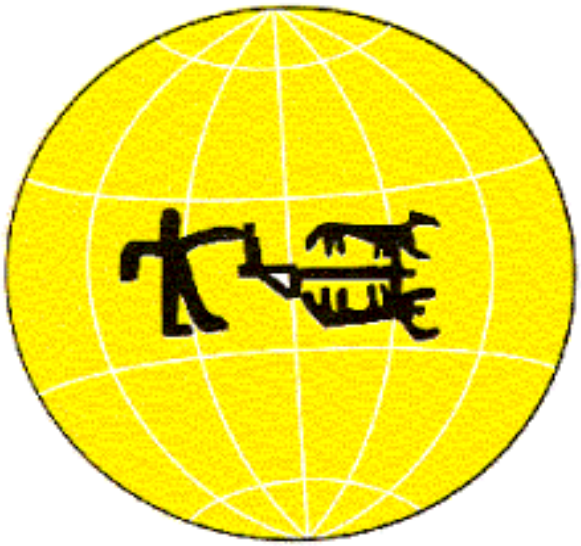

20th International Soil Tillage Research Organization Conference (ISTRO)

ABSTRACT

14-18th, September, 2015

Nanjing, P.R. CHINA

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Poster Presentaion

20th International Soil Tillage Research Organization Conference (ISTRO)
14-18th, September, 2015
Nanjing, P.R. CHINA

Research Innovations in soil physics

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Abstract

Soil is one of the most critical life-supporting compartments of the Biosphere. It provides numerous ecosystem services such as a habitat for biodiversity, water and nutrients, as well as producing food, feed, fiber and energy. Soils undergo intense and irreversible changes due to a none site adjusted land management and improper application of machinery and techniques in its broadest sense. However, to feed the rapidly growing world population in 2050, agricultural food production must be doubled using the same land resources footprint.

Thus, also the soil physical research has not only to quantify in detail scale dependent processes and functions (from the micro- to the macroscale), but it also has to include the obtained results in coupled soil models which allow to link physical, physico chemical, and biological processes and functions. These links between detailed and well defined intensity properties and functions and the uncounted number of models available needs further improvement. According to Verreeken et al. 2014 a new generation of soil models based on a whole systems approach comprising all physical, mechanical, chemical and biological processes is required to address these critical knowledge gaps and thus contribute to the preservation of ecosystem services, improve our understanding of climate-change–feedback processes, bridge basic soil science research and management, and facilitate the communication between science and society.

Furthermore, the definition of boundary conditions and the inclusion of site and climate dependent soil properties and functions in combination with the transition from rigid to non-rigid soil systems needs more in depth research approaches in order to define and to quantify also the often used general definitions of sustainability and resilience as well as to link these properties with a broad range of societal challenges including climate change mitigation and adaptation, land use change, water resource protection, biotechnology for human health, biodiversity and ecological sustainability, combating desertification. Thus, the in depth research on water fluxes , soil mechanical properties(from the micro- to the macroscale from rheometrical to geophysical approaches), the overall available problem of hydrophobicity and wettability as a major threat of water storage, soil erosion and gas emission changes), the link between thermal, hydrological, gaseous fluxes and processes under various mechanical and hydraulic stresses must be quantified more in detail in the following decades for the various soils and land use management systems worldwide.

In the lecture some more detailed information about up to date research approaches in soil physics will be documented.

Increasing soil productivity as a foundation of enhanced sustainable crop production

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Abstract

China's economy underwent great changes since 1949, especially since China initiated economic reforms and the open-door policy in the 1980's. The growth of agricultural production has been one of the main national accomplishments. By 1999 China was feeding 22 % of the global human population with only 7 % of the world's arable land. It has been acknowledged widely that the crop yield increase was accomplished by greater inputs of fertilizers, irrigation, new crop strains, and other technologies of the "Green Revolution". However, soil productivity improvement in most of the arable land has been base of "Green Revolution" in China. The unique experience in improvement of inherent soil productivity was combination of engineering-based measurements (e.g. leveling and consolidating soil) and biological approaches (e.g increase input), which led to increase in soil organic carbon (SOC) and macro-nutrients especially for low and moderate yielding soils.

Looking towards 2030, further increases in crop production on the remaining arable land to meet the demand for grain and to feed a growing population will be more problematical than it has been for the last 50 years for China. The availability of high quality soil remains one of the major limiting factors in China. Thus, we propose the advancement of food security in 21th century in China will depend on a continuous improvement of soil productivity.

This paper summarizes historical trends, current situation and future perspective in soil productivity in China. Then, the approach of increasing further soil productivity of arable land for advancing food security in China and for strengthening other ecosystem services in the new century is discussed.

Keywords: Food Security; Soil productivity; Intensification of crop production

Utopus: a novel autonomous robot that uses renewable energy to cultivate soil without causing compaction.

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Abstract

Cultivation, seeding and weed control are fundamental to arable production. In the developed world these activities use increasingly large machinery with tyres or tracks that damage the soil by compaction. The large machines use fossil fuels for power, but as fuel reserves are finite, increasingly expensive and contribute to Greenhouse Gas Emissions alternatives are needed. In the developing world cultivation, seeding and weeding are equally important, but farmers with small, poorly connected land-holdings can neither afford nor use large machines or expensive fossil fuels. There is a need for a way to cultivate the soil without the compaction associated with heavy machines and tyres, using renewable energy to decrease reliance on fossil fuel and save manual labour and that can work on the scale appropriate for different farming systems. We propose an autonomous robot, using a novel traction mechanism that does not use tyres, powered by renewable energy as a technological advance suitable for multiple agricultural applications.

Utopus, is a farmer initiated and designed machine that develops traction with retractable anchors instead of tyres. The machine operates on a push-pull configuration – with two independent frames. The front frame anchors the machine and hauls in the rear frame which engages the soil; then the rear frame anchors and pushes forward the front. Using experimental prototypes we have demonstrated the capacity to cultivate soil and for mechanical weed control. The anchors are narrow (typically 1cm diameter) rods that engage the soil to a depth of 10 – 30 cm at an angle of around 60° depending on soil resistance. The prototypes have a weight of less than 200 kg with the weight resting on the anchors, the tines and depth control guides. Power is from an electric motor that can be run from a re-chargeable battery or solar panel.

Development of the machine is ongoing, including improved guidance and steering. We will present results of field evaluation, energy efficiency, likely costs and soil conditions generated.

Keywords: agricultural robotics; push-pull, renewable energy; traction; cultivation; prevention of compaction

Soil Structure Dynamics: Evidence from Bulk Density and Water Retention Characteristics during Wetting/drying Processes

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Abstract

The structure and pore related functions of a tilled soil layer vary dynamically under the impact of wetting and drying (WD) cycles. Our objective in this study is to characterize the variation of soil structure as a function of WD cycles as indicated by bulk density (ρb) and water retention characteristic (WRC). In situ soil water content, matric potential, and bulk density were monitored continuously after tillage. The results show that right after tillage WD cycles resulted in rapid ρb increase, but no significant soil WRC change was observed. After five wetting/drying cycles (about 20 days), ρb reached a steady state, and soil water holding capacity was improved considerably, i.e., the soil could hold more water at the same matric potential. The influence of WD cycles on soil water retention characteristics was weakened at deeper soil layers. Our results suggest that soil structure, as indicated by total porosity and pore size distribution, has complicated spatial and temporal variability under the influences of wetting/drying process.

Keywords : Water Retention, Characteristics, Wetting/drying Processes

Temperature of zero and reduced tilled clay soils before spring sowing in Northern European boreal climate

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Abstract

Conservation tillage has taken its position among other tillage options in boreal conditions during the last two decades. The reduction of tillage intensity increases the crop cover remaining on soil surface layer and changes soil physical properties. These changes have been assumed to slow down soil warming in spring which may delay the sowing season. We addressed these questions by investigating the effects of autumn tillage intensity on soil temperature in two long-term field experiments during three springs before sowing time.

Continuous soil temperature measurements were carried out on two field experiments located on clay soils in Jokioinen (60°49'N, 23°28'E) in Finland. The field experiments were established 12 years earlier than the measurements started. Spring barley (Hordum vulgare) was cultivated on the experiments. Soil temperature and water content were determined at 10 cm depth in autumn ploughed (0–20 cm depth), autumn stubble cultivated (to 10–15 cm), and zero tillage (direct drilling in spring) plots. For continuous soil temperature and water content measurements 5TE and 5TM (Decagon Devices Inc. Pullman, WA, USA) sensors were installed in soil after autumn tillage and measurements (interval 1 hour, data logging: EM50 data loggers (Decagon Devices Inc. Pullman, WA, USA)) were done until spring sowing time. Air temperature was determined at 50 cm above the soil surface.

Based on the results of first year, during the snow and frost melting time the mean temperature of ploughed soil was lower than that of other tillage treatments. The daily variation of temperature was the highest in ploughed soil. All treatments reached, however, the mean soil temperature of 5 degrees at the same time. The results of the two later springs will be included in the paper to discuss the effects of winter conditions on soil warming up in spring.

Keywords: Autumn tillage, Ploughing, Stubble cultivation, Zero tillage, Spring barley

Mapping tillage intensity by integrating multiple remote sensing data

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Abstract

Tillage practices play an important role in the sustainable agriculture system. Conservative tillage practice can help to reduce soil erosion, increase soil fertility and improve water quality. Tillage practices could be applied at different times with different intensity depending on the local weather condition and farmer's assessment. Remote sensing approach has been applied to identify tillage intensity at field scales by mapping crop residues left on the soil surface shortly after planting. Medium spatial resolution remote sensing data such as Landsat (30m) provides residue information at field scale from the two shortwave infrared bands. However, remote sensing data may not be available shortly after the planting date due to long revisit cycle (16 days for Landsat) and cloud contamination etc. Efforts to assess tillage intensity using a single date of Landsat data have been only moderately successful. A multi-temporal approach has been demonstrated more robust in different cropping regions of the United States. In order to build high spatial and temporal information that are required for mapping tillage intensity, we introduce data fusion approach by integrating multiple remote sensing sources. The Moderate Resolution Imaging Spectroradiometer (MODIS) (daily revisit, 500m pixel resolution) are fused with Landsat data to generate the daily 30m pixel resolution reflectance using the Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM). We test the hypothesis that the fused Landsat and MODIS data provides more accurate information on mapping crop residue and tillage intensity than using individual sensor imagery alone. The study area covers the South Fork and Walnut Creek (USDA Conservation Effects Assessment Project, CEAP) watershed in central Iowa USA. Over the study sites, crop residue cover was measured in more than 50 fields per year using the line point transect method and estimated visually in more than 200 fields/year using roadside survey methods. We used partial measurements to train remote sensing data and then evaluated results using the remaining samples. Figure below demonstrates the procedure for mapping tillage intensity using data fusion approach. Results based on single Landsat, dense time-series MODIS and the fused Landsat-MODIS are compared and analyzed using the 2011 and 2013 field measurements. We will discuss the potential and limitation of the data fusion approach for the tillage intensity mapping in this presentation.

Keywords: crop residues, tillage intensity, remote sensing, MODIS, Landsat, data fusion

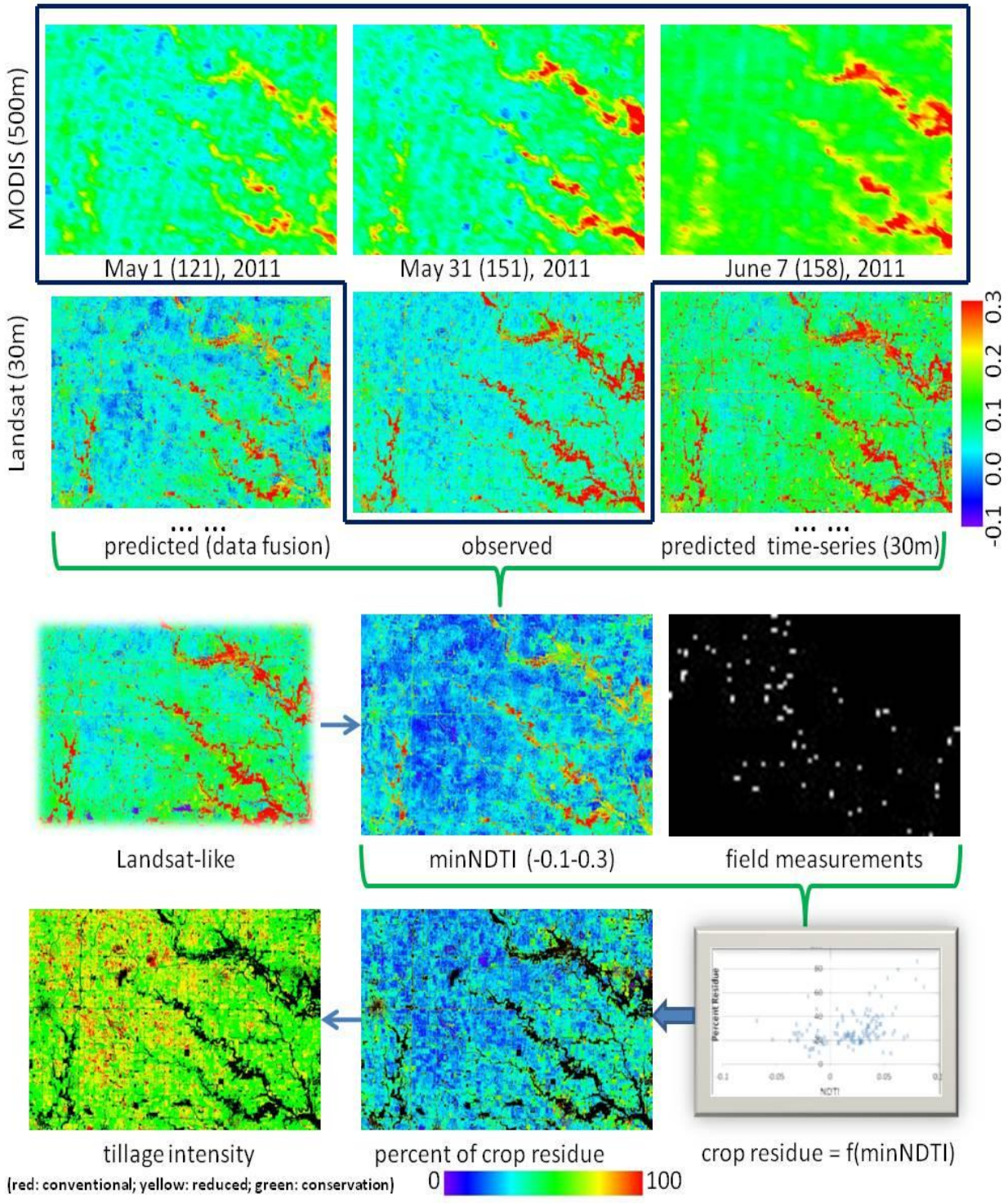

Figure. The crop residue and tillage intensity mapping by fusing multiple remote sensing (Landsat and MODIS) data as illustrated in South Fork, central Iowa, USA.

