Effect of conservation agriculture practices on soil biological and physico-chemical properties of light black soil under peanut-wheat cropping system

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Introduction

- Peanut-wheat is major cropping system in the Saurashtra region of Gujarat, India and is practiced over not less than 1.0 M ha area in the region.
- However, the soils in the region are less fertile, shallow, and prone to water erosion.
- Further, the prevalent practice of clean cultivation involving several passes of tillage makes soils highly vulnerable to water erosion.
- Moreover, burning of wheat residues to prepare fields for sowing of groundnut is a common practice in this eco-sensitive region.
- Peanut is mainly grown as rainfed crop in the region and hence, moisture conservation is important for successful cultivation of the crop.
- Conservation Agriculture (CA) was seen as a potential solution for the above issues , however understanding of the effects of conservation agriculture practices on soil properties is important for its successful implementation in the field.
- However, no studies have been done till now to investigate the effect of tillage and residue management practices on soil biological and physico-chemical properties in peanut-based cropping systems in light black soils of Saurashtra peninsula of western India.
- Therefore, this study was initiated with the hypothesis that the CA based practices will improve desirable characteristics of calcareous, low carbon, poorly fertile and shallow light black soils of the region.

Picture 1. Sowing of peanut through wheat stubbles.

Table 1. Tillage and residue effect on soil aggregation.

Treatments	Total aggregate %		MWD		GMD	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Tillage practices						
CT	57.9^{B}	58.6^{B}	0.44^{B}	0.58^{B}	0.54^{B}	0.62^{B}
MT	58.6^{AB}	59.0^{AB}	0.47^{B}	0.66^{A}	0.57^{B}	0.68^{A}
ZT	60.9^{A}	59.8^{A}	0.74^{A}	0.72^{A}	0.63^{A}	0.70^{A}
Residue management/mulching						
NR	50.7^{C}	56.3^{B}	0.44^{B}	0.56^{B}	0.55^{B}	0.61^{B}
WS	57.8^{B}	60.3^{A}	0.57^{A}	0.64^{B}	0.56^{B}	0.65^{B}
WC	68.9^{A}	60.8^{A}	0.64^{A}	0.76^{A}	0.63^{A}	0.74^{A}

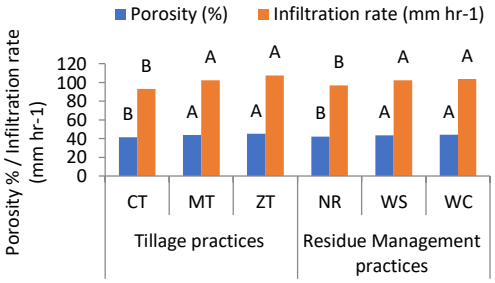

Figure 1. Tillage and residue management effect on soil porosity and infiltration rate.

Materials and Methodology

- A field experiment was initiated at Research Farm of ICAR-Directorate of Groundnut Research, Junagadh during rainy season of 2012.
- The soil at the experimental site was clayey, moderately calcareous (30.9 % $CaCO_3$), slightly alkaline (pH 8.2) with electrical conductivity (EC) of 0.7 dS/m, low in organic carbon (4 gkg^{-1}) available N (197.3 kgha^{-1}), and available P_2O_5 (9.2 kgha^{-1}) and medium in available K_2O (269 kgha^{-1}).
- The study was done in split plot design with three replications. Treatments were three tillage practices *viz*., conventional tillage (CT); minimum tillage (MT), and zero tillage (ZT) in main plots, and three residue management/mulching practices *viz*., no residue (NR), wheat stubble retention (WS), and wheat stubble retention + *Cassia tora* mulching wheat (WC) in sub-plots.
- Peanut was sown in rainy season (Pic. 1) while wheat was grown in post rainy season. *Cassia tora* mulch was applied in wheat @ 5t/ha after sowing.
- The soil samples were taken at 30 days after sowing of peanut from 0-15 and 15-30 cm depth in 2013, 2014 and 2015 to study the soil enzymatic activities and soil microbial biomass carbon (SMBC).
- While, soil samples were taken from the two depths after the completion of cropping sequence i.e. after harvesting of wheat crop in 2016 to study physical and chemical properties of the soil. Porosity and infiltration rate were studied in 0-30 cm depth.
- Earthworm counts were recorded in 2013 and 2015 during peanut season in 0-15 and 15-30 cm depth and pooled values are presented.
- All the soil parameters were analyzed following standard procedures.

Results and Discussion

Effect of tillage practices

- Dehydrogenase, alkaline phosphatase, and urease activities were similar in MT and ZT but significantly higher over CT in 0-15 cm depth.
- β glucocisade activities and SMBC were in the order ZT>MT>CT ($p<0.05$) in 0-15 cm depth. However, activities of all the enzymes and SMBC were significantly high with CT over ZT in 15-30 cm depth.
- Earthworm population was significantly higher under ZT under the two depth profiles (0-15 cm and 15-30 cm).
- Total aggregate percent, mean weight diameter (MWD), geometric mean diameter (GMD) (Table 1), porosity and infiltration rate (Fig 1) was found to be significantly high in ZT, while least values were observed under CT in both the depths.
- Available NPK and CEC were high under ZT as compared to CT in both the depths ($p<0.05$).
- OC was found high with ZT in 0-15 cm depth over CT, but in 15-30 cm depth SOC was high with CT as compared to ZT ($p<0.05$).

Effect of residue management/mulching practices

- Activities of dehydrogenase, alkali phosphatase, β glucosidase and urease, and SMBC (0-15 and 15-30 cm) were found to be higher under WC as compared to NR ($p<0.05$).
- Earthworm counts (0-15 and 15-30 cm) were observed significantly higher under WC over NR.
- Total aggregate percent, MWD, GMD (Table 1), porosity and infiltration rate (pic 1) were found to be significantly higher under WC while least values were found under NR in both the depths ($p<0.05$).
- CEC, SOC, total aggregate associated carbon, available N, P and K were found higher under WC as compared to NR at both the depths ($p<0.05$).
- Total aggregate associated carbon was found at par between MT and ZT. Least values of these parameters were recorded under NR.

Conclusion

- Thus these results suggest that zero and minimum tillage, and wheat stubble retention and *Cassia tora* mulching are effective in improving soil biological and physico-chemical properties of light black soils of Saurashtra region of India.
- This is important for sustainable production in these calcareous, low carbon, and poorly fertile shallow soils of the region.