International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; SP6: 718-720

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(Special Issue -6)
3rd National Conference
On
PROMOTING & REINVIGORATING AGRI-HORTI, TECHNOLOGICAL INNOVATIONS
[PRAGATI-2019]
(14-15 December, 2019)

Effect of residue retention on soil quality parameters under conservation agriculture in vertisols of central India

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Abstract
Conservation Agriculture (CA) is an advance approach to achieve improved soil health and ecologically and economically sustainable agriculture. Residue management under CA restricts its adoption by the farmers resulting in *in-situ* burning of the crop residues. This burning of the residues pollutes the environment and also results in loss of essential plant nutrients, and adversely affects beneficial soil micro-flora and fauna. Therefore, a field study was conducted in an ongoing CA field experiment to evaluate the effect of residue management practices on soil quality parameters under maize (*Zea mays* L.) chickpea (*Cicer arietinum* L.) cropping system in Vertisols of central India. The experiment was conducted in randomized complete block design with six replications and four treatments comprising different residue retention levels. The results showed improved physical properties of soil *viz.* bulk density and porosity at 0-5 and 5-10 cm depth with residue retention under CA. The maximum soil organic carbon (1.01%) was recorded with 90% residue which was followed by 60% and 30% residue retention level. Therefore, by following the CA-based residue management practices can help in improved soil quality along with the advantage of higher and sustained crop productivity.

Keywords: Residue, soil quality, conservation agriculture, vertisols

Introduction

Soil health is a dynamic and complex system, and its functions are mainly mediated by agricultural management practices (Doran and Zeiss, 2000) [5]. Soil with better health and quality will be able to produce higher crop yield under favourable as well as extreme climatic conditions. Soil health acts as a critical component for adaptation and mitigation of climate change effects by the crops (Congreves *et al*., 2015) [4]. Residue management practices under CA can affect crop performance and soil health. It is reported that crop residue management provides an opportunity to protect the topsoil, enriched with organic matter, moderate soil temperature, improve soil biological activities and also enhance the water and nutrient use efficiency (Gathala *et al*., 2011; Jat *et al*., 2012) [6, 9].

In India, about 500-550 million tonnes (Mt) of crop residue is produced annually (Bhan and Behra, 2014) [1] and nearly 90-140 Mt annually, is burnt on-farm primarily to clear the fields to facilitate timely sowing of succeeding crops. Burning of crop residues leads the release of dust particles and smoke causing human health problems; emission of greenhouse gases; loss of essential plant nutrients; adverse impacts on soil properties and wastage of valuable crop residues. Retaining plant residues on the soil surface under CA can sustain organic carbon content, improve soil physical properties, enhance biological activities and increase nutrient availability. Residue management under CA could be one of the potential practices for conserving soil and water along with soil health benefits in vertisols of central India (Salem *et al*., 2015). Further, CA can help to address the issues of resource degradation, declining factor productivity, climate-change-induced variability, and also help in maintaining the soil health and the overall sustainability of the system. Crop residue management under CA has been reported to improve crop productivity and profitability, bulk density, availability of nutrients and soil organic carbon stock (Jemai *et al*., 2013; Choudhary *et al*., 2018) [10, 3].

Residue retention also play a major role in improving soil health by increasing the number and diversity of soil micro-organisms (Doran and Zeiss, 2000) [5]. Alterations in tillage, residue recycling, and crop rotation practices induces significant changes in the quantity and quality of plant residue entering the soil, which influence soil microorganisms and soil microbial processes (Govaerts *et al*., 2007; Choudhary *et al*., 2018) [7, 3]. Microbes function as agents of transformation of organic matter, nutrient cycling, and energy flow among other functions (Six *et al*., 2004) [14] that invade sustainability. However, the benefits of CA with residue retention vary from location to location and depend on management practices, agro-climatic condition, and type of soil. The differential effect of residue retention under CA in vertisols of central India under long term experiment needs in-depth study and documentation on various aspects of soil health parameters. Therefore, the present study has been conducted in an ongoing long-term field experiment under CA to find out the effect of crop residues on soil quality parameters.