Visual Evaluation of Soil Structure on Amazon soils

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Abstract

Visual evaluation of soil structure (VESS) has being used to compare soil with contrasting textures, tillage, crop rotations, agricultural traffic, land use and grassland management, mainly on temperate soils. Few studies have tested VESS under tropical conditions and this work is the first to use VESS on Amazon soils and the "Terra Preta de Índio" (TPI). VESS allows fast, simple and reliable assessment of soil physical structure, which makes it an important diagnostic tool, especially in developing countries, such as Brazil, where expensive equipment and training can be limited. We tested the feasibility of VESS to evaluate soil structural quality under Yellow Oxisol and TPI. The sample sites were located near Santa Isabel do Rio Negro, Amazon, Brazil. The evaluated areas, which had not been subjected to mechanisation, were (1) TPI – area used for fruit tree and vegetable cultivation, under "Terra Preta de Índio"; (2) Secondary Forest; (3) Crop – cassava and pineapple; (4) Pasture – under cattle grazing; and (5) Native Forest. At each site ten VESS samples were taken along a transect. The evaluations attributed a structural quality score (Sq) to the top layer (25 cm) of the soil based on shape, strength, colour and porosity of aggregates among others such as root development. VESS was useful for identifying layers of contrasting structures, as well as different soil use. The Native Forest, Crop and Secondary Forest areas did not present significant statistical differences, all with a Sq of ~1.2, (very good structural quality). Although the Crop area had a low Sq the soil in this area was structureless, which could be attributed to the use of fire as a management practice. The TPI and Pasture showed statistically higher Sq than the rest of the sites (TPI = 2.2 and Pasture = 2.8). Although these values are considered adequate for plant development, in the pasture area, below 5 cm in depth, a layer of compaction (~15 cm deep) was observed, which could cause restrictions to root growth. This result also highlighted the importance of scoring individual layers and not only assigning an overall Sq to a 25 cm block. VESS was shown to be a useful tool for surveying soil in the Amazon, considering the areas vastness and the difficulty of sampling in this area.

Keywords: Terra Preta de Índio; Aggregates; Soil quality; VESS; Soil structure

Effects of soil tillage intensity and compost application on soil physical properties in ecological management systems

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Abstract

Conventional soil tillage include practices to enhance plant nutrient acquisition by modifying water infiltration, aeration, temperature regimes and organic matter among others, affecting mostly the topsoil, but often to the detriment of subsoil properties. No-tillage may improve top/subsoil structure by natural recovery, but often at a high cost because of the slowness of this process. The use of minimal tillage, subsidiary crops and organic mulches could accelerate the natural regeneration of soil physical functions by enhancing biological activity and related soil structure formation. The main goal of this work is to provide guidelines from the perspective of soil physics for the EU-Research Project OSCAR, which main goal is the development of improved conservation tillage systems based on subsidiary crops. In this work we analyzed soil physical properties (saturated hydraulic conductivity, air conductivity, water retention function, bulk density, precompression stress) in undisturbed soil samples taken in a field experiment. Two factors (tillage and compost) were analyzed in a randomized setup with four field replicates at the experimental station of Eichenberg of the University of Kassel. The levels for tillage were (1) standard plow to 30 cm depth and (2) light grubbing to 5 cm depth with light tractor for seedbed preparation. Both tillage levels were prepared with and without application of compost, thus achieving four treatments in total. The samples were taken one year after start of the experiment. Results show a high influence of the tillage treatments in the topsoil on soil physical properties, especially macroporosity and water conductivity. A decrease in macropore volume could be observed in the minimal tillage treatments, although this did not significantly influence air conductivity. This reflects a loss in macropores whith low transport functionality. No differences were detected in the measured physical soil properties below a depth of 40 cm, hence emphasizing the need for further monitoring those properties during longer periods.

Key words: structure, oscar, organic farming, agromachinery, wenz

Annual and Perennial Biofuels Crops: Ethanol potential yield and Nutrient removal

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Abstract

Increasing demand for biofuels sources has motivated the need for knowledge about diverse crops or rotated crops for ethanol yield and nutrient removal, a very important factor that must be considered in bioenergy. This study was conducted to determine dry matter production (grain, residue, total biomass) and estimated ethanol yields and nutrient balance (N, P, K) of annual and perennial crop in west Uruguay for six years (2008-2014). Sweet sorghum (Sorghum bicolour) grown continuously; corn (Zea mays L.) rotated with wheat (Triticum aestivum) and grain sorghum (Sorghum bicolour) with two residue harvest scenarios removed (without or low cut) and perennial grass as switchgrass (Panicum virgatum L.) were evaluated. The total highest ethanol in these six years evaluated were achieved with switchgrass (27.270 L ha^{-1}) followed by rotated corn-wheat-sorghum with residue removed (21.150 L ha^{-1}). The lowest treatment was with sweet sorghum with only 10.100 L ha^{-1}. Total N-P removal rates were greatest for grain crops rotated (578 Kg N ha^{-1} and 138 Kg P ha^{-1} and 571 Kg N ha^{-1} and 155 Kg P ha^{-1} without or with straw removal treatments, respectively). However, the total K removal rates were highest for switchgrass and continuous sweet sorghum (419 and 349 Kg K ha^{-1} , respectively). These results indicate that perennial grasses as switchgrass can produce greater total biomass and then greatest estimated ethanol yields for renewable fuel production greater. However, high biomass removal could increase extra fertilizer inputs to maintain soil productivity.

Keywords: biofuels, ethanol production, nutrient removal, biomass production

Impact of long-term conservation tillage of clay soils on grain yield of spring cereals in North European boreal conditions

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Abstract

In Scandinavian boreal conditions, farmers have adopted conservation tillage for environmental and time saving reasons during the last two decades. Numerous reduced tillage studies focused on grain yield have been published. However, only few long-term studies have been carried out to examine the grain yields in zero tillage system on clay soils. The objective of this study was to examine the long-term effects of tillage intensity on the yield of spring cereals in northern boreal conditions. Based on the grain yields, the mean annual soil carbon inputs were estimated.

In three long-term field experiments, spring cereals were cultivated on clay soils in Jokioinen (60 °49'N, 23 °28'E) in southwestern Finland. In a field experiment lasting 30 years, the effect of autumn tillage (stubble cultivation or ploughing) and straw management (retained, removed or burnt) on grain yield was examined. In two other field experiments the autumn tillage treatments were ploughing (to 20−23 cm depth), stubble cultivation (10−15 cm), and zero tillage (direct drilling in spring). The grain yield results of 15 years were available. Based on the grain yield results, the mean annual carbon inputs (crop residues (above ground) and roots (below ground)) into soil were estimated by using the plant C allocation coefficients proposed in literature.

As mean of 30 years, the grain yield of spring cereals was 4.3 t/ha in ploughed treatment and 2% less in stubble cultivated treatment. The removing or burning of straw did not affect markedly the yields. Also in the two other clay soil fields, the grain yield was 3 to 4% less in stubble cultivated than in ploughed treatment. On the silty clay soil, the mean grain yield of zero tilled treatment was 3% less than that of ploughed treatment. On the heavy clay soil, the mean grain yield of zero tilled treatment was, however, 17% lower than in ploughed treatment. The annual C input followed the yield results.

Keywords: Ploughing, Autumn tillage, *Hordeum vulgare*

Agricultural practices savings, focusing to soil as carbon sink and water storage in San Juan of Castrovirreyna – Huancavelica (Peru)

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Abstract

The small farmers of the Andes of Peru has developed traditional agricultural practices, as soil tillage with animal traction or hand power, earthing crops up and stubble burning, leading soil depletion with high production cost and the migration of youths to urbane zones. This context worries Caritas Huancavelica, which bet on the conservation agriculture, with aims to reduce crops production cost, save time and adapt agricultural practices against the climate change. The project implementation started in june 2008, with 51 small farmers in San Juan, with demonstrative plots and farmer field school. In the plots, where there were cornstalks, they sowed beans and the ones, where there were only weeds, they sowed corn. These plots were not plowed, farmers did not burn vegetable residue in these plots, neither they did not earth crop up, only these plots received an suitable nutritional and sanitary management. So, by not plowing, farmers saved 2 workers and animal traction working 10 days per hectare; y without earthing crops up, farmers saved 4 workers with 7 work's days per hectare. Also, it was decreased the soil erosion impact and lesser CO_2 emission (Reicosky 1997. Tillage- induced CO_2 emission from soil). The watering frequency in the traditional agriculture was every 7 days, while in the conservation agriculture was every 11 days, saving 7 watering or 2052 m^3 of water per crop cycle, doing efficient the using of water and keeping longer humid soil, due to shallow stubble, it decreased the water evaporation. Also, when the environment temperature, at middle day, was 30°C, these factors, stubble, temperature and humidity, they attenuated drastically the soil temperature to 21°C, versus 41°C in the soils with traditional management. These factors, were keys for the growing of earthworm exponentially, from 0 to 670000 units/hectare. Also, the crops yields doubled the local yield. Finally, the demonstrative plots allowed to save money and time, 266 dollars/hectare and 13 days workless, respectively. Furthermore, there was an increase of the biological activity and efficient use of irrigation water.

Key words: agricultural practices; workers; CO_2 emission; using of water; soil temperature and earthworms

Timing of liquid manure injections and use of nitrification inhibitors to reduce N_2O emissions from cropped fields

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Abstract

It is well acknowledged that nitrous oxide (N_2O) is a major greenhouse gas (GHG), which is mostly derived from agriculture. About 58% of GHG emissions from agriculture are N_2O, and two‐third of those N_2O emissions come from cropping systems having soils that repeatedly receive manures or synthetic nitrogen fertilizers. The main objectives of this research are to investigate GHG reduction strategies and provide efficient mitigation management practices. This research compares N_2O emissions from two contrasting manure injection times (fall vs. spring), examines the effectiveness of two nitrification inhibitors {nitrapyrin and 3, 4‐dimethylpyrazole phosphate (DMPP)} and identifies the key ecological controls on N_2O flux in Alberta cropping systems. In the early fall of 2014, field experiments were initiated at two locations (Edmonton and Lacombe) and will continue until winter 2016. The two locations received different manure types; dairy manure was injected at Edmonton, while swine manure was injected at Lacombe. The manure was applied at a rate of 74.1 m^3 Ha^{-1}. The dairy manure and the swine manure contained 6.94 and 3.55 g total N L^{-1}, respectively. Flux measurements were done weekly or two times per week following major rainfall or manure addition during the frost free periods. Based on the results from fall 2014 measurements, all manure injections resulted in a significant increase in N_2O emissions compared to the controls without manure (264 vs. 18 g N_2O‐N ha^{-1} for Edmonton, and 348 vs. 2 g N_2O‐N Ha^{-1} for Lacombe; *P*s < 0.005). The overall average reduction due to the use of nitrification inhibitors was about 26%. These experiments will continue during the next two growing seasons to reveal the annual effects of manure injection times and inhibitors, as well as nitrous oxide flux measurements by manual static chambers and automatic chambers, plant responses, soil properties and manure characteristics.

Keywords: Manure, Nitrous oxide, Nitrification inhibitors

Does strategic tillage have a place in no-till farming systems?

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Abstract

No-till (NT) farming systems have advantages in economic, environmental and soil quality aspects over conventional tillage. However, NT systems contributed to the build-up of herbicide-resistant weed populations, increased incidence of diseases and stratification of nutrients and organic carbon near the soil surface. Farmers often resort to an occasional tillage operation (strategic tillage, ST) to manage these problems. However, the success of ST operations, which depends on the timing of tillage and prevailing climatic conditions is not well understood. We established 14 experiments in north-eastern Australia in 2012-14 on sites with a long-term history of NT. Treatments consisted of ST with commonly used tillage implements (tine, disc, or disc chain) at different timings and frequencies. Over 3 years, we evaluated the impact of ST on factors which influence farmers' decisions (i.e. profitability, soil health and environmental impacts). Use of ST generally reduced weed populations and improved productivity and profitability in the first year, with little or sometimes negative impacts in subsequent years. Available phosphorus, total organic carbon, particulate organic carbon and total microbial activity were mostly not impacted by either cultivation frequency, implement type or timing of ST. However, negative impacts of ST were observed in soils with texture contrast properties and weakly structured A-horizons, therefore ST should be considered with caution in those situations. The ST produced a slight increase in simulated annual sediment loss and runoff. At all sites, ST also resulted in reduced plant available water stores in the short term. This effect could result in unreliable sowing opportunities in marginal rainfall seasons. Rainfall between ST and sowing or immediately after sowing is necessary to replenish soil water lost from the seed zone. Results suggest that a minimum of 75-100 mm rainfall would be required to replenish evaporative soil water losses from the seed zone following ST. An analysis of historical climate data (1960-2013) on these sites showed that probability of receiving 100 mm rain prior to winter crops sowing was 40-55% and 90-95% for a

3 month and 5 month pre-sowing period, respectively. These figures allow growers to better assess the balance between optimum time for the tillage operation and subsequent risks to cropping success. Results suggest that occasional ST could be utilized as a viable management option to manage constraints of NT systems without impacting on long-term soil health benefits of NT systems. Improved farm profitability and reduced reliance on pesticides/herbicides can be achieved if ST can be conducted at a time that minimizes the risk of reduced soil water at seeding.

Keywords: No-till, strategic tillage, productivity, soil health, environment

Evaluating liquid fertilizer to increase wheat straw decomposition in no-till systems – A physical evaluation

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Abstract

To solve stand establishment issues in high residue situations, the utility of an application of liquid nitrogen (N) fertilizer to stimulate microbial activity and subsequent decomposition of crop residue is often debated. We conducted field experiments to assess winter wheat (*Triticum aestivum*) straw decomposition under different fertilizer rates and application timings at three locations in western Kansas (Hays, Colby, and Garden City) following wheat harvest in 2011 and 2012. Urea ammonium nitrate (UAN) was applied at rates of 0, 22.4, 44.8 and 67.2 kg N ha^{-1} and ammonium thiosulfate (ATS) was applied at rates of 16.8 and 33.6 kg S ha^{-1}. A double shear box apparatus instrumented with a load cell measured the shear stress required to cut wheat straw. Twenty-five wheat straws from each plot were tested. Photomicrography and image analysis software were used to measure the cross-sectional area of each individual wheat straw after shearing and these data were used to calculate shear stress and specific energy parameters. Total C and N content was measured for bulk wheat straw samples from each plot. Treatment differences were often observed; however, there were few site years that had significant differences in wheat straw decomposition as compared to the no-fertilizer control. For example, fertilizer rate and timing of application during summer 2012 and Fall 2013 at the Hays site had impacts on wheat straw shear stress at break point. Across site years, earlier (fall) fertilizer application generally resulted in lower remaining aboveground biomass as compared to a spring application. Multivariate and linear regressions suggested that N content and C:N ratio can explain the results observed with respect to treatment effects on winter wheat residue decomposition.

Keywords: residue decomposition, liquid fertilizer, shear stress, specific energy

New management options of subsoil constraints for sustainable food production

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Abstract

Subsoil constraints are widespread in agroecosystems in the world, and their amelioration is costly and often practically infeasible. These constraints include compaction, sodicity, salinity, acidity, alkalinity and low fertility which limit crop production mainly by restricting root growth and hence water and nutrient uptake. This paper reports on the recent development of management options to ameliorate subsoil acidity and physical constraints. Biological amelioration through managing excess anion (nitrate) uptake was shown as a promising method to ameliorate subsoil acidity. The major challenge for this method is to synchronize nitrate movement and root capture in the subsoil for maximal alkalization and minimal nitrate leaching loss. To ameliorate subsoil compaction associated with sodicity, we developed a new technology termed subsoil manuring. This involves the deep incorporation of large amounts of organic manures in subsurface layers to improve the physical properties of dense clay subsoils that restrict root growth, water uptake and crop yields in dry years. Macroporosity and hydraulic conductivity were markedly improved in subsoil layers with subsoil manuring, which was attributed to the increased microbial activity associated with the proliferation of crop roots in the amended layer and the breakdown of the organic amendment. This subsoil intervention has led to large increases in crop yields across multiple sites and reasons. The feasibility of these new management options is also discussed.

