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Impact of different croplands on nutrient index, microbial diversity and soil quality

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Abstract

In the last two decades, the productivity of Rice-wheat cropping system in the upper Indo-Gangetic Plains of India has stagnated and now in a declining trend. As a result, farmers shifted to a different cropland grown systems so as to achieve a higher net productivity. This study aim to assess as how nutrient index (NI), microbial diversity and soil quality changed after replacement of rice-wheat by vegetable (VGS), pulse (PGS), potato (PoGS) and mustard (MGS) grown system. An analysis of 307 soil samples from various croplands revealed a soil pH range of 6.58-8.87 with 75.3% soils under low category of mineralized N (MN) resulting in its low NI (<1.67). The highest NI, enzymatic activity and microbial biodiversity was recorded under PGS, which restored 34.2, 24.1 and 10.2% greater SOC, carbon substrate oxidation rate and MN than PoGS, respectively. The diversity indices were the highest in PGS followed by VGS, but soil quality index was 0.783 (VGS), 0.771(PGS), 0.695 (WGS), 0.663 MGS), and 0.647 (PoGS). The silt content, SOC, Zn, total N, acid phosphatase activity (ACP), available P and total culturable fungi were the key soil indicators across the cropland grown systems. Among the cropland systems, silt content, SOC, total N and ACP were the main soil indicators for PGS, whereas, silt content, SOC, P and Zn were the ideal indicators for VGS that affected microbial dynamics and soil quality. Overall, it is concluded that PGS maintained higher nutrient index, microbial and functional diversity, but VGS improve greater soil quality.

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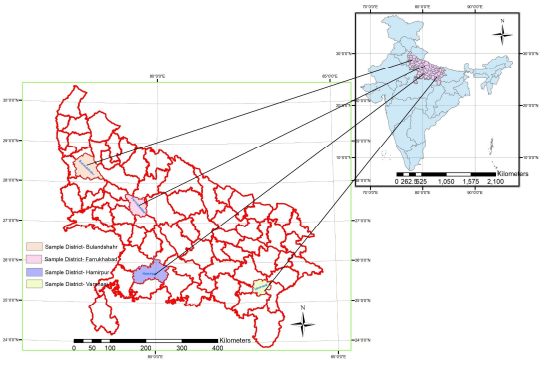

Figure 1 Geographical locations of soil sample sites under different cropland grown system. The shaded area indicated the five cropland grown system in four County of Uttar Pradesh Province, India.

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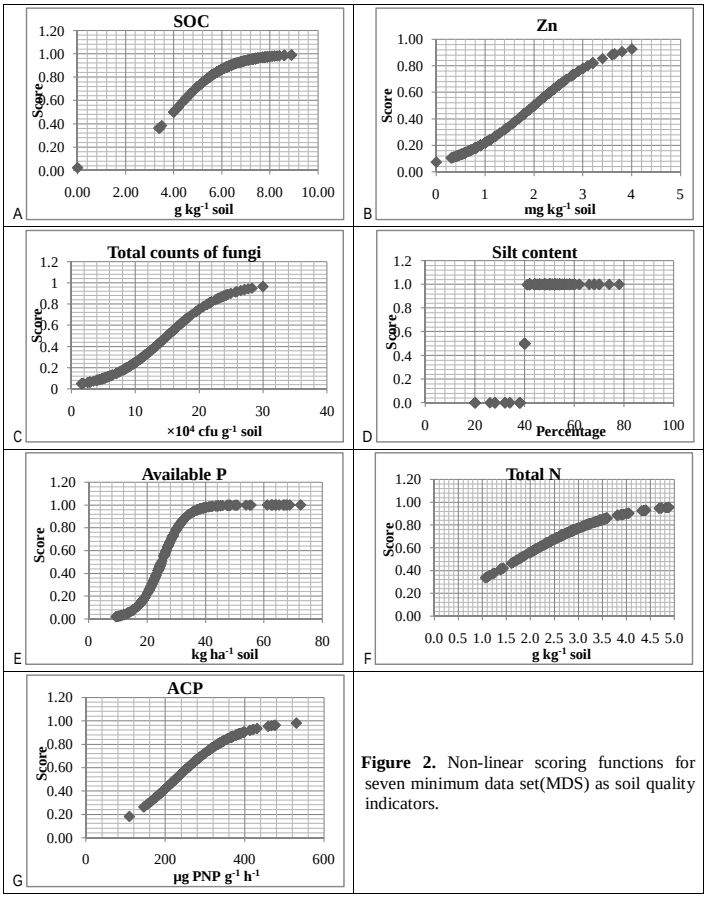

Figure 2. Non-linear scoring functions for seven minimum data set(MDS) as soil quality indicators.

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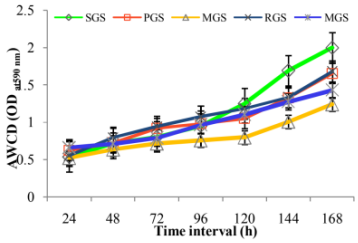

Figure 3 Effect of different cropland grownsystemson microbial diversity (AWCD) of soil. VGS-vegetable grown system, PGS-pulse grown system, PoGS-potato grown system, WGS-wheat grown system, MGS-mustard grown system. Bars represent mean±standard error.

