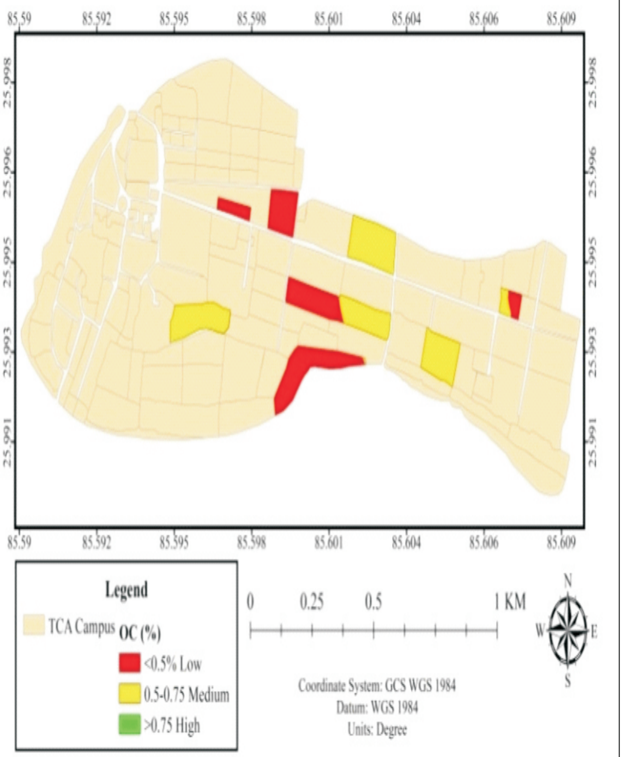


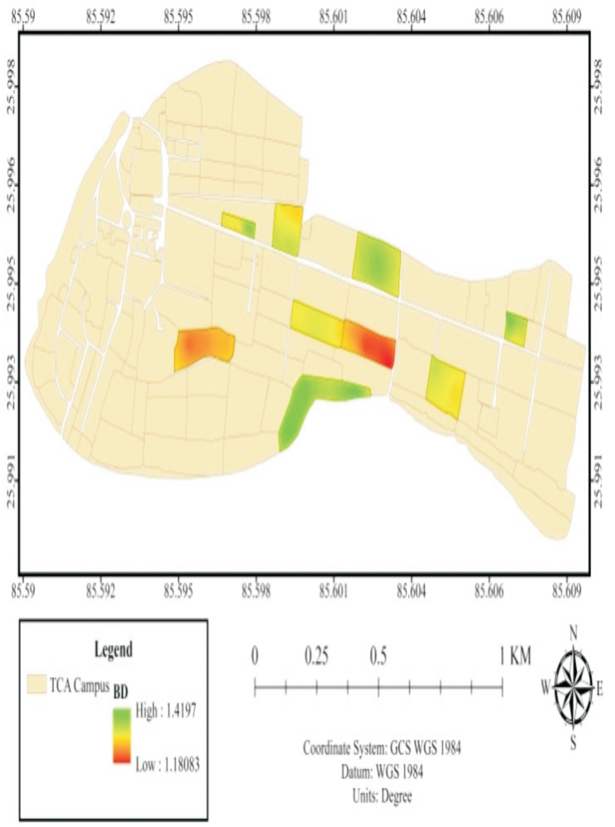
Figure 2. Soil strength at various levels of soil depths in different cropping systems



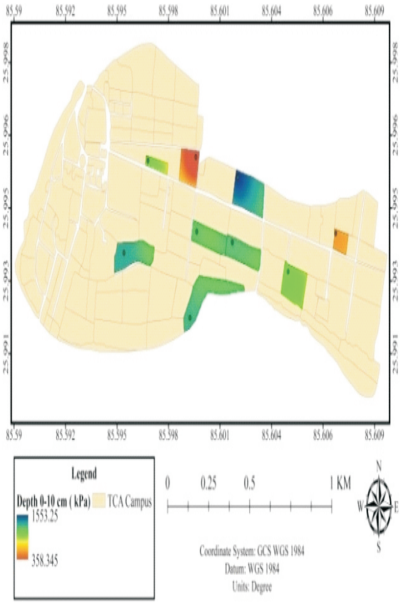
Map 1. Description of the study area of different cropping system