Keywords: Cation-anion balance, Dense clay subsoil, Nitrate uptake, Organic amendments, Subsoil acidity, Subsoil sodicity

Comparison of finite and discrete finite element methods for modelling the effect of cutting edge height on soil cutting during tillage

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Abstract

Tillage is the physical manipulation of the agricultural soil to improve soil conditions and place seed and fertiliser for the growth of plants. It is an extremely vital part of crop production. The energy required for tillage processes accounts for a significant proportion of total energy used in crop production. Hence, optimising tool performance can assist with improving economic crop production. Fielke (1994) showed that the cutting edge geometry of shallow working tillage tools has a major effect on tillage forces which in-turn affects energy consumption. In order to optimise energy efficiency one approach is to model the soil-tool interactions. Modelling of soil-implement interactions is a complex process due to variability of the soil, non-linear behaviour of the soil material and the dynamic effect of the soil flow. This paper compares two methods of modelling of soil cutting during shallow tillage with glass sided soil bin tests. It compares the results of the Finite Element Method (FEM) with the Discrete Element Method (DEM). Modelling of tools with different cutting edge heights was undertaken to compare draft and vertical tillage forces and soil movement around the cutting edge with observations from glass-sided bin tests. The DEM simulation results were able to provide better draft and vertical force predication, but due to the larger than actual particle sizes for the DEM particles used in the study it was not able to predict the soil movement as well as could be achieved with the FEM. In the future, using more powerful computers that can analyse more particles, closer in size to soil grains the results of the DEM will improve and DEM will be an ideal method for studying soil-tillage interactions.

Keywords: DEM; FEM; Cutting edge; Soil movement; Draft force; Vertical force

Optimization of tillage energy and tillage-induced soil structure for a rotary tiller using an in-situ test rig

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Abstract

Agricultural soil structure is a result from long-term tillage system and crop rotations, significantly altering soil mechanical properties and tillage tool performance. However, when a soil is remolded for tool evaluation purposes, pre-existing structure of the soil is destroyed. The acquired result from laboratory soil bin test is therefore largely limited, lacking the detail of the real tool performance in the field. A test rig was thus developed for in-situ soil tillage test, with specific intention for rotary tiller performance optimization in paddy soils. The designed test rig facilitates an adjustment of both rotating speed and forward speed, allowing a wide range of bite length to be attainable. Energy consumption and soil structures were evaluated on the basis of the bite lengths. Results proved that the bite length, a theoretical controlling scale for tillage-induced soil structures, provided only partial information for the interactions among tillage energy, soil structure and the working parameters of rotary tiller. Bite length should be considered with both rotating speed and forward speed when system optimization was to be made. The forward speed divided both energy consumption and soil structure into 2 distinctive sections. This distinction allows another two indices, i.e. energy potential and soil structural potential, to be evaluated. The proposed 2 indices were proved to be useful to quantify the performance of rotary tillers and system optimization.

Key words: In-situ test rig, rotary tiller, bite length, energy and soil structural potential

Effects of adjusted tillage and seeding operations on soil properties and grain yields in Western Siberia

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Abstract

The Western Siberian grain belt is of global significance in terms of agricultural production as well as carbon sequestration. Regional downscaling of global climate change modelling predict increasing drought risks and water scarcity for that region. These changing conditions lead to upcoming challenges for crop production and soil conservation in this semi-arid area.

The German-Russian interdisciplinary research project "SASCHA" aims to provide sustainable land management practices to cope with these far-reaching changes. In particular, strategies to improve efficiencies in crop production systems are being developed on farm scale. Therefore a 3-factorial field trial (RCBD, 3 replications) with tillage (conventional/no-till) and seeding (high/low seed rate and seed depth, respectively) adjustments was installed on 10 ha in 2013, growing a regional spring wheat variety (dominant crop) on clay-loam soils (Phaeozems) in Ishim (56.17˚N, 69.49˚E).

Results indicate highly significant impacts of reduced tillage on soil temperature and soil moisture. Depending on yearly weather conditions, effects of seeding adjustments vary. Mean season soil temperature was significantly lower (by 0.52˚C) under no-till compared to currently usual conventional tillage. Differences in soil moisture (35-47%) between both tillage systems became obvious immediately after tillage/seeding operation. The effect was also detectable shortly after rainfall events, all no-till plots showed significantly higher water content over the entire growing season. Results after two years show that reduction of tillage intensity has a more dominant effect than seeding adjustments, because no-till effects are reflected in higher yield tendencies and in 2014 also in significantly better grain quality (+0.4% protein content).

Even if optimal seed rates and seed depths have been identified since decades, changing climate conditions as well as advancement in cultivation technology and plant breeding require a look on these details again. In conjunction with progressing climate change there seems to be high potential for enhanced production efficiency by no-till systems for the study region in Western Siberia. Saving soil water also enhances nutrient use efficiencies at all and thereby covers soil conservation issues by avoiding reclamation of abandoned farmland or even cultivation of unused areas.

Keywords: tillage systems, sustainable agriculture, climate change, Western Siberia

Puddling Performance of the Tilling Wheel of Float-assisted Tillers at Different Forward Speed

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Abstract

Float-assisted tiller is one of the land preparation equipment used for lowland tillage in the Philippines. It consists of a tilling wheel plus a float chamber on which the engine is mounted. The tilling wheel has the same configuration as that of a lowland walking-type tractor's cage wheel. The cage wheel-like configuration of the tilling wheel produces traction and floatation for the tiller. The study aimed to determine the effect of varying forward speed (0.5, 1.0 and 1.5 kph) on the puddling characteristics of the tilling wheel. The experiments were done using a single tilling wheel in a laboratory soil bin. Torque transducer, speed shaft sensor and load cells were used to measure forces. The highest maximum draft of 135.02 N was at 1.0 kph on the 1st pass. The highest performance index of 1,173.98 m^3/MJ was at 1.0 kph (third pass). Generally, the performance index increases as number of pass increases for all forward speed. Moreover, the tilling wheel best performed at 1.0 kph fprward speed. Mean differences of draft and performance index were not significant between second and third pass.

Keywords: float-assisted tiller; tilling wheel; tillage draft; performance index

Development of a Costing Model for Land Clearing Operations

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Abstract

Land Clearing is seldom considered in the strides to mechanizing tillage in Kwara state and indeed Nigeria because farming has been predominantly peasant in Nature, up till recent when commercialization of agriculture is being encouraged, despite its huge financial and material requirement a trend not unconnected with the small farm holdings of most farms. The tool for the determination of Land clearing costing model were developed, simulated and verified. It was deduced that cost, time or period of operation, number of labour and machine employed and farm size and location are significant in the land clearing option selection. The land clearing model (options) consisting of manual land clearing plus burning, manual land-clearing cum winching and sawing, and mechanical land clearing using D6H bulldozer sub-models (options 1, 2 and 3 respectively) were replicated thrice in three locations of Elemere, Lasoju and Igbaja in Kwara North, Kwara Central and Kwara South Senatorial Districts of the State respectively. The evaluation of the land clearing model revealed that using options 1 and 2, ₦149,000.60 and ₦203,455.80 are the respective costs of clearing 1Ha while using option 3 costs ₦319,379.9667. Considering the respective average periods of 1.33days, 1.03days and 0.33hour for clearing 0.05Ha of land using options 1, 2 and 3 respectively, indicate gradual reduction in clearing cost per hectare with option as opposed to the other options. It is thus deducted that options 1and 2 are best suited for clearing fields not exceeding 2ha except that option 2 is better suited for land with fairly high tree population. Option 3 on the other hand is best suited for farm sizes of 5ha and above to enhance less and more affordable land clearing cost per hectare. Development of an all encompassing model to select the most appropriate land clearing option alongside tillage combination best suited for any given ecological zone is desirable. (₦ 166 = US$ 1).

Keywords: Land Clearing, Tillage, Costing, Mechanization, Tree Population

Response of soil properties and cocoyam growth and yield to tillage and poultry manure in a tropical Alfisol

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Abstract

In order to develop a suitable soil management adapted to the low activity fragile dominant Alfisol in southwest Nigeria, two field experiments were carried out at two sites in 2007 and 2008 on Alfisols at Owo, southwest Nigeria to evaluate the effect of years, tillage and poultry manure on soil properties, plant height, cormel and corm yields of cocoyam. The treatments were five tillage methods: manual clearing (MC), manual ridging (MR), manual mounding (MM), ploughing plus harrowing (P+H) and ploughing plus harrowing twice (P+2H) and five poultry manure (PM) levels: 0, 2.5, 5.0, 7.5 and 10.0 Mg ha^{-1}. These were factorially combined and arranged in a randomized complete block design and replicated three times. Years of study did not have effect on soil bulk density. Soil water content and soil temperature were significantly higher ($p = 0.05$) in 2008 compared with 2007. Among tillage methods, P+H had the least bulk density and highest plant height, cormel and corm yields of cocoyam while MC which had the highest soil organic matter, N, P, K, Ca and Mg, and the highest bulk density produced the lowest values of plant height, cormel and corm yields of cocoyam. Soil chemical properties, growth and yields were higher in 2007 than 2008; the reduction of cocoyam plant height, cormel and corm yields between 2007 and 2008 were 9.6, 7.5 and 10.3%, respectively. Bulk density dictated the performance of cocoyam in this study and not soil chemical properties. Poultry manure tended to lower soil bulk density and temperature, and increased soil water content, soil organic matter and soil nutrients. Poultry manure increased soil OM, N, P, K, Ca and Mg from 0 to 10 Mg ha^{-1}. Poultry manure only increased soil K, Ca and Mg, growth and yield of cocoyam up to 7.5 Mg ha^{-1} which is the optimum value for cocoyam production on Alfisols of southwest Nigeria.

Keywords: Tillage, Cocoyam, Poultry manure, Soil bulk density, Soil water content, Soil chemical properties

Dynamic Modeling of Implement Draft Force and Width of Cut in Prediction of Tractor and Plough Performance During Ploughing Operations

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Abstract

A field study of soil factors affecting tractor field performance was conducted in three local government areas of Adamawa state in the North east region of Nigeria in order to produce a predictive model of the performance of tractor and plough combination in ploughing operations. The effect of relative parameters that affect tractor and plough performance in these fields were assessed using a split-split plot experimental design, having two tractors and two plough types, four soil types and four hitching arrangements giving 64 treatments(i.e 2x2x4x4). The tractors, that is the Mersey Ferguson 435 and Ford New Holland TT55, with their accompanying ploughs as main plot treatments. The four soil types as sub-plot treatments were the sandy soil, the hard soil (clay), the silty loam and sandy clay. The sub-sub-plot treatments. Four types of hitching arrangements V0, V1, V2 and V3. The soil parameters were also measured. The results obtained showed that all the parameters measured had statistical significant effects on the tractor performance at 5% probability level ($P<0.05$) and 1% probability level ($P<0.01$) using Analysis of Variance (ANOVA). Measured soil parameters when subjected to ANOVA also showed statistically significant differences at $P<0.01$ and $P<0.05$ levels, thus making the experiment significant. A paired comparison of means was performed on all the measured parameters using the Duncan Multiple Range Test (DMRT) in the Statistical Analysis for Sciences (SAS) programme. It was observed that statistical significant difference between treatment means existed at the 0.05 level of probability. Linear relationship was found to have existed between the observed parameters and the tractor drawbar pull with all coefficients of correlation (r2) being high. Multiple linear correlations was performed and mathematical predictive models were produced. giving Coefficients of determination (R2) values of 98%. The obtained multiple regression predictive equations were then subjected to dimensional analysis using Buckingham Pie theorem. Predictive equation was obtained. A paired t-test performed on the model versus the actual field results showed a positive correlation with the R2 value of implement draft force versus dbp, implement width of cut versus dbp, as 0.98, indicating that the obtained model really represented a perfect predictive mathematical model for the above parameter.

Keywords: tractors, ploughs, tillage, performance, and model

CAD software development of milling machine spindle for machining tillage tools

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ABSTRACT

The design of a Milling Machine spindle takes time for even an experienced designer to design. This led to the development of a CAD software for the design of a milling machine spindle, which makes use of a computer system to assist in the creation, modification, analysis, or optimization of a design. The CAD software is used to increase the productivity of the designer, improve the quality of design, improve communication through documentation, and to create a data base for manufacturing.

The method employed for the development of the CAD software is the use of a computer programming language called C-Sharp (C#). An interface is created whereby the designer can select the different parameters (length, breadth, etc.) or shapes (slanted, curved, rectangular, etc.) which he desires. The shapes and parameters have already being programmed into the software by the designer. The designer continues to select the different parameters until he gets the desired shape.

The different shapes and sizes of the spindle is displayed on screen as the designer makes the selection so as to achieve the desired shape he wants. It helps to fasten the work of the designer.

The CAD software was developed and tested, and it fulfilled the purpose for which it was designed.

Keywords: Spindle, CAD

Strategies for sustainable intensification based on spatio-temporal analysis of land use intensities in Tyumen, Siberia (Russian Federation)

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Abstract

The Western Siberian grain belt is of global significance in terms of agricultural production as well as carbon sequestration and biodiversity preservation. Since the dissolution of Soviet Union and collapse of the state farm system, land use intensities in Tyumen province (Western Siberia, Russian Federation) are decreasing on grassland due to declining livestock whilst on cropland opposite trends are being observed since 2003. Recultivation of abandoned cropland as well as increasing fertilizer inputs indicate significantly growing land use intensities on arable land during the last decade. Regional downscaling of global climate change models predict increasing drought risks and water scarcity. Together, these changing conditions lead to upcoming challenges for agricultural production in this semi-arid environment. For sustainable land management practices, in particular strategies for eco-efficient cropland cultivation are needed. The conceptual framework of sustainable intensification (SI) covers both issues, improvements in agricultural production of food and fodder as well as protection of natural environments.

We developed a spatio-temporal land use intensity index to identify potentials and risks for sustainable agriculture under climate change conditions. 18 year's statistical data from 22 provincial districts were analysed and compared to maximal intensities in the end of Soviet era. Together with environmental and infrastructure variables, spatial patterns for adapted strategies of sustainable land management could be derived from that index.

Since the key issue for sustainable crop production under global warming in the study area is improving water use efficiency, we also set up an on-farm field trial to demonstrate how to apply sustainable intensification on farm scale. Jointly, our findings will merge aspects on different scales and therefore help to ensure stable yields under changing climate and avoid additional environmental damage, as there will be no need to expand production areas.

Keywords: land use intensity, sustainable intensification, climate change, Western Siberia

Discrete Element Method (DEM) for modelling both soil forces and soil movement of a mouldboard plough during tillage

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Abstract

The mouldboard plough is a primary tillage tool to manipulate agricultural soil. It provides soil inversion to bury plant residue which helps control weeds, it also loosens and aerates the soil. The mouldboard plough has a very complex shape. In order to understand mouldboard ploughs empirical or finite element modelling (FEM) techniques have previously been employed. However, due to limitations they can be used to model tillage forces but not soil movement. If the soil movement as well as the tillage forces can be accurately modelled, improvements in soil manipulation and energy efficiency may be achieved without performing expensive and time consuming field tests. Modelling of soil-tool interaction is a highly complex process due to the variability of the soil structure and non-linear behaviour of soil. Recent studies (Ucgul et. al., 2014a; Ucgul et. al. 2014b; Ucgul et. al 2015) have proven that in order to overcome the difficulties in modelling soil, discrete element method (DEM), which is a dis-continuum numerical modelling technique, can be used. In this study the interaction between the soil and mouldboard was modelled using 3D DEM. The same contact model and calibration process as previously used by Ucgul et al (2014a) was used. The simulation results of soil-mouldboard interaction were validated by performing a series of small scale laboratory tests. The results of the study showed that DEM is a reliable method to model both soil movement and tillage forces.