Materials and Methods

The field study was conducted in an ongoing experiment under CA at the research farm of ICAR–IISS, Bhopal during *Rabi*, 2018-19. The mean annual precipitation of experimental site was 1094 mm, with clay (*typic Vertisols*) texture, and medium in organic C, low in available nitrogen (N), and high in available phosphorus (P) and available potassium (K). The experiment was conducted in a randomized complete block design with six replications and four treatments including 0% residue level; 30% residue level; 60% residue level and 90% residue level of the preceding crop. Zero tillage was followed in all the residue retained treatment and conventional tillage in without residue retained treatments. The sowing of the chickpea was done using variety RVG-202 by Turbo Happy in anchored maize residue with the seed rate of 80 kg ha^{-1}. N, P and K were uniformly applied @ 30, 60 and 40 kg ha^{-1}, respectively to all the plots. Two irrigations were applied; first irrigation was applied immediately after the sowing and second at 40 days after sowing. For effective weed control, a pre-emergence herbicide mixture of oxyfluorfen + paraquat @ 150g a.i. ha^{-1} + 720 g a.i. ha^{-1}. The attack of pod borer was controlled by foliar application of trizophos 40% EC. Soil samples were collected from 0-10 cm soil depth randomly using a soil auger (5 cm internal diameter) and analyzed for soil pH and organic carbon by Walkley and Black method. Soil bulk density was measured using a core sampler *in situ* by core method. The statistical analysis was done by using the standard technique of analysis of variance (ANOVA). The significance of treatment means was tested using F-test. The critical difference (P=0.05) were worked out to evaluate differences between treatment means.

Results and Discussion

Soil bulk density and porosity

The residue retention has significantly influenced the soil bulk density (0-5 cm) and porosity, however, bulk density at 5-10 cm depth was non-significant (Table 2). The lowest bulk density was recorded with 90% of residue level at both depths (0-5 cm and 5-10 cm) followed by 60% and 30% residue level. The bulk density was lower in upper soil surface (0-5 cm) as compared to the lower depth (5-10 cm). Likewise, highest porosity was recorded with 90% residue level (52.6%) which was at par with 60% residue level (52.1%). The lowering of bulk density due to residue retention might be attributed to the loosening of soil and creating more pore space (Bhattacharyya *et al*., 2015) [2]. ZT with residue helps in improving soil aggregation and reducing bulk density (Govaerts *et al*., 2009) [8]. Further, higher soil organic matter added higher amounts of organic carbon that may resulted in lesser soil bulk density.

Table 1: Effect of different residue retention levels on soil bulk density and porosity

Treatments	Bulk density (Mg m^{-3})		Porosity (%)
	0-5 cm	5-10 cm	
No residue	1.32	1.33	48.9
30% residue	1.29	1.32	50.2
60% residue	1.26	1.30	52.1
90% residue	1.24	1.27	52.6
SEm±	0.016	0.015	0.76
CD (*P* = 0.05)	0.049	NS	2.29

Soil organic carbon

Soil organic carbon is an important indicator of the soil health and residue retention with zero tillage system leads to improved soil quality. In this study, results showed that the soil organic carbon increased significantly with each successive increase in the rate of residue retention (Fig 1). The maximum organic carbon of 1.01 percent was recorded with the treatment of 90% residue retention level which was superior to rest of the treatments. Addition of organic matter through residue incorporation/retention helps in improving SOC (Singh *et al*., 2016) [13]. Under conventional tillage, ploughing disturbs the soil and promotes oxidation of organic C in soils. Increase in SOC content was observed with crop residues under both zero tillage which was associated with the addition of a large amount of crop residues and root biomass in the soil (Mandal *et al*., 2008) [15]. Das *et al.* (2018) [16] reported that increased SOC improve the soil aggregation, which results in increasing available soil moisture storage capacity and that in turn can be helpful for better plant growth and development.

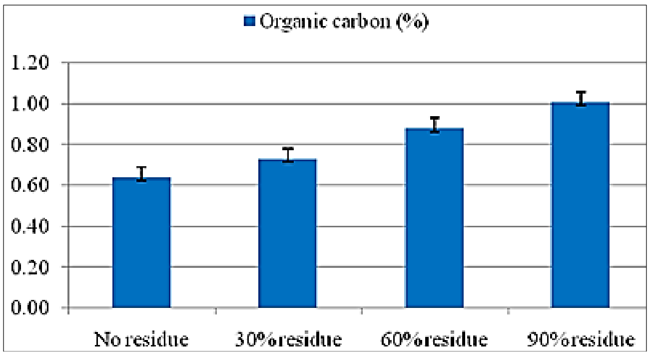

Fig 1: Effect of different residues levels on soil organic carbon

Conclusion

Results from the present study suggest that residue retention under CA based maize-chickpea cropping system improved the soil physical properties like bulk density and porosity, and soil organic carbon as compared to without residue retention.