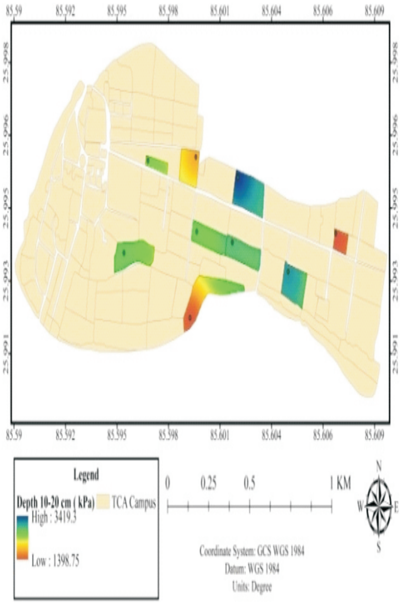
Map 2. Distribution of soil organic carbon % at different cropping systems



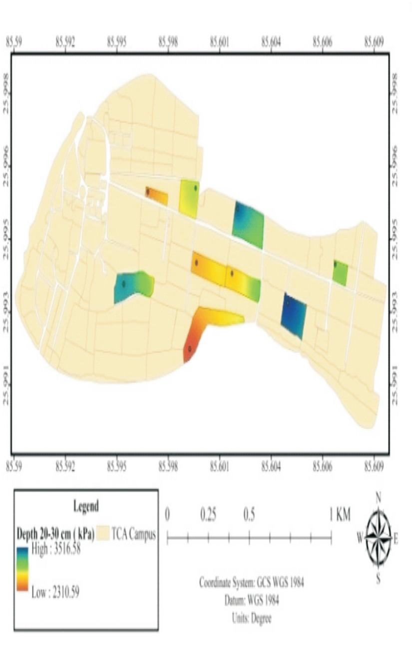
Map 3. Distribution of bulk density (mg m^{-3}) in different cropping system



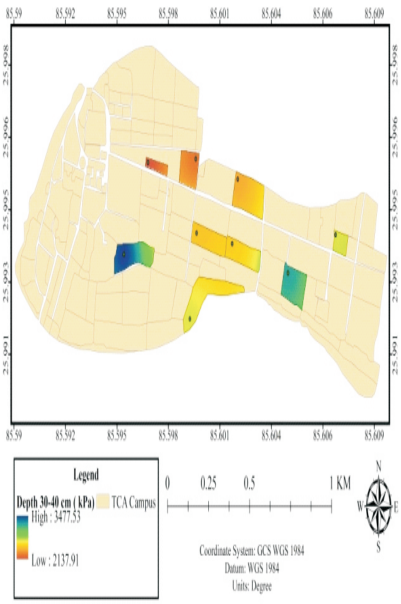
Map 4



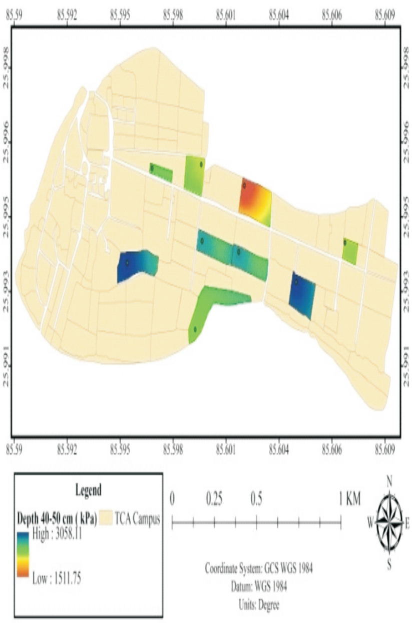
Map 5



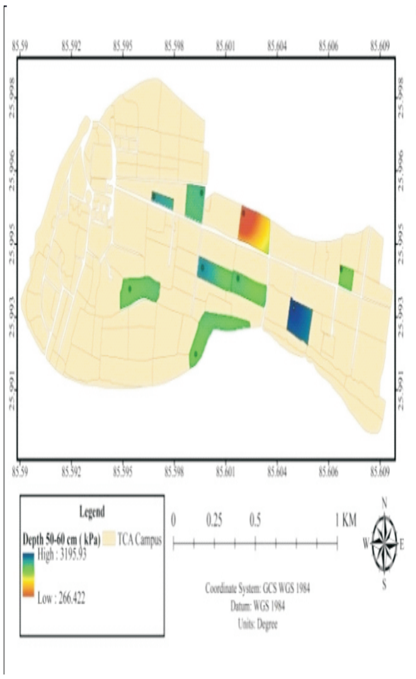
Map 6



Map 7



Map 8



Map 9

Map 4,5,6,7,8& 9 showed distribution of soil strength at different soil depths under various cropping systems