Keywords: DEM, mouldboard plough, tillage forces, soil movement

The Analysis of Bacteria Azotobacter Rhizopzfer Cocoa Plants To Produce Indole Acetic Acid And Cytokinin Management Suboptimal Land

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Abstract

A Total of 10 isolat Azotobacter sp. bacterial has been isolated from the rhizosphere of cocoa plants in Sulawesi. Furthemore ,testing the ability to produce Indole Acetic Acid and Cytokinin production testing, using NB medium supplemented with L-tryptophan and incubated for 3 days. From the results shown, Azotobacter isolates produced IAA in the range of 0,48-45.87ppm. Azotobacter isolates Az 12 that showed high IAA production was 45.87 ppm. Cytokinin produce tes by the method Pikovskaya. in the range of 5.188 to 20.589 ppm. Six Azotobacter isolates that high to ptoduce cytokinin Az 5, Az 12, Az 13, Az 24, Az 26 and Az 34.

Keywords: Azotobacter, cocoa, indole acetic acid and cytokinin

Strategic tillage caused minimal impact on soil microbial communities in a vertisol under 44 years of no-tillage and conventional tillage managements in Queensland, Australia

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Abstract

Strategic tillage (ST) was implemented to reduce weed infestation and stubble borne diseases in a wheat-fallow monoculture (*Triticum aestivum* L. cv. Timgalen) under 44 years of no-tillage (NT) and conventional tillage (CT) managements in a Vertisol from Queensland, Australia. The long-term experiment included a factorial combination (CT or NT x crop residue retained or burnt) with four replications. In March 2012, each treatment was longitudinally split in two, with half receiving narrow point chisel tillage to depths between 0.15 and 0.20 m and the other half left untilled. Seven soil samples were collected from each plot in May 2013 from 0.0 – 0.1 m and 0.1 – 0.2 m soil depths and combined according to each depth. We evaluated the impact of one-time ST on microbial communities 13 months after tillage operation. Soil microbial biomass (chloroform fumigation-extraction), enzymatic activity (fluorescein diacetate, FDA), metabolic diversity (Microresp^{TM}), microbial profiling (terminal restriction fragment length polymorphism, T-RFLP) and bacterial and archaeal composition (16S RNA gene amplicon pyrosequencing) were used to assess the impact of ST on soil health. After ST operation, oxalic acid utilisation was significantly reduced on CT systems in the top 0.1 m depth ($P < 0.05$). Redundancy analysis on soil community structure showed significant differences between NT control treatment and ST application for the top 0.1 m depth ($P < 0.05$). Pyrosequencing revealed 69 operational taxonomic units (OTUs) which were present at a relative abundance higher than 1%. Acidobacteria and Chenarchaeota were the most abundant phyla with 28.13% and 25.05% of OTU's present, respectively. Furthermore, Actinobacteria showed a decrease in the relative abundance after ST operation on CT treatments for top 0.1 m depth communities ($P < 0.05$). Significant differences between treatments were observed in individual OTUs after ST application, with most changes observed for top 0.1 m communities. Differences observed between ST and original treatments (CT or NT) may be attributed to rainfall fluctuations and physicochemical properties of this Vertisol, including pH, soil water content and self-mulching properties. Our results suggest that 13 months after one-time ST operation exerts a minimal impact on most biological indicators used in this study. Therefore, strategic tillage has the potential to be used in strategies to control weed and diseases without compromising soil health.

Keywords: Pyrosequencing, strategic tillage, enzymatic and metabolic activity, soil microbial diversity

The application of visual soil examination and evaluation techniques in temperate grasslands

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Abstract

Visual Soil Examination and Evaluation (VSEE) techniques are useful indicators of soil quality appropriate for use by agricultural advisors and farmers. Such techniques allow the rapid and holistic evaluation of soil structure over wide areas, a necessity quantitative measurements do not satisfy. In Ireland, increased agricultural production threatens grassland soil quality. There is a need for simple methods to assess grassland structural quality in temperate climates that Ireland typifies. A number of VSEE techniques exist, differing in methodology and origin. The objective of this research was to determine the most effective technique in the assessment of grassland topsoil structure and suitable for farmer use. Following a literature review, two VSEE techniques were selected and deployed on 20 grassland sites around Ireland representing all major mineral soil types. The techniques included the Visual Evaluation of Soil Structure (VESS) and Visual Soil Assessment (VSA) procedures. Cores for bulk density (ρ_b) determination were also taken at 5-10 cm and 10-20 cm depths. Preliminary results indicate no significant ($P = < 0.05$) correlation between VESS and VSA scores. Both scoring systems were capable of differentiating between the quartile ranges of ρ_b measurements, however VESS scores were found to more clearly indicate differences. VESS scores were found to have a significant positive correlation with ρ_b 5 – 10 cm (r = 0.55) and ρ_b 10 – 20 cm (r = 0.59) while VSA scores were found to not significantly correlate with ρ_b measures. Difficulties were also noted in relation to the practical application of the methods. Grassroots presented problems when conducting a drop-shatter test for structure evaluation in the VSA procedure. The VESS method was found to be unnecessarily complicated, while aggregate shapes and anerobic zones in surface water gley soils did not fit the classification described. Overall, it was concluded that the VESS procedure is more effective in evaluating grassland soil structure, though modifications are required. Notably a better system for evaluating the grass-root mat layer structure and the re-wording and simplification of the VESS score sheet.

Keywords: Soil structure, agricultural extension, grassland soil quality

TERENO: a network of terrestrial environmental observatories and data platforms

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Abstract

In 2008, a network of terrestrial environmental observatories was established in Germany comprising four distinct regions in Germany sensitive to climate changes. The objective of TERENO is to collect long term data of all compartments in the terrestrial system, to study feedbacks between the soil-plant-atmosphere system, to develop and deploy new measurement technologies in combination with remote sensing and data assimilation techniques. Within the individual TERENO observatories, different in-situ sensors provide spatial and temporal distributed information on various physical and biogeochemical parameters including soil moisture, temperatures, ground water levels, and gas fluxes (CO_2, N_2O). In this presentation we will report about recent results in the field of monitoring hydrologic fluxes and soil moisture states. Specific attention will be given to the analysis of spatially variable soil moisture in relation to hydrologic fluxes and the estimation of soil hydraulic properties from the spatio-temporal distribution of soil moisture. In addition we will report on further development of the TERENO research platforms including the installation of a network of 132 fully automated weighable lysimeter systems and the establishment of ICOS sites focusing on observing greenhouse gas emissions for a period up to 25 years. The collected data are being made available to the science community through the TERENO data portal (www.tereno.net) and used in data assimilation approaches to predict the hydrologic and biogeochemical states and fluxes of the terrestrial system.

Keywords: TERENO, soil moisture, lysimeters, hydrologic fluxes

Space-time processes of soil water storage in a farmer's field under no-tillage

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Abstract

The spatial behavior of soil water strongly varies in time. Whereas under wet conditions close to soil water saturation, the variance of soil water is small, spatial patterns with marked differences evolve with increasing dryness. It is not clear what the sources of variation are and under which external conditions local variance or large-scale variance dominates the spatial pattern of soil water. The objective of this study was to identify whether the spatial variance behavior of soil water storage is related to its mean across the profile or at particular depth intervals in the profile, and whether it is furthermore related to the redistribution status of soil water after rainfall events. Moreover, main scales of spatial variation and their change over time should be investigated. Between 2007 and 2010, a field study was conducted in a Crider silt loam soil in Princeton, Caldwell County, in western Kentucky. Along a 450-m transect, soil water content was measured using a Diviner capacitance probe at 45 locations at 10-cm-depth intervals between 0 and 80 cm depth. PVC access tubes had been inserted at regular 10-m distances. In total, soil water content was measured 45 times in approximately 2-week intervals during the growing season and longer intervals during the winter season, resulting in 45 spatial data sets. The variance behavior was analyzed using semivariography and Fourier-based transformations, i.e., spectral and wavelet analysis. When considered over the 80-cm soil profile depth the spatial variance behavior did not exhibit obvious dependence with the mean soil water storage or the phase of redistribution, i.e., the time after a rainfall event. Further analysis of different depth segments of the soil profile revealed an inverse behavior between soil water storage in the upper depth compartments and its variance. Parameters of spatial semivariograms did not show dependence on average soil water content or rainfall events. Under medium-wet to dry conditions large scale fluctuations dominated the spatial variation whereas smaller variation scales were typical for wet to medium-wet conditions. The results of this study are relevant for field-scale model descriptions of soil water processes, and for planning ground truth observations in relation to remote sensing information.

Keywords: Soil water storage; spatial variance behavior; temporal variance behavior; spectral analysis of soil water storage; wavelet transform of soil water storage

Hot moments of nutrient export from artificially drained lowland catchments

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Abstract

Artificial drainage systems may accelerate and increase nutrient loading of surface water resources depending on soil type and functioning of drainage pipes. It has been previously reported that concentration patterns of nitrogen and phosphorus compounds in drain effluent often follow discharge intensity. In this study we were aiming at analysing hydrograph characteristics and their impact on nitrate export. Eight years of data from three spatial scales (from 4.2 to 1550 ha) covering 212 events were subjected to a Principal Component and a Linear Discriminent Analysis. The data evaluation revealed that the rainfall-runoff events can be classified as summer events (28%), snowmelt events (10%), events controlled by rainfall duration (16%), rainfall totals (8%), dry antecedent conditions (10%), and events characterized by wet antecedent conditions (14%). The relatively large number of unclassified events (15%) demonstrated the difficulty in separating event types due to mutually influencing variables. NO3-N concentrations showed a remarkably consistent pattern during the discharge events regardless of event type, with minima at the beginning, increasing concentrations at the rising limb, and maxima around peak discharge. However, the level of NO3-N concentrations varied notably among the event types. The highest average NO3-N concentrations were found for events controlled by rainfall totals (NO3-N=17.1 mg/l), events controlled by wet antecedent conditions (NO3-N=17.1 mg/l), and snowmelt (NO3-N=15.2 mg/l). Average maximum NO3-N concentrations were significantly lower during summer events (NO3-N=10.2 mg/l) and events controlled by dry antecedent conditions (NO3-N=11.7 mg/l). The results have furthermore shown that similar hydrological and biogeochemical processes determine the hydrograph and the according NO3-N response at the various investigated spatial scales. The management of tile-drained agricultural land to reduce NO3-N losses should focus explicitly on flow events and, more specifically, active management should preferably be conducted in the winter season for discharge events after snowmelt, after heavy rainstorms and when the soil moisture conditions are wet.

Keywords: Agricultural Drainage, Nitrate, Nutrient Export

Characterization of intact biopore walls and aggregate coatings for describing preferential flow in structured soils

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Abstract

Soil consists of a dynamic and hierarchical system of organic and inorganic constituents and organisms. Physical as well as biological activities result in soil aggregation or in the formation of biopores that are affecting the 3D pore structure of the soil. It has frequently been demonstrated that soil water can preferentially move along macropores or within a network of highly permeable inter-aggregate pores thereby partially bypassing the lower permeable intra-aggregate pore system of the bulk soil matrix. Preferential flow of water and transport of dissolved chemicals in structured soil may have drastic impact on ground and surface water quality. A numerical finite element dual-permeability model can be used to describe preferential flow and solute transport in two interacting porous domains. Based on model analyses and observations, one key component for understanding preferential flow processes seems to be the mass transfer of water and solutes between aggregates and inter-aggregate pores that controls local nonequilibrium conditions during storms. Mass transfer depends on the local soil properties of preferential flow path surfaces. These surfaces are biogeochemically relevant interfaces such as interaggregate pores, cracks, or biopores that may have locally distributed hydraulic and biogeochemical properties. Aggregate coatings consist of clay-organic compounds. The coating material can be different from the matrix with respect to its mineralogical and organic composition. Since organic matter is mostly covering the mineral particles in soil, sorption, wetting, and other reactive surface properties are characterized mainly by the organic properties at the surfaces. Parameters of the mass transfer term for aggregates with intact coatings were found to be reduced as compared to aggregates with coatings removed. Results suggest that for identical soil structural geometries, water and solute movement can be completely different depending on mass transfer properties. For particular soil environments, preferential flow analyses should consider whether macropores are created by decayed roots or earthworms. Plants and soil organisms may to a certain extent effectively control local non-equilibrium conditions by creating more or less permeable coatings along decayed root channels or worm burrows. Still a challenge is to describe or predict the degree of preferential transports in soil landscapes depending not only on tillage practices but also on crops or crop rotations and soil management that affect biological activity in soil.

Simulation of soil water and heat flow in mulched ridges and furrows wheat field of Loess Plateau, China

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Abstract

A widespread measures for improvement of soil water use efficiency (WUE) in the semi-arid region of China is the ridge-furrow planting system combined with mulching. However, it is not well understood, how and to which extent the water and heat flow regime in this manmade field is hereby modified. The objective of this study was to investigate soil water distribution and heat transport under four experimental treatments consisted of conventional fertilization (CF), recommended fertilization (RF), recommended fertilization plus straw mulching (RF+S), and recommended fertilization plus plastic film mulching on soil ridges and straw mulching in furrows (RF+PM+S). The model HYDRUS-2D was calibrated and experimentally validated, so as to be use a reliable tool for accurately simulating the coupled soil water and heat processes in the plastic mulched ridge cultivation system. The results showed that the highest water storage and therefore the highest WUE occurred in the RF+PM+S treatment, due main to the lateral water flow storage in the furrows effectively and the reduced evaporation under mulching. While soil daily mean temperature was very similar among treatments, the intraday changes were significantly different affected by the plastic film mulching. We conclude the plastic mulched ridge cultivation system improved water resource use through reducing evaporation and elevated temperature in this agro-ecosystem. Therefore, we recommend the application of perforated and biodegradable plastic mulch in this region to improve crop production.

Keywords: Winter wheat; Water use efficiency; HYDRUS-2D model; Loess plateau

Untangling soil water variability and its control at multiple scales

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Abstract

Soil water varies spatially and temporally within the landscape. The variability is controlled by a complex suite of environmental factors and processes acting in different intensities over a variety of scales. While modeling approach has made progresses in this aspect, but its application has been hindered by the lack of detailed measurement of soil hydraulic properties and biophysical properties of land surface. There is a need for developing new statistical methods for untangling this nonstationary, potentially nonlinear variability and its dominant controls at multiple scales in the landscapes. The objective of this study is to summarize recent progresses in methodology and a few recent applications of the methods on understanding of the soil water dynamics and the underlying processes causing the variability. Soil water storage (SWS) was measured down to 1.4 m (0.2 m depth interval) at 128 regularly spaced locations along a transect over five years from the Hummocky landscape of central Canada. The locations and the scales of the most persistent spatial patterns over time and depth were quantified using the wavelet coherency. The variability in SWS spatial patterns was controlled by different factors at different scales. Scale specific dominant controls were identified after separating the variance contribution of each scale towards the overall variance. The large scale macro-topographical control and medium scale landform control were much stronger than very large scale soil textural control on SWS. The scale-specific relationship with controlling factors improved the prediction of SWS.