Therefore, by following CA based residue management practices, soil quality can be improved along with the advantage of sustained and higher productivity in vertisols of Central India.

References

1. Bhan S, Behera UK. Conservation agriculture in India-Problems, prospects and policy issues. International Soil and Water Conservation Research. 2014; 2(4):1-12.
2. Bhattacharyya R, Das TK, Pramanik P, Ganeshan V, Saad AA, Sharma AR *et al*. Conservation agriculture effects on soil organic carbon accumulation and crop productivity under a rice-wheat cropping system in the western Indo-Gangetic Plains. Eur. J Agron. 2015; 70:11-21.
3. Choudhary M, Datta A, Jat HS, Yadav AK, Gathala MK, Sapkota TB *et al*. Changes in soil biology under conservation agriculture-based sustainable intensification of cereal systems in Indo-Gangetic Plains. Geoderma. 2018; 313:193-204.
4. Congreves KA, Hayes A, Verhallen LL, Van Eerd LL. Long term impact of tillage and crop rotation on soil health at four temperate agroecosystems. Soil Tillage Res. 2015; 152:17-28.
5. Doran JW, Zeiss MR. Soil health and sustainability: managing the biotic component of soil quality. Appl. Soil Ecol. 2000; 15:3-11.
6. Gathala MK, Ladha JK, Saharawat YS, Kumar V, Kumar V, Sharma PK. Effect of tillage and crop establishment methods on physical properties of a medium textured soil under a seven-year rice-wheat rotation. Soil Sci. Soc. Am. J. 2011; 75: 1851-1862.
7. Govaerts B, Mezzalama M, Unno Y, Sayre KD, Luna-Guido M, Vanherck K *et al*. Influence of tillage, residue management, and crop rotation on soil microbial biomass and catabolic diversity. Appl. Soil Ecol. 2007; 37:18-30.
8. Govaerts B, Sayre KD, Goudeseune B, De Corte P, Lichter K, Dendooven L *et al*. Conservation agriculture as a sustainable option for the central Mexican highlands. Soil Tillage Res. 2009; 103:222-230.
9. Jat ML, Malik RK, Saharawat YS, Gupta R, Bhag M, Paroda R *et al*. Proceedings of Regional Dialogue on Conservation Agricultural in South Asia, New Delhi, India, APAARI, CIMMYT, ICAR, 2012, 32.
10. Jemai I, Ben Aissa N, Ben Guirat S, Ben-Hammouda M, Gallali T. Impact of three and seven years of no-tillage on the soil water storage, in the plant root zone, under a dry sub-humid Tunisian climate. Soil and Tillage Research. 2013; 126:26-33.
11. Salem HM, Valero C, Muñoz MÁ, Rodríguez MG, Silva LL. Short-term effects of four tillage practices on soil physical properties, soil water potential, and maize yield. Geoderma. 2015; 237:60-70.
12. Schofield RK, Taylor AW. The measurement of soil pH. Soil Science Society of America Proceedings. 1955; 19:164-167.
13. Singh VK, Singh Yadvinder, Dwivedi BS, Singh SK, Majumdar K, Jat ML *et al*. Soil physical properties, yield trends and economics after five years of conservation agriculture based rice-maize system in north-western India. Soil Tillage Res. 2016; 155:133-148.
14. Six J, Ogle S, Breidt F, Conant R, Mosier A, Paustian K *et al*. The potential to mitigate global warming with no-tillage management is only realized when practiced in the long term. Glob. Chang. Biol. 2004; 10:155-160.
15. Mandal B, Majumdar B, Adhya TK, Bandyopadhyay PK, Bandyopadhyay A, Sarkar D *et al*. Potential of double cropped rice ecology to conserve organic carbon under sub-tropical climate. Global Change Biology. 2008; 14:1-13.
16. Das TK, Saharawat YS, Bhattacharyya R, Sudhishri S, Bandyopadhyay KK, Sharma AR *et al*. Conservation agriculture effects on crop and water productivity, profitability and soil organic carbon accumulation under a maize-wheat cropping system in the North-western Indo- Gangetic Plains. Field Crops Research. 2018; 215:222-31.