REFERENCES

Acosta-Martínez, V. Lascano, R. Calderón, F. Jill, D. Booker, Ted, M. Zobeck, R. Dan and Upchurch, 2011.Dryland cropping systems influence the microbial biomass and enzyme activities in a semiarid sandy soil. Biol. and Fert. Soils.**47**:655-677.

Balpande, S. S, R. M. Ghodpage, A. R. Mahaske, W. P. Badole and S. N. Deotale, 2020. Soil quality of various cropping systems in Rahatmicro watershed of Vidarbha. J. Soils and Crops **30(1):** 185-190.

Black, C.A. 1965. Methods of Soil Analysis.Part I and II. American Society of Agronomy Inc., Madison, Wisconsin, U.S.A.

Birkás, M.C.S,Gyuricza, M. Jolánkai, T.Szalai, M.Gecse, and A. Percze, 2000. Crop responses to subsoil compaction.Proc. 2nd Int. Conf. on Subsoil Compaction (ISBN 963 9256 161), 29–31 May, 2000, Gödöllo, Hungary, 58–63.

Bronick, C.J. and R.Lal, 2005 Soil Structure and Management: A Review. Geoderma, **124**:3-22.

Carlos, M. P. V, M. M. Juliana, C. D. M. Isabella, and T. V. G. Martinus, 2013.Scaling the dependency of Soil Penetration Resistance on Water Content and Bulk Density of Different Soils.J. Soil Sci. Soc. America. **77**:1488–1495.

Dexter, A.R.G. Richard, D. Arrouays, E. A. Czyz, C. Jolivet, and O. Duval, 2008. Complexed organic matter controls soil physical properties. Geoderma.**144**:620-627.

Gliñski J. and W. Stêpniewski, 1985.Soil Aeration and Its Role for Plants. CRC Press, Boca Raton, FL, USA.

Jackson, M.L,1973.Soil Chemical Analysis. New Delhi, Prentice Hall, 48–302.

Kumar, A., Y. Chen, A. Sadek, and S. Rahman, 2012. Soil Cone Index in Relation to Soil Texture, Moisture Content, and Bulk Density for No-Tillage and Conventional Tillage. Agriculture Engineering International : CIGR J.**14**: 26-37.

Lipiec, J. and A. Nosalewicz, 2000. The influence of subsoil compaction on the early growth of wheat. Proc. 2nd Int. Conf. on Subsoil Compaction (ISBN 963 9256 161), 29–31 May 2000, Gödöllo, Hungary, 181–185.

Lowery, B. and J. E. Morrison,2002.Soil Penetrometers and Penetrability. In: Methods of Soil Analysis , Part 4. Physical Methods , Soil Sci. Soc. of America, Inc., Madison,WI, 363-385.

Marino-France, J.And A. A. Paul, 2017. Relating cone. penetration and rooting resistance to variation in forest soilproperties and daily moisture fluctuations. Open J. Soil Soc. pp. 149-171.

Potdar, S. S, V.V, Gabhane, H. Potdar, S. P. Wagh, M. Pudsekar and S. R. Imade, 2020. Soil quality assessment and mapping for management of resources using geospacial techniques of schegoan watershed, dist, Chandrapur, J. Soils and Crops. **30** (**2**): 290-297.

Sweta, B. P, O. D. Kuchanwar, M. A. Kore and N. K. Chopde, 2017. Assessment of soil site suitability for Nagpur mandarin in eastern part Nagpur district. J. Soils and Crops, **27**(**1**): 212-218.

Tim Chamen, W. C. A. P, W.Moxey, B. Towers, P. D. Balana andHallett,2015."Mitigating arable soil compaction: A review and analysis of available cost and benefit data", Soil and Till. Res., ISSN: 0167-1987, **146**: 10-25.

Rec. on 22.06.2021 & Acc. on 27.06.2021