Towards an International Network of Critical Zone Observatories

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Abstract

The Earth's Critical Zone (CZ) determines the availability of nearly every life-sustaining resource and provides the foundation for all human activities. It is also the crucial interface among all spheres of the Earth system and the only region of the solid Earth readily accessible to direct observations. The CZ concept provides a holistic and unifying framework to understand diverse Earth surficial processes: the hydrologic cycle, the geochemical cycle, the carbon cycle, the nutrient cycle, gas exchange (major and trace gases), erosion and deposition, weathering, lithification (diagenesis), soil formation and evolution (pedogenesis), life processes (macro- and microbial communities), and human impacts (land use and management). Among the complexity in the CZ are the integration of abiotic and biotic processes, the linkage of the belowground and the aboveground systems, and the unification of the time and the space dimensions. The timescales considered in the CZ range from seconds to eons, embracing both geological and biological timescales, while the spatial scales of the CZ are also enormous, ranging from the molecule to the globe. Three "deep" aspects are unique of CZ: 1) Deep time (i.e., geologic time to understand the formation and evolutionary history of the Earth's surficial environment) and the reconciliation of long- and short-time scale processes; 2) Deep into weathered bedrock (i.e., deeper than the classical perception of soils generally perceived as 1-2 m root zone); and 3) Deep understanding of coupled processes (i.e., interactions and feedbacks among geologic, pedologic, hydrologic, biologic, geochemical, atmospheric, and anthropogenic processes). The development of an international network of Critical Zone Observatories (CZOs) will serve international scientific community through interdisciplinary research, common infrastructure, shared database, integrated models, and the education of new generations of earth and environmental scientists. The US, EU, Germany, UK, China, and Australia are leading the way to establish such an international network of CZOs that offers an unprecedented platform for major breakthroughs and sustainability practices.

Soil and solute transport through buffer strips in Central Sweden

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Buffer strips along ditches and water courses are constructed to abate leaching of nutrients and pesticides to water bodies. In Sweden, Phosphorus leaching to surface waters is the main cause of eutrophication in most lakes and in the central parts of the Baltic Sea. To mitigate this problem the farmers get subsidies if they leave a minimum of a six m wide vegetated zone along the water courses or greater ditches. Currently, this measure is very common in Sweden but its effectiveness to reduce nutrient losses, especially phosphorus, has not been well investigated. This paper summarizes results from a field trial, which has been underway to investigate the effectiveness of buffer zones in Central Sweden for abating soil and phosphorus losses to water bodies. The trial has been underway since 2011 with the following treatments: A) control (cultivated as the upstream field; B) grass vegetation; C) grass vegetation, harvested once a year. The plot-size is 6 m x 6 m and the treatments are replicated 4 times in a randomized block design. Each plot is drained with a 6 m long tile pipe in the middle and surface runoff is collected in a gutter at the lower part of the plots. Water from drainage and surface runoff is directed to automated measuring station for flow proportional sampling using tipping buckets. The samples have been analyzed for dissolved reactive phosphorus (DRP), particulate phosphorus (PP) and turbidity. Recently, we included measurement of total organic carbon since it seems that it contributes significantly to phosphorus leaching from the vegetated areas. Surface runoff has been rare and occurred only at snow-melting. In contrast, water discharge via drain tiles occurred more often, mainly during autumn-spring time. Soil porosity and saturated hydraulic conductivity were significantly higher in the grass buffer strips compared with the cultivated land. Concentration of soil in the drainage water was 20% lower in the grass strips than in the tilled plots. The amount of clay particles in relation to total soil particles was 55% in the surface runoff and 85% in the drainage water. On average, buffer strips reduced both DRP and PP but the differences were not statistically significant.

Key words: Buffers strips; Dissolved reactive phosphorus; Particulate phosphorus; Turbidity

Mineral nitrogen leaching from a furrow irrigated wheat-maize rotation under different tillage-straw management practices

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Abstract

Nitrate (NO3) leaching from agricultural soils represents a substantial loss of fertilizer nitrogen (N) and may lead to considerable contamination of ecosystems. The objective of this study was to quantify NO3-N leaching losses with ion exchange resins for two tillage-straw management practices in the Yaqui Valley, NW-Mexico. In these irrigated wheat systems in which farmers apply on average 250 kg N ha-1 as anhydrous ammonia or broadcast urea, conservation agriculture (CA) is promoted based on minimum tillage, crop residue retention, and crop rotation. To investigate N use efficiency of this system a long term experiment was established in 2005 using a randomized complete block design with two replications and two subplots on a Hyposodic Vertisol. Tillage-straw treatments were conventionally tilled beds with incorporation of crop residue (CTB-straw incorporated) and permanent beds with crop residue retained at the surface (PB-straw retained). Ion exchange resins were installed at 90 and 120 cm depth in two consecutive cropping cycles: wheat (Triticum durum L.), planted in November 2012 and split-fertilized with 278 kg N ha-1 and maize (Zea mays L.), planted in June 2013 and split-fertilized with 203 kg N ha-1. Ion exchange resins were extracted with 1 M KCl and 0.5 M H2SO4 whereby also the effects of the number of extractions (1 to 6 times) were investigated. Nitrate concentrations in the extracts were determined by flow injection analysis on a Skalar San+ Automated Ion Analyser. Compared with KCl the use of H2SO4 as an extractant increased N-yields triple fold whereby almost 90% of the NO3 ions could be extracted with two extractions. NO3-N leaching was with 20 kg N ha-1 largest for wheat with PB-straw retained at 90 cm depth compared with only 7 kg N ha-1 in CTB-straw incorporated. For maize, leaching losses amounted to 101 kg N ha-1 at 90 cm depth in PB-straw retained compared with only 74 kg N ha-1 NO3-N with conventional tillage.

Our data indicate that resin-based NO3-leaching losses depend on installation depth, cartridge layer and the cultivated crop, but not on tillage. Residual soil NO3-N was high and averaged 22.4 ppm after wheat and 26.5 ppm after maize harvest, indicating the potential of improved fertilizer management to enhance nitrogen use efficiency and reduce environmentally harmful N losses. Additional multi-annual studies are necessary to assess the effects of reduced irrigation, climatic variation and different fertilizer application on nutrient leaching in CA systems of NW- Mexico.

Keywords: Nitrate leaching; Permanent raised beds; Ion-exchange resins; Nitrogen use efficiency

Crop yield, soil organic carbon, phosphorus and potassium as affected by tillage and direct drilling

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Abstract

The aim of this paper is to summarize the results of investigation in a 31- years old direct drilling trial in western Sweden. The investigation included crop yield, soil organic carbon (org-C), phosphorus (P) and potassium (K) content of the soil. The treatments comprised: conventional tillage (A); direct drilling with occasional ploughing (B) and direct drilling (C). Crop yields were recorded since start, and soil samples were collected in 2013 layer by layer following cultivation depths or natural boundaries down to 50 cm soil depth. Total org-C was determined using a Leco CN 2000 dry combustion analyser. P and K were determined according to Swedish standard by extracting with ammonium lactate (hereafter AL-P & AL-K) solution and reserve P was extracted with 2 M HCl (hereafter HCL-P & HCl-K). We compared the treatments with respect to the stratification of org-C, P and K and with respect to their total storage per ha. On average (1982-2014), crop yields in B and C were 7-8% less than that in A. The concentration of org-C in the soil declined with depth in all treatments but only C in the 0-5 cm soil layer contained significantly more org-C than the topsoil in A. AL-P increased with depth irrespective of treatment. AL-K concentration in 0-5 cm layer was greater in treatment B and C than that in A, indicating the accumulation of K from decomposing plant residues. Total storage of org-C, AL-K and HCl-P was more in B and C than A but the difference was statistically significant for only HCl-P. About 80% of AL-P was found in the subsoil irrespective of treatment. This might be due to the apatite content of the parent material, which is rich in phosphorus. Generally, treatment B and C showed org-C stratification but this was not the case with P and K contradicting earlier researches.

Keywords: Soil organic carbon stratification; Nutrient stratification

Changes in soil organic carbon by tillage systems under winter wheat-summer maize cropping system in the North China Plain

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Abstract

Growing concerns about climate change have enhanced interests in appropriate land use and soil management. However, climate variability in different seasons along with tillage practices also influence soil organic carbon (SOC) sequestration. Five treatments were tested in the North China Plain (NCP), including plow tillage with residue removed (PT0), plow tillage (PT), no-till (NT), subsoiling (ST), and rotary tillage (RT). The SOC concentration in 0-110 cm soil profile decreased with increasing soil depth among all treatments for both winter wheat (*Triticum aestivum* L.) and summer maize (*Zea mays* L.) seasons. Compared to PT0 and PT, NT significantly increased the SOC concentration by 34% and 27% at 0-5 cm depth, and 11% and 9% at 5-10 cm depth at the winter wheat harvest in 2012 ($P<0.05$), respectively. But no significant differences occurred at 50-110 cm depth among all treatments. Similar trends were also observed in the maize seasons. NT increased SOC stock in 0-30 cm layer by 13% compared to PT0 at the winter wheat harvest in 2012 ($P<0.05$), but the highest SOC stock in 0-50 cm profile was observed under PT except at the maize harvest in 2012. Therefore, tillage can affect SOC depth distribution, even over a short-term tillage duration (4-5 yrs). Seasons varitions and cropping system also influnece the SOC dynamics. These data are relevant to the understanding of underpinning processes governing the variations in SOC and depth distribution.

Keywords: Soil organic carbon; Soil organic carbon stock; Tillage practices; Residue management; North China Plain

REDUCING TILLAGE in ORGANIC FARMING: an opportunity to sequester more carbon?

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Abstract

Organic farming can provide multiple ecosystem services along with food production. A recent meta-analysis by Gattinger *et al.* (2012. PNAS. 109: 18226–18231) indicated significantly higher soil organic C concentrations and stocks in organic farming systems compared to non-organic with differences in external inputs and crop rotation cited as likely causes. However, the reliance of organic farming systems on deep inversion tillage for weed control and residue incorporation can result in soil degradation and increased consumption of fossil fuels. In conservation agriculture (CA) soil disturbance is minimized and kept covered by a living crop or residues, and crop rotations are diverse. CA systems increase surface soil C concentrations and may also sequester C in some cases. In this study we investigated the impacts of implementing CA practices in organic farming systems, specifically reduced tillage intensity, using a meta-analysis of data from published and unpublished sources. Tillage treatments were ranked from most intensive (deep inversion) to least intensive (no-till) and effects on crop yields, weed pressure and soil C stocks were analyzed. Reducing the depth of inversion tillage in organic systems resulted in minimal reductions in crop yields (4-6.5%) with no significant increase in weed pressure, while significant soil C gains were achieved. No-till was used in only a few cases, however, it appeared to be most effective where soil water was limiting. These results suggest that there is potential to improve ecosystem service provision in organic farming through reducing tillage intensity.

Keywords: no-till; organic farming; conservation tillage; conservation agriculture; meta-analysis; crop yield; weeds; soil C

Terrestrial carbon losses in cotton farming system in Australia

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Abstract

Soil contains large reserves of organic carbon globally, so small changes in soil organic carbon (SOC) could result in significant changes in atmospheric CO_2 levels. Theoretical estimates of soil carbon sequestration often do not coincide with measured values of soil carbon in irrigated cotton (*Gossypium hirsutum* L.) farming systems in Australia. It is speculated that losses of sequestered carbon through terrestrial pathways such as runoff, drainage and erosion may be significant. The relative amounts of organic carbon lost in such pathways have not been studied in the past, and consequently, remain unknown. We studied the effect of tillage and cotton-based crop rotations on soil carbon storage, carbon gains with irrigation water, and losses through terrestrial (non-gaseous) pathways such as runoff, erosion, and leaching in irrigated cotton farming systems. The experimental treatments, begun in 1985, were three historical treatments viz., conventional tillage continuous cotton, minimum tillage continuous cotton and minimum tillage cotton-wheat rotation arranged in a randomised block design. Corn (*Zea mays* L.) was introduced as a rotation crop in each of the three treatments in 2011, thus forming a split plot design with historical treatments as main plots and corn rotation and control as sub plots. SOC levels (0–1.2m depth) are measured annually since 2012. Irrigation volume, runoff and carbon loads in irrigation water and runoff were monitored from October 2014. SOC stocks measured in 2012 indicated an increase in SOC (0–1.2 m depth) in all the treatments with corn as rotation crop in previous year. Soil organic carbon in treatments that included a corn crop during the 2011–12 season ranged from 143 to 162 t C/ha of SOC in 0–1.2 m. However, after the following cotton crop (2012–13), the stored SOC declined to between 132 and 137 t C/ha. Runoff measurements from five irrigation events during the 2014–15 cotton crop indicated that an average of 30% of irrigation water was lost as runoff. The measured runoff volumes from the plots with and without corn in previous season were 24% and 36% of the applied irrigation water, respectively. The lower runoff volume from plots with corn in the previous season could be a result of higher water usage by the following cotton crop which usually yields more after a cereal rotation. The mean runoff volumes for minimum tillage continuous cotton and conventional tillage continuous cotton main plots were 33 and 27% of applied irrigation water, respectively. These differences in runoff volume among treatments may have implications for carbon losses in cotton farming system.

Keywords: Carbon loss, Runoff, Cotton soil, Tillage, Maize rotation

Two decades of no-till in the Oberacker long-term field experiment: Crop yield, soil organic carbon and nutrient distribution in the soil profile

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Abstract

The absence of mechanical disturbance and the crop residues on the soil surface in no-till systems influence soil chemical and physical properties, and may promote a strong stratification of the nutrients in the profile. The objectives of this study were to investigate the impact of two decades of contrasting tillage systems: mouldboard ploughing (MP) and direct drilling (DD), with respect to the i) nutrient distribution in the soil profile, ii) the total storage per ha, and iii) crop productivity. The Oberacker long-term field experiment situated on a loamy soil, was grown in a six-year crop rotation, namely peas (*Pisum sativum* L.)- winter wheat (*Triticum aestivium* L.)- field beans (*Phaseoulus vulgaris* L.)- winter barley (*Hordeum vulgare* L.)- sugar beet (*Beta vulgaris* L.)- silage maize (*Zea mays* L.). Soil samples were collected layer-by-layer following cultivation depths and natural soil horizons in a metal frame (0.5 m x 0.5 m cross-sectional area) down to 0.5 m depth. The layer boundaries were approximately 0.02, 0.05, 0.15, 0.25, 0.30, 0.40, 0.50 m for DD, and 0.25, 0.30, 0.40, 0.50 m for MP. For each layer, were measured pH, soil organic carbon (OC), total nitrogen (TN), phosphorus (P), calcium (Ca), potassium (K), magnesium (Mg), and bulk density. The nutrient distribution in DD showed a strong stratification with higher concentrations in the first layers for OC, TN, K and Mg. The high accumulation at the surface in DD was probably due to the residues maintained in the surface, and reduced plant uptake due to low pH. In contrast, the distribution of P and Ca in DD was rather uniform in the 0-0.3 m depth with a trend towards maximum concentrations at around 0.2 m depth, resulting from plant uptake in the surface layers and downward transport. The total storage of nutrients per ha in the whole soil profile was similar between DD and MP for all nutrients. Also, OC stock did not

differ between DD and MP. Crop yields did generally not differ between DD and MP, although the long-term average crop yield was slightly higher in DD. However, the crop yield was significantly higher in DD for winter cereals (winter wheat, winter barley). In summary, overall crop yield and nutrient stocks did not differ between DD and MP, although the depth distribution of nutrients was markedly different, that is partly associated with the lower pH in the surface layer of DD, which would pose agricultural problems.