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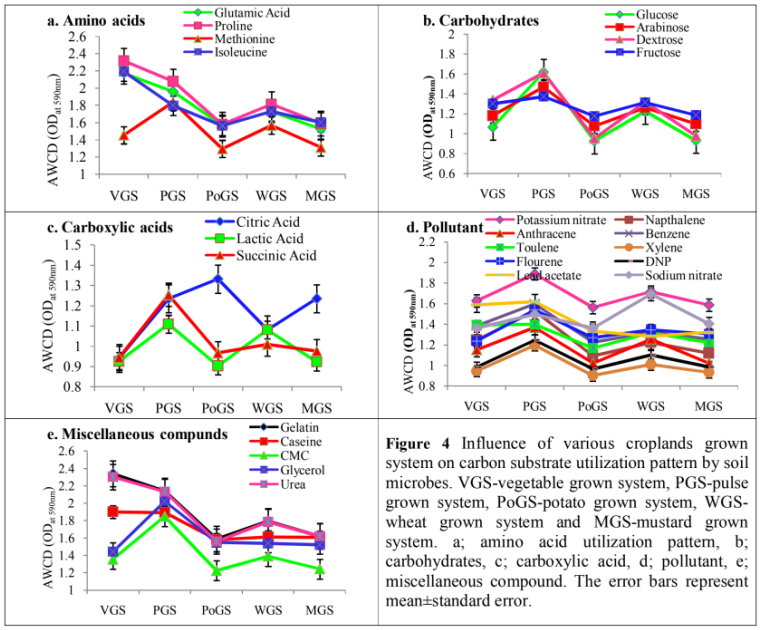

Figure 4 Influence of various croplands grown system on carbon substrate utilization pattern by soil microbes. VGS-vegetable grown system, PGS-pulse grown system, PoGS-potato grown system, WGS-wheat grown system and MGS-mustard grown system. a; amino acid utilization pattern, b; carbohydrates, c; carboxylic acid, d; pollutant, e; miscellaneous compound. The error bars represent mean±standard error.

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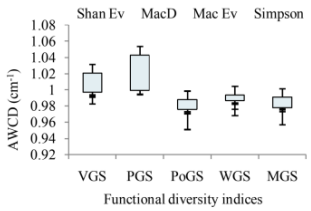

Figure 5 Functional diversity changes under various cropland use system.VGS-vegetable grown system, PGS-pulse grown system, PoGS-potato grown system, WGS-wheat grown system and MGS-mustard grown system. The error bars represent standard errors of mean.

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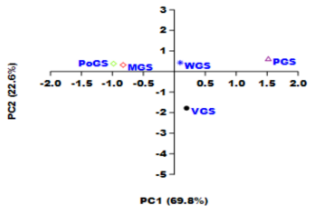

Figure 6. Principal component analysis of substrate utilization pattern from different cropland grown system. VGS-Vegetable grown system, PGS-pulse grown system, PoGS-Potato grown system, WGS-wheat grown system, MGS-mustard grown system. Carbon substrate variables wereglutamic acid, proline, methionine, isoleucine, glucose, arabinose, dextrose, fructose, gelatin, caseine, CMC, glycerol, urea, citric acid, lactic acid, succinic acid, potassium nitrate, nathalene, anthracene, benzene, toluene, xylene, flourene, DNP, lead acetate,sodium nitrate.

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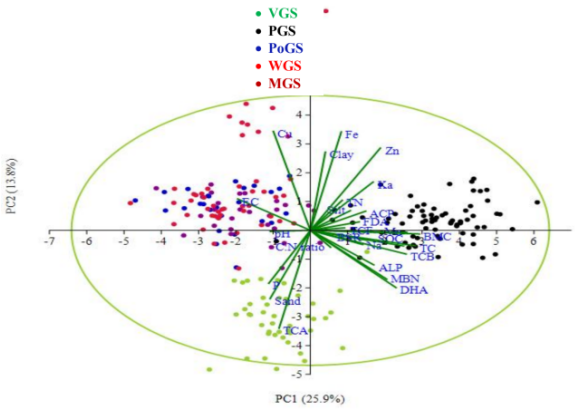

Figure 7 PCA bi-plot (PC1 *vs* PC2) of physical, chemical and biological properties of different cropland grown system,*viz*., VGS-vegetable grown system, PGS-pulse grown system, PoGS-potato grown system, WGS-wheat grown system and MGS-mustard grown system in upper IGP region. The abbreviations of the variables refer to as indicated in Table 7.

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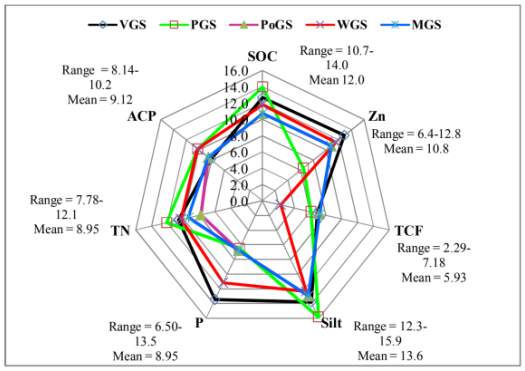

Figure 8 Range and average contribution of minimum data set indicators toward development of soil quality index under different cropland grown systems. VGS-vegetable grown system, PGS-pulse grown system, PoGS-potato grown system, WGS-wheat grown system and MGS-mustard grown system.

Note: SOC (g kg^{-1}), Zn (mg kg^{-1}), TCF ($\times 10^4$cfu g^{-1}soil), Silt content (%), P (kg ha^{-1}), TN (g kg^{-1}), ACP (µg PNP g^{-1} soil)