Keywords: Direct drilling; Crop rotation; Mouldboard ploughing; Nutrient stratification; Organic carbon

Tillage and cover crop species affect soil organic carbon changes for 11 years period in Andosol, Kanto, Japan

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Abstract

No-tillage, cover crops, and N fertilization play important roles in conserving or increasing soil organic carbon (SOC). However, the effects of their interaction are less well known, particularly in Asian countries. We examined the effects of three tillage management systems, moldboard plow/rotary harrow (MP), rotary cultivator (RC), and no-tillage (NT); three winter cover crop types (FL: fallow, RY: rye, and HV hairy vetch); and two nitrogen fertilization rates (0 and 100 kg N ha^{-1} for upland rice and 0 and 20 kg N ha^{-1} for soybean production) on changes in SOC. Vertical distributions at 0–2.5, 2.5–7.5, 7.5–15, and 15–30 cm depths of soil carbon content and bulk density were measured each year. From 2003 to 2011, NT and RC management increased SOC by 10.2 and 9.0 Mg ha^{-1}, whereas SOC under the MP system increased only by 6.4 Mg ha^{-1}. Cover crop species also significantly increased SOC in the same period by 13.4 and 8.6 Mg ha^{-1} for rye and hairy vetch, respectively, although SOC with fallow increased only by 5.4 Mg ha^{-1}. Continuous soil management for 9 years enhanced SOC accumulation. Summer crop species between upland rice and soybean strongly affected SOC; the SOC increases were 0.29 Mg ha^{-1} $year^{-1}$ for the upland rice rotation and 1.84 Mg ha^{-1} yea^{r-1} for the soybean rotation. However, N fertilization levels did not significantly affect SOC. This experiment has continued additional 2 years, the data of SOC changes will be added to the presentation.

Key words: soil carbon, no-tillage, plow, rotary cultivator, cover crop

Tillage, residue management and crop cover impacts on soil organic carbon accumulation and crop productivity under a rice-wheat cropping system the Indo-Gangetic Plains

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Abstract

Retention of carbon (C) in arable soils has been considered as a potential mechanism to mitigate soil degradation and to sustain crop productivity. Hence, we appraised the 3-yr effect of different tillage and residue management practices on grain yield and soil organic C (SOC) accumulation under a rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) cropping system in the Indo-Gangetic Plains. Results indicate mean (of three years) rice grain yield under green gram (mungbean in Hindi*; Vigna radiata*) residue + tilled direct seeded rice (DSR) followed by zero tilled wheat (ZTW) with 40% rice residue (RR) retention and zero tilled relay summer mungbean (MBR + DSR-ZTW + RR-ZTMB) plots was similar to farmers' practice [transplanted rice (TPR)-conventionally tilled wheat (CTW)]. But, the MBR + DSR-ZTW + RR-ZTMB treated plots had ~15% higher mean wheat grain yield than TPR-CTW (4.6 Mg ha^{-1}). The DSR + brown manuring (BM)-ZTW + RR plots had comparable mean rice and wheat yields to MBR + DSR-ZTW + RR-ZTMB. Total estimated C input (~10.7 Mg C ha^{-1} in three years) to the 0-30 cm soil layer under MBR + DSR-ZTW + RR-ZTMB was ~174% higher than TPR-CTW. Soil bulk density under MBR + DSR-ZTW + RR-ZTMB and DSR + BM-ZTW + RR treatments significantly decreased in the 5-15 and 15-30 cm layers compared to TPR-CTW. Again, plots under MBR + DSR-ZTW + RR-ZTMB had ~14% higher total SOC (8.30 g kg^{-1}) and ~24% larger labile C (3.85 g kg^{-1}) than TPR-CTW in the 0-5 cm layer. But, management practices had no impacts on recalcitrant C pools in all layers or total SOC in lower layers. The MBR + DSR-ZTW + RR-ZTMB treated plots had a gain of ~313 kg C ha^{-1} yr^{-1} over the initial soil in the 0-30 cm, whereas TPR-CTW plots had no gain. Results also reveal ~8.9% (R^2 = 0.86; $P < 0.05$; n = 6) of the added C was retained in the 0-30 cm soil layer under tilled DSR-ZTW practices. Thus, the MBR + DSR-ZTW + RR-ZTMB treatment has considerable potential for C accumulation, decrease sub-surface compaction and increase the system (rice-wheat-green gram) productivity in this region. The global warming potential of the said MBR + DSR-ZTW + RR-ZTMB treatment was also less than TPR-CTW. Hence, adoption of MBR + DSR-ZTW + RR-ZTMB is a good proposition. Future studies on tilled *versus* zero tilled DSR- ZTW + RR-ZTMB would be fascinating.

Keywords: Rice residue management, Tilled direct seeded rice, zero tilled wheat and green gram, Total soil organic C stock, Labile and recalcitrant C pools

Twenty years no-till crop-pasture rotation systems impacts on soil organic carbon.

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Abstract

Soil organic carbon (SOC) is a key soil quality indicator for agricultural systems sustainability. We evaluated 20 yrs. soil use intensity effects on SOC (0-5 cm and 5-15 cm depth) in a 72 ha no-till crop-pasture rotation experiment under direct grazing (33°:15'36"S, 54°:29'26"W, 60-m elevation) in Uruguay (Abruptic Argiaquolls and Oxiaquic Vertic Argiudolls). Initial treatments included forage crops-pasture rotations (FCPR): 1) Continuous Cropping (CC) of *Lolium multiflorum* Lam. or *Avena sp*. in winter and *Sorghum bicolor* L. or *Setaria italica* in summer; 2) Short Rotation (SR): two years idem CC and two years pasture of *Trifolium pretense* L. and *Holcus lanatus* L.; 3) Long Rotation (LR) two years idem CC and four years pasture of *Festuca arundinacea* L., *Trifolium repens* L. and *Lotus corniculatus* L.; 4) Permanent Pasture (PP): natural pasture overseeded with legumes used in LR. All rotation phases were present in 6 ha plots each year. After 10 yrs., FCPR plots were split and grain crops included, resulting grain crops- pasture rotations (GCPR). Grain crop sequence was: *Avena sativa* L., *Sorghum bicolor* L., *Avena sp*., (as a winter cover crop), *Glycine max* L. and *Triticum aestivum*, maintaining same pasture phases in LR and SR. After 20 yrs., SOC differences (0-5 cm depth) between GCPR and FCPR were found only in CC (21.5 g kg^{-1} vs. 19.5 g kg^{-1}), respectively. However significant SOC differences were observed between rotations in GCPR and FCPR. In GCPR, CC had 17 % lower SOC than SR and LR (25.9 g kg^{-1}) and 31% lower than PP (31.3 g kg^{-1}), respectively. Similarly, in FCPR, CC had 28 % lower SOC than SR and LR (26.9 g kg^{-1}) and PP (31.3 g kg^{-1}), respectively. No SOC differences were found between SR and LR, but they had lower SOC than PP, both in GCPR and FCPR. A SOC decrease trend of 12% was observed in PP compared to the original undisturbed soil under natural pastures (35.3 g kg^{-1}). No SOC differences (5-15 cm depth) were found between treatments that included pastures, but they had 14% and 28% higher SOC than CC (11.7 g kg^{-1} in GCPR and 10.2 g kg^{-1} in FCPR, respectively). Results suggest that, even under no-till and pasture rotations, cropping systems reduced SOC compared with permanent pastures. For undisturbed Mollisols incorporated to cropping systems, like those prevalent in Eastern Uruguay, perennial pastures are critical to mitigate SOC losses during cropping.

Keywords: Soil quality, conservation systems, carbon sequestration, long-term experiments

Particulate organic carbon content of Ultisols under selected land use in wet tropical area

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Abstract

Particulate organic carbon (POC) is considered as an indicator of soil quality. POC content of Ultisols, as a marginal soil dominantly found in West Sumatra, was seemed to be affected by the management of the soil. A research conducted in wet (>5000 mm annual rainfall) tropical area was aimed to determine POC content of Ultisols under different land use. Soil sampling was taken from 0-20 cm and 20-40 cm soil depths under 4 types of land use (zalacca, uncaria, bush, and seasonal crop) and forest as a comparison. Soil POC content was separated from TOC by using method introduced by Cambardella and Elliot (2002). The data resulted was compared to forest land use using t-test at 5% level of significance. The results showed that, total soil organic carbon (SOC) of Ultisols Limau Manis under wet tropical area was dominated by POC. It was found that around 82-88% of total SOC was in form of POC at the top 0-20 cm soil depth, and 79-84% at the lower (20-40 cm) depth of Ultisols. The POC content linearly correlated to TOC content either at 0-20 cm (R2=0.99) or at the lower 20-40 cm soil depth (R2=0.96). Land use change from forest to Zalacca after 15 years decreased POC content by 3% (P>0.05), by 37% (P<0.001) to bush, by 39% (P<0.001) to Uncaria, and 42% (P<0.001) to seasonal crop land use for the first 0-20 cm soil depth. At the lower (20-40 cm) soil depth, the tendency of POC content followed the top 0-20 cm depth. The value of C/N ratio followed the trend of POC (R2=0.68) on the top 20 cm soil depth, but less correlated (R2=0.47) on the lower (20-40 cm) depth. It could be concluded that after >10 years intensive cultivation of Ultisols for seasonal crops in wet tropical area decreased almost half of the POC, even though OM was regularly added to the soil.

Keywords: POC, land use, Ultisols, cultivation, wet tropical area

Loss of soil quality increase wheat yield gap in Uruguay

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Abstract

The increase in cropped area that occurred in the Rio de la Plata region since 2002 was largely achieved by substituting the traditional crop-pasture rotation by continuous annual cropping under no-till systems. Our objective was to determine whether recent adoption of continuous cropping system had altered soil quality and wheat yield in Uruguay. Forty six 46 fields were selected from wheat growers for two years. The field were suited on similar soil type (Typic Agrgiudols) including from 1 to 10 years of continuous cropping (YCC) after last pasture phases. For each field two treatment were compared: 1. Actual yield (Ya) corresponds to yield obtained under commercial conditions and 2. Attainable yield (Yatt) corresponding to yield obtained under no limiting nutrient supply (N, P, K and S). We calculated the Yg as the difference among Yatt and Ya. Soil quality was summarized building a soil quality index (SQI) including the minimal data set. It was composed combining nitrogen mineralization potential (NMP), soil organic carbon (SCC) concentration, total soil depth and infiltration rate. The YCC reduced significantly SQI ($p \leq 0.05$). We used Classification and Regression Tree Analysis to uncover relationships between Yatt or Yg and SQI. The Ya was positively related to SQI generating an increased Yg. The Yg varied from 0. 55 to 2.06 Mg ha-1 depending from SQI. Our results indicates that intensifying crop production with continuous annual cropping under no-till can cause a measurable reduction in soil quality when compared to traditional crop-pasture rotation, determining an increased Yg. This Yg could be compensated by increased nutrient inputs.

Keywords: no till; continuous cropping

Soil management for potato production – consequences of multiple operations

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Abstract

Globally potato production is in excess of 364 million tonnes and growing with China the largest single producer with an output in excess of 85 million tonnes. Productivity varies greatly with western European and North American nations typically exceeding 40 t/ha, while the global average is less than 17 t/ha. To achieve high yields producers in the UK take the soil through multiple operations. Typically this includes: primary and secondary cultivation; bed-tilling or rotary cultivation, bed-forming, de-stoning (typically in which the entire top 25 cm of soil is lifted and stones and clods greater than 45 mm placed into the interrow spaces) and then planting. During crop growth it is usual to spray fungicides every 2-3 weeks to control pathogens. Prior to harvest the crop is sprayed with 2 applications of knock-down herbicide to kill off the plant tops. Harvesting involves lifting the entire soil beds, separating the potatoes and replacing the soil. Harvester sizes vary but can be amongst the largest agricultural machines.

While subsoil compaction is a major problem, in this paper we will focus on changes in the structure of the surface soil. Using a range of indexes of soil physical quality such as Least Limiting Water Range and Water Stable Aggregation we will consider the consequences of including potatoes in the crop rotation.

Keywords: Potatoes, Compaction, Soil structure, LLWR, aggregate stability

Dynamic of Runoff, Soil Loss and Soil Properties as Affected by Different Organic Input during Peanut growth

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Abstract

The aim of this research was to study the influence of different fertilizer application on runoff and soil loss during peanut growth in a field experiment. Rice straw mulch, rice-derived biochar and swine manure were incorporated into a hillslope planted with peanut at a rate of 2 t C ha-1. Surface runoff, soil loss, leaf area index and soil properties (soil organic carbon, mean weight diameter, percentage of aggregate disruption, soil temperature, soil volume water content) were measured.

Compared to CK, soil organic carbon was significantly improved by the fertilizer ($P<0.05$) but there was no difference between the types of organic input ($P>0.05$). The value of dry and wet aggregate stability ranged from 0.36-0.86 mm and 1.87-2.79 mm without significant difference between treatments($P>0.05$).The biggest Leaf area index about 1.83 m2 m-2 and average soil water content about 0.21 cm3 cm-3 were under the NPK+SM treatment. Approximately 28.8%-40.4% of runoff concentrated in P2 (Seeding stage, 29 Apr-20 May) except for NPK+Str and 32.2%-42.4% of soil erosion cumulated in P4 (Podding stage, 24 Jun-23 July) except for NPK+SM. Rice straw mulch and swine manure decreases runoff and soil erosion to a significant extent ($P<0.05$) while the application of mineral fertilizer and biochar had limited influence. A significant relationship was observed between runoff and rainfall characteristics (rainfall amount and rainfall intensity) ($P<0.05$). Soil loss was significantly related to dry aggregate stability, soil water content and runoff ($P<0.05$).The results demonstrated that straw mulch and swine manure are sensible to be extensive applied in red soil district to solve the severely serious problem of soil erosion.

Keywords: Runoff; soil erosion; biochar; swine manure; straw mulch

Survey of rill erosion characteristics of small-scale farmers' crop fields in the northern part of Taraba state, Nigeria

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Abstract

This study reprts results of field scale soil erosion assessment that employed survey methodology of rills conducted under actual farming condition at two contrasting topographies (hillslope and flatland), in northern part of Taraba State, Nigeria.The desire was to gain a better understanding of farmer's reasons for cultivating hill slopes, while, flat land areas exist in the study region. Results obtained from this study show that the erosion magnitudes were 1.158 t/ha and 0.643 t/ha/yr in the hillslope and flatland farm plots respectively. Assumingthat inter-rill contributes 30% , actual soil loss were estimated at 1.501 t/ha (3.37 Mg ha^{-1} per year) in hillslope and 0.836 t/ha (1.87 Mg ha^{-1} per year) on the flatland. These estimates, are within the lower range of soil loss due to water erosion under cultivated farms for the ecological region regarded as greater than the soil forming rate. This findings revealed that there is no differences in the magnitude of soil erosion under agricultural fields in both sites and, therefore, the farmer's reasons for cultivating the hillslope areas while flatland exist in the study region.

Keywords: Rill erosion, Land use site, small-scale Farmers, Nigeria.

Impact of FGD Gypsum Soil Amendment Applications on Soil and Environmental Quality

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Abstract

This paper will discuss the utilization of FGD gypsum in agriculture for improving soil quality and other environmental benefits. Gypsum ($CaSO_4 \cdot 2H_2O$) has been used as an agricultural soil amendment for over 250 years. It is a soluble source of calcium and sulfur- for crops and has been shown to improve soil physical and chemical properties. Flue gas desulfurization (FGD) gypsum is a manufactured gypsum by-product of the coal-fired combustion process. As a result, the availability of gypsum as an agriculture amendment has greatly increased over the last few years. Several studies have shown that gypsum can be used to reduce environmental degradation from agriculture. The environmental benefits to be discussed include reduced erosion losses and reduced soluble P and As in runoff from agricultural fields, especially fields which receive poultry litter. For example, a rainfall simulation study on a Coastal Plains soil has shown a 51% reduction in total dissolved P load. New developments in the utilization of gypsum in the USA will also be discussed.

Keywords: Gypsum, Soil Quality, Water Quality, Animal Manure Management

Sediment fingerprinting as a method of determining sources of erosion in an agricultural watershed in Atlantic Canada

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Abstract

Sediments adversely affect the quality of surface waters and are a major source of contaminants, such as nutrients and pesticides in agricultural watersheds. In many agricultural watersheds, it has been assumed that the majority of suspended sediment is coming from water erosion occurring in agricultural fields. This assumption was challenged by many recent studies, which showed that bank erosion contributes more than in-field water erosion in many watersheds. In Atlantic Canada, many potato fields are prone to some of the most serious water erosion in Canada due to the climate, topography and soil conditions, and the intensive management associated potato cropping. The objectives of the study are: (I) to determine the sources of sediment in an agricultural watershed in the Appalachian region of Atlantic Canada (II) determine the proportion of each source in order to identify the sources with the greatest contribution. The study was carried out in the Black Brook Watershed (BBW), a small watershed in the potato belt of the province of New Brunswick in Atlantic Canada. Soil samples were taken from different sediment sources, including potato fields, riparian areas, stream banks and stream beds. Suspended sediment was collected monthly at eight locations in the watershed during the growing season for six years. All samples were measured for a set of chemical and biophysical properties, such as Cs-137 radioactivity, particle size and shape, color and geochemical measurements, which were used as signatures to distinguish the different sources. Sediment fingerprinting technique was used to quantify the contributions of each source towards the suspended sediments collected at the eight locations. Our results show that the contributions of different sources varied a lot within the BBW watershed. However, there appear to be a trend with scale and a strong influence of land use. Bank erosion was found to contribute substantially to suspended sediment in some locations, whereas the contribution of in-field water erosion showed strong impact at the local level. The proper identification of sediment sources allows for the most appropriate beneficial management practices (BMP's) to be implemented in order to effectively minimize the environmental impacts of agriculture.

Keywords: Erosion, Sediments, Sediment Fingerprinting, Surface water, Potato-growing

Quantifying Different Water Erosion Processes by Detecting Soil Surface Evolution on a Cultivated Field

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Abstract

Up to date, most water erosion studies have been conducted at small plot scale and erosion rate is often obtained as an average value for the whole plot. There is a lack of detailed information on the contributions of different water erosion processes: sheet and inter-rill erosion, rill erosion and gully erosion. This information is essential for water erosion modeling and mitigation. Since different water erosion processes result in distinctive patterns of morphological changes in soil surface, one way to quantify them is to detect the soil surface evolution after water erosion events. In this study, we conducted a plot experiment in the experimental farm of the Potato Research Centre in Fredericton, New Brunswick, Canada. The study was carried out on six plots with three treatments: cropped with up-down-slope tillage (T1), cropped with contour tillage (T2), and fallow with up-down-slope tillage (T0), which served as the control. The study focused on two critical periods when the soil is most susceptible to water erosion: 1) from seeding to about one third canopy coverage (summer); and 2) from snow fall to snow melting (winter). Digital Elevation Models (DEMs) of the soil surface were created at the beginning and ending of each period using two methods: 1) a total station scanner, and 2) photogrammetry. Changes in the DEMs reflect the soil surface evolution during those periods. For all plots in both periods, there were distinctive patterns of soil erosion at different slope positions along the slope, largely associated with the local topography. For up-and-down slope, higher soil loss was observed at about 10 – 30 m distance from the top of the slope. At about 40 – 50 m, there a slight concave shape at the slope, resulting in a substantial decrease of soil loss rate and in some cases, soil accumulations. Beyond 50 m, the slope shape become linear again and soil loss rate increased in the range of 50 – 60 m and then decreased again in the range of 60 – 70 m. For the plot as a whole, there was a lowering of soil surface, which translates to a net soil loss from the plot as a whole. For the winter period, averaged net water erosion rates were around 26.4 kg/m2, 32.7 kg/m2 and 28.7 kg/m2 for T0, T1 and T2 respectively.

Keywords: Potato; Water Erosion; Photogrammetry; Total Station Scanner

Conservation agriculture effects on soil pore characteristics

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Abstract

Conservation tillage in combination with crop rotation, residue management and cover crops are key components of conservation agriculture. A positive long-term effect of applying all components of conservation agriculture on soil structural quality is expected. However, there is a lack of quantitative knowledge to support this statement. This study examines the long-term effects of crop rotations, residue management and tillage on soil pore characteristics of two sandy loam soils in Denmark. Results are reported from a split plot field experiment rotation as main plot factor and tillage as subplot factor. The crop rotations differed from a cereal based rotation with winter crops to a diverse rotation including a mix of winter and spring crops as well as cover crops. For the latter crop rotation, straw was removed in some plots and retained in others. The tillage systems were: Mouldboard ploughing to a depth of 20 cm (MP), harrowing to a depth of 8-10 cm (H) and direct drilling (D). Minimally disturbed core samples were taken at 4-8, 12-16 and 18-27 cm depths 11 years after experimental start. Water retention characteristics were measured for a range of matric potential ranging from -10 to -1000 cm. Air permeability and gas diffusivity were measured at matric potentials ranging from -30 to -300 cm for 4-8 and 12-16 cm depth (100 cm^3 cores). At 18-27 cm depth (250 cm^3 cores) air permeability was determined at matric potentials ranging from -10 cm to -100 cm. Tillage systems clearly influenced almost all the investigated parameters at all depths and at all matric potentials studied. The MP resulted in highest air-filled porosity, air permeability, gas diffusivity and the lowest bulk density at 4-8 and 12-16 cm depth. At the 18-27 cm depth, however, direct drilling resulted in a higher air permeability and pore continuity index. Generally, residue input, especially when combined with direct drilling at the Foulum site, decreased bulk density and the volume of blocked air porosity, and increased air-filled porosity, volumetric water content, air permeability and gas diffusivity. Our results suggest that a strategy of leaving residues in the field can alleviate negative effects of reduced tillage on soil structural quality.

Keywords: Conservation agriculture, crop rotation, tillage, residue management, soil pore characteristics

Conservation Agriculture: Research Status, Opportunities and Challenges in Dryland Areas of Pakistan

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Abstract

Soil degradation, desertification, climate change and increasing cost of inputs are big challenges for crop production in dryland areas of Pakistan. Mismanagement of natural resources through clean cultivation, intensive tillage, deforestation and overgrazing are also worsening the situation. Therefore, it is the need of time to search alternative systems. Conservation agriculture (CA) is an emerging technology, which serves as an alternate system to improve soil health by increasing soil organic carbon contents, moderate climate change by carbon sequestration also reduce fuel, labour and other related input cost by eliminating tillage operations. It has been successfully adopted worldwide for sustainable agriculture but dryland areas of Pakistan seem to have missed the opportunity. Most of research studies from dryland areas of Pakistan are short term and they indicate that different forms of CA increase organic matter content, improve soil structure, provide equal yield and economic benefits by decreasing input cost. Particularly chisel plow performed better in comparison with moldboard plow in most of the investigations. There is need to establish long term, multi-location and collaborative research experiments on different aspects of CA along with use of computer based models for long term simulations. On farm practice of CA is scarce due to social hindrance, unavailability of local ZT drills, alternative uses of residue, non interest of Government organizations. There are big opportunities of CA in dryland areas of Pakistan as climate, soils and crop diversity are conducive to that. Promotion of CA can be enhanced by encouraging local manufacture of zero tillage drills and on farm trainings of farming community. CA is the need of hour to combat desertification and provide healthy environment to coming generations and resource poor farmers of dryland areas of Pakistan.

Keywords：Tillage, Residue, Microbial Biomass Carbon, Soil Organic Carbon, Particulate Organic Carbon, Mineral associated Organic Carbon. Conventional Tillage, Minimum Tillage, Zero Tillage, Soil Water Content, Wet Aggregate Stability, Wheat Yields, Gross Mmargins

Integrated assessment of soil structural quality in 'tropical' soils

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Abstract

Soil structure regulates the majority of the chemical, physical and biological properties and processes of soil. Hence, in a strict sense, soil quality is essentially soil structure-related. The overall aim of this study was to examine the use of visual examination methods for assessing soil structural quality (SSQ) and develop SSQ indicators for medium-textured soils in tropical environments. The results showed that the soil quality scoring procedure (SQSP), the visual evaluation of soil structure (VESS), and the visual soil assessment (VSA), were able to detect an unfavourable soil structural quality on soils under conventional tillage or animal trampling with low soil organic matter content. In the 'tropical' soils from Venezuela there were also significant relationships between the visual assessment and soil physical properties, as has been reported for 'temperate' soils. It was found that for those cases where the rooting system cannot be evaluated, VSA and VESS are the most appropriate methods for assessing the SSQ. The rating of the indicator 'number of earthworms' should be adjusted for local condition to improve the accuracy of the VSA method. The acceptable performance of the visual examinations methods, in the studied soils supports the idea of applying them as complementary methods for assessing structural quality not only in temperate regions (for which they were developed), and subtropical ones (as demonstrated by other researchers), but tropical environments as well. Furthermore, a judiciously selection of a minimum data set of SSQ indicators was conducted omitting redundant material, by growing classification trees and model trees. Results showed to be promising tools in demonstrating that the SSQ description required for merging morphological, physical and chemical properties for minimum data set of SSQ indicators. This statistical tool seems also promising for representing structural dynamics. Finally, this study also contributes to the assessment of the performance and suitability of the visual examination methods. This allows agreement with McKenzie (2013), who stated that these methods could be considered as crucial components of future schemes for soil assessment in conjunction with modern soil databases. Additionally, much remains to be achieved about the assessment of SSQ in terms of the selection of indicators for a wide range of conditions present in agricultural soils.

Keywords: Soil indicators, soil structure, visual assessment

Landscape based assessment of total soil erosion risk on agricultural fields in Canada

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Abstract

Soil erosion is a major threat to the sustainability of agriculture in Canada. Soil erosion occurs through three major processes in agricultural land: water, wind and tillage erosion. However, each erosion process has its distinctive patterns in the landscapes and the effects are not always additive. In order to provide more accurate information to guide management practises, a landscape based total soil erosion indicator was developed to assess the combined effects of all three forms of erosion in Canada's agricultural fields. The indicator was built on the scale of Soil Landscapes of Canada (SLC) polygon. Each SLC polygon is characterized by one or more representative landforms, and each landform is characterized by a segmented hillslope. Water, wind and tillage erosion rates were modeled on the representative hillslope for each landform such that for each segment, there were erosion rates for each individual erosion process. The sum of the three erosion rates was the total soil erosion for that segment. The soil erosion rates for individual segments were aggregated to the SLC polygon, province and national levels. The soil erosion rates were calculated for seven years (1981, 1986, 1991, 1996, 2001, 2006 and 2011) corresponding to the Census of Agriculture in Canada. Our results show that the risk of soil erosion on Canadian cropland has steadily declined between 1981 and 2011. The majority of this change occurred between 1991 and 2006. The decrease in all forms of erosion in Canada is largely due to the widespread adoption of conservation tillage, particularly no-till systems. Changes in share and mix of crops grown were less of a contributing factor.

Keywords: Total soil erosion; Landform; Segment;

Response of soil physical properties to exogenous ionic surfactants

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Abstract:

More and more surfactants exported to soil mediums by various approaches with the increase surfactant application in domestic and industrial manufactures. The exogenous surfactant is obliged to affect the physicochemical properties due to the unique features of surfactant. Unfortunately, the understanding of the sorptive mechanism of surfactants on soil and the response of soil physical properties to surfactants was limited. In this study, cationic surfactant cetyltrimethylammonium bromide (CTAB) and anionic surfactant sodium dodecyl sulfate (SDS) were selected to investigate the sorptive mechanism and its adverse effect on soil aggregates and soil water characteristics. The results showed, compared to pseudo-first-order rate equation, pseudo-second-order rate equation was more suitable to fit the sorption kinetic curves of CTAB and SDS on soil. The sorption equilibrium for CTAB and SDS was 24 h and 240 h under 25℃, respectively. Langmuir equation was better than Fruendlich equation for simulating the sorption isotherm of CTAB and SDS on brown soil. The maximum adsorbed capacity of CTAB was much higher than that of SDS. With the enhancement of surrounding temperature, the adsorbed capacity of both CTAB and SDS decreased. In addition, the sorptive process of them on brown soil was spontaneous and exothermal, which could be deduced from the absolute values of Gibbs free energy and enthalpy of CTAB and SDS. Consequently, physical adsorption is mainly responsible for CTAB and SDS sorption. The aggregates (0.25-0.053 mm) was damaged in soil prior to dealing with CTAB and SDS, consequently the amount of 2-0.25 mm and <0.053 mm size aggregate was enhanced. The mean weight diameter of soil aggregate increased, indicating that the aggregate stability was generally improved. Soil infiltration rate with various CTAB concentration treatments was enhanced compared with the control treatment, except for 200 mg L^{-1} CTAB exposure. However, the exposure to SDS decreased the soil infiltration rate in comparison with the control treatment. Soil water repellency depended on the exposure to CTAB concentration. SDS strengthened soil water repellency under the tested concentration range. In brief, these results were crucial basis to understand their environmental behavior.

Keywords: Surfactants; Sorption; Soil aggregate; Infiltration rate; Soil water repellency

Comparison between contour hedgerow and terracing hedgerow as soil conservation method in Three Gorges Reservoir region, China

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Abstract

Soil and water loss is a serious worldwide environmental problem. Especially, soil loss from the sloping cultivated lands. Various soil protection techniques were adopted to conserve soil loess. However, as the abundant precipitation and most of the lands were steep degree sloping cultivated lands in southern china, the contour hedgerow technique was not welcomed by local people in the Three Gorges Reservoir region, China. Meanwhile, the terracing hedgerow was a traditional soil and water conservation strategy and was actively accepted by local people. But the structure and effects of the soil and water conservation of the terracing hedgerow had not been adequately evaluated in these regions. Thus the structure and effects of soil conservation between contour hedgerow and terracing hedgerow were analyzed in this study. The obvious difference was that the terrace hedgerow had a certain height of lynchet to walk by farmers to do the farming activates more convenience and effectively reduce the soil and water loss. And the H15H reduced runoff 55.56%±6.25%, reduced runoff 21.11% ±1.36% and reduced erosion modulus 79.26%±3.50% when compared to the sloping cultivated land plots with no lynchet and no hedgerow. The contributions of the independent variables on runoff, soil erosion reduction and soil anti -souring were in the following order: H15H > H10H > HOH > CK. So the traditional terracing hedgerow with 15cm lynchet height was recommended in Three Gorges Reservoir region of China, even should be recommended often and used extensively in the similar climatic regions in other countries.

Keywords: terracing hedgerow, structure, mechanism of the soil and water conservation, contour hedgerow

Can we quantify the soil degradation we see in the field?

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Abstract

Soil structure degradation is a key environmental and agricultural issue. It is commonly observed in the field, e.g. as wheel tracks, compacted layers or poorly degraded matter. Both farmers and soil experts can easily observe these features, via different techniques. Among these, the Visual Estimation of Soil Structure (VESS) is popular because it is very easy to perform and because it provides a semi quantitative estimation of the structural state, at the pit scale. But scoring the structure is partly depending on the observer, the soil condition, and the soil type. These limitations lead to the requirement of physical determinations as a base to separate acceptable versus damaged structure, for example for legal matters. Recent investigations have shown the potential of shrinkage curve analysis (ShC) to accurately quantify physical properties related to soil structure. The aim of this study is to analyse how far the results of this hydro-structural characterization are consistent with what can be seen on the field. A series of soil samples in different degrees of degradation were randomly taken on cambi-luvisols of the Swiss plateau. Three different land management, namely permanent pasture, no till and conventional tillage were represented. The spade block and its layers were visually evaluated with the VESS (Ball et al. 2007) on each site, and undisturbed samples of 125 cm^3 were taken at 5-10 cm depth. They were physically characterized by ShC to determine their hydro-structural stability, structural and plasma (textural) pore volumes, swelling dynamics, water retention curve, and specific volume change upon drying. Because of the intra layer heterogeneity each soil core was broken and visually scored after shrinkage analysis. CEC, texture and soil organic carbon content were analysed on the fine earth fraction of each sample. Two aspects will be discussed. The first is the local heterogeneity. How much can the score of a clod vary in a scored layer or spade block? The second is the agreement between clod shrinkage analysis and the visual estimations at different scales (clod, layer, spade block) that can be performed in the field. To which extent do they agree and according to which observations?

Keywords: soil structure, soil porosity, shrinkage analysis, VESS, soil quality, compaction diagnosis

Soil wind erosion due to crop residue removal under no-till system in central Great Plains, USA

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Abstract

Crop residue removal for livestock feeding and biofuel production at large scales must be evaluated to assess impacts on soil productivity and properties. Among all the potential negative impacts, wind erosion is a major concern in the central Great Plains. We conducted an on-farm study from 2011 to 2013 by removing crop residue at five levels (0, 25, 50, 75, and 100%) to determine the effects of crop residue removal on soil wind erosion parameters such as dry aggregate size distribution including soil wind erodible fraction (EF <0.84 mm aggregates), geometric mean diameter (GMD) and geometric standard deviation (GSD), dry aggregate stability, and soil surface roughness. The sub-model of Wind Erosion Prediction System (WEPS) developed by the USDA-ARS, Single-event Wind Erosion Evaluation Program (SWEEP) is a stand-alone companion software package that can be applied to simulate soil loss and dust emission from a single windstorm event. We applied measured data (i.e. EF, GMD, GSD, and roughness) to SWEEP for predicting wind velocity that can initiate wind erosion and soil loss under each crop residue removal condition with wind velocity at 13 m s^{-1}. The threshold wind velocity to initiate wind erosion generally decreased with increase in crop residue removal levels, particularly for residue removal >75%. For three of six sites, 75% removal appears sufficient to prevent wind erosion, while for the other 3 sites 50% removal is the permissible removal level to prevent wind erosion. The total amount of soil loss in 3 hours ranged from about 2 to 25 Mg ha^{-1} and depends on soil condition and crop residue cover.

Keywords： residue removal, soil wind erosion, Single-event Wind Erosion, Evaluation Program

Physical protection of soil organic matter : a matter of life in soil pores

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Abstract:

The persistence of organic matter in soils and its sequestration is partly ascribed to the physical protection of organic matter from the decomposing action of soil microorganisms. This process has essentially been studied through aggregate fractionation approaches. Yet, soil microorganisms live in pores within soil structure and aggregates, i.e., a complex 3-D framework which can cause a variety of micro-environments to develop that are more or less suitable for microbial growth, activity and survival. In particular, the soil pore system controls the accessibility of substrates and oxygen to microorganisms and the local moisture conditions. Experiments, in which the location of microorganisms and substrates and the soil structure were manipulated, showed how the heterotrophic soil respiration depended on the size of pores and on their connectivity. Tools are available now to describe the complex soil architecture and locate microorganisms and organic matter at relevant spatial scales. Innovative models are also being developed that explicitly represent soil architecture and how microhabitats control the activity of microorganisms and hence the fluxes of C in soil. Such in-depth mechanistic understanding should help to define relevant descriptors of soil characteristics to improve larger scale biogeochemical models, accounting for the effects of soil structure management and moisture on soil organic matter.

Key words: organic matter, microorganisms, habitat, pores, moisture

Soil structure recovery and evolution of physical properties of a compacted soil

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Abstract

Soil compaction due to agricultural vehicular traffic is a major threat to soil productivity, soil functions and crop growth, caused by compaction-induced changes of the size distribution, connectivity and network tortuosity of pores. Soil compaction is widely studied, but knowledge on soil recovery from compaction damage is incomplete. A soil structure observatory (SSO) was launched in 2014 on a loamy soil in Zurich, Switzerland, aiming at quantifying degree and rate of structural recovery in compacted agricultural soil, through mechanically-assisted (tillage) and natural processes (e.g. bioturbation, wetting-drying regimes, and freeze-thaw cycles). We implemented three compaction treatments: non-compacted, full-surface compaction, and wheel-track compaction, which we combined with four cropping systems: bare soil; permanent grass; crop rotation under no-till; and crop rotation under conventional tillage. Sensor banks were installed for continuous monitoring of soil moisture status, temperature, CO_2 and O_2 concentrations, redox potential and oxygen diffusion rates. Soil sampling and measurements are done periodically, including soil physical properties, earthworm abundance, below and above ground crop measurements, as well as electrical resistivity tomography (ERT) and ground penetrating radar (GPR) imaging. The objective of this presentation is to show features of the SSO and first results of the post-compaction evolution of soil structural properties. Compaction was carried out with a self-propelled vehicle with 8 Mg wheel load, which increased bulk density by 11, 5 and 2% at 0.1, 0.3 and 0.6 m depths, and decreased air permeability by 40-60% and water transport properties by 1-2 orders of magnitude. GPR and ERT images showed higher electrical permittivity and lower resistivity in compacted soil, and wheel tracks were identifiable from non-compacted soil. The evolution of soil physical properties in the SSO during the first year after compaction will be presented at the conference. Tillage improved soil bulk density and transport properties governed by macroporosity (e.g. air permeability, saturated hydraulic conductivity) in

the topsoil, but did not recover crop yield as we measured 20% yield reduction in compacted plots. We show that different soil properties recover at different rates, and that recovery rates decrease with increasing soil depth. For instance, a biopore (e.g. an earthworm burrow, or a channel made and previously occupied by a plant root) may largely increase saturated hydraulic conductivity, but does not significantly change soil porosity.

Keywords: Soil compaction; Soil structure; Soil recovery; Long-term field experiment

Transport and Retention of Stabilized Silver Nanoparticles in Soils

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Abstract

Widespread application of silver nanoparticles (AgNPs) may result in agricultural soil contamination due to the fact that the main portion of AgNPs released into wastewater treatment plants is incorporated into sewage sludge. This study aims to provide a better understanding of transport and retention of surfactant stabilized AgNPs in soils under environmentally relevant conditions. The influences of grain size, ionic strength (IS), input concentration, and flow velocity on AgNP transport were systematically investigated. Experimental results of simplified soil (quartz sand) and undisturbed soil columns were described using a numerical model that considers time- and depth-dependent retention. In addition, the remobilization of retained AgNPs from undisturbed soil was investigated by changing the solution chemistry such as change of cation types (K^+ for Ca^{2+}) and IS reduction. The information on the retention and the remobilization of AgNPs from undisturbed soil is essential to assess the long-term AgNP contamination in soil and the potential risk of groundwater contamination. Experimental and simulated results for sand and undisturbed soil columns showed similar trends with regard to the effects of physicochemical factors, e.g., enhanced transport with decreasing solution IS, increasing AgNP input concentration and flow velocity. The model used successfully described the breakthrough curves and retention profiles (RPs) with uniform and hyperexponential shapes, respectively. The simulated maximum retained concentration on the solid phase and the retention rate coefficient increased with IS and as input concentration and/or grain size decreased. In contrast to the conventional filtration theory, RPs in sand exhibited uniform, nonmonotonic, or hyperexponential shapes that were sensitive to physicochemical conditions. Significant retardation of AgNP breakthrough and hyperexponential RPs were observed in almost all the transport experiments with soil. Remobilization experiments indicated that the release of AgNPs and clay from the soil was induced by cation exchange that

reduced the bridging interaction and by IS reduction that expanded the electrical double layer. Results of transmission electron microscopy combined with energy-dispersive X-ray spectroscopy and the correlations between released soil colloids and AgNPs indicated that some of the released AgNPs were associated with the released clay fraction (co-transport). These findings demonstrate that the release processes can produce significant amounts of AgNP migration that pose a potential risk for groundwater contamination during rain and irrigation events that produce transient changes in solution chemistry.

Keywords: Silver nanoparticles, Soils, Transport, Remobilization, Co-transport

Analysing the interaction between biology and architecture of soil with X-ray microtomography

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Abstract

Biopores are an important factor for nutrient cycling in soils. They provide biologically highly active zones in the soil and can be re-colonized by roots developing soil-root interfaces for water and nutrient uptake. On the other hand earthworms can modify previously generated root pathways by changing the architecture of the soil pore space especially in the rhizosphere due to compression and excretion of casts and linings. Such structural modifications are assumed to have an impact on microscale physical soil properties thus controlling oxygen and water flows from the bulk soil to the root and vice versa from biopore channels to microbial habitats. While a few studies in the past have investigated biopore networks on a larger scale little is known on the microscale pore morphologies of the rhizo-drilosphere and it is not clear how the characteristic differences between biopores of different genesis, for example earthworm or root-induced, impact water, oxygen and nutrient flows in the zone between roots and the bulk soil. Our understanding of biophysical interactions between plants and soil could be significantly improved by quantifying 3D biopore architectures bridging scales between single biopores to biopore networks and linking pore morphologies to microscale measurements of transport processes (e.g. oxygen diffusion). The goal of this contribution is to provide an insight into the capabilities of X-ray microtomography (XRCT) in combination with microscale measurements of oxygen partial pressures and diffusion rates to gather more detailed knowledge on the potential influence of pore morphologies on biophysical interactions in soils. The results presented here are obtained from investigations within a joint research effort on the effect of preceding crops (chicory, alfalfa and fescue) on nutrient acquisition from the subsoil. Here we focus on X-ray microtomography (XRCT) and 3D image analysis of individual biopores and its surrounding rhizosphere and oxygen diffusion

measurements using microsensors. Clear differences in pore morphologies between root- and earthworm colonized biopores were observed to influence the lateral transport of oxygen from the biopore surface into the rhizosphere and the bulk soil. Based on these first results we will discuss the implications of various biopore architectures for the accessibility of nutrients in soils and the potential use of parameters derived from image analysis to be included in novel spatially explicit modeling approaches.

Keywords: soil structure, X-ray tomography, biopores

Investigation of spatial variability and interrelations among crop and soil physicochemical parameters

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Abstract

Characterizing agricultural soil properties is a key step in understanding the source of spatial variability in crop productivity across the field is essential component for Variable Rate Application (VRA) of agricultural inputs under precision agriculture practices. Therefore, this study was conducted to investigate the spatial trends of selected soil properties and identify their impact on the productivity of a 16 ha center pivot system irrigated field in the eastern region of Saudi Arabia. Geo-referenced measurements from 86 sampling locations were performed for soil compaction (SC), EC, pH and texture components. The collected data was subjected to geo-statistical analysis to reveal the spatial variability across the study field. Furthermore, maps representing the spatial pattern of soil properties were generated utilizing the geo-spatial interpolation (kriging) tool of ArcGIS Software. The spatial productivity of the experimental field was investigated through studying the performance of Rhodes grass crop utilizing the Normalized Difference Vegetation Index (NDVI) extracted from Landsat-8 images. Descriptive statistics indicated that the experimental field was dominated by sand (54-97%) with low silt (4-13%) and clay (4-17%) contents; with relatively high variability in clay (CV of 22%) and silt (CV of 21%) compared to sand (CV of 7%). The SC was observed to vary spatially (CV of 22%) across the experimental field with values ranging from 617 to 2264 kPa. On the other hand, the field soil EC exhibited low variability (CV of 14%) for values ranging from 0.71 to 1.19 dS m^{-1}. The soil pH, however, ranged from 7.83 to 8.00 with very low variability (CV of <1%). The spatial interaction between soil compaction and clay content was the strongest compared to other investigated soil parameters; which was explained by a correlation coefficient (R^2) of 61% and Range values of 110.5 and 132.0 m for compaction and clay content, respectively. Results also showed low variability in Rhodes grass performance across the study field as indicated by NDVI values estimated at 32 days after sowing (NDVI of 0.35 to 0.59; CV of 7.13%) and that at 9 days after 2nd cut (NDVI of 0.13 to 0.17; CV of 4.12%). The spatial interaction between NDVI (at 32 days after sowing) and soil EC was the strongest, among the tested soil properties, as indicated by the approximately equal Range values (28.70 m for NDVI and 28.77 m for EC). The results of this study can be useful in better understanding of the sources of yield variability in agricultural fields and better management practices.

Keywords: Precision agriculture; Soil properties; Geostatistical analysis; Rhodes

Fate and transport behavior of chlordecone and sulfadiazine in an agriculture soil in the presence of functionalized multi-walled carbon nanotubes

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Abstract

Co-transport of chemicals by colloids in soil is an important process for environmental protection. In this study, the sorption and mobility of chlordecone (CLD, $C_{10}Cl_{10}O$) and sulfadiazine (SDZ, 4-amino-N-pyrimidin-2-yl-benzenesulfonamide) in the presence of functionalized multi-walled carbon nanotubes (CNT) in a loamy sandy and agricultural used soil (Kaldenkirchen, Germany) were investigated performing batch and column experiments. CLD is a highly chlorinated and slowly degrading pesticide. SDZ is a widely used sulfonamide. CNT can be released in the environment owing to its widely applications and have great potential for the sorption of organic chemicals like pesticides and antibiotics. The sorption isotherms indicated that CNT have a stronger sorption of CLD (Freundlich model, $R^2 = 0.95$) than the loamy sandy soil (linear sorption isotherm, R^2 of 0.99). Column experiments showed that more than 99% CLD were retained in the soil column and most of them in the first soil layers. When flushed by CNT, CLD was remobilized into the deeper soil layer. In contrast, more than 90% SDZ could migrate though the soil column. When the soil column is flushed first by CNT, more SDZ could be retained. The code Hydrus 1D employing convection-dispersion equation, the colloid filtration theory and kinetic sorption were used to simulate the co-transport and retention of the organic chemicals coupled with the CNT migration in saturated soil.

Keywords: Chlordecone; Sulfadiazine; Multi-walled carbon nanotubes; Sorption; Co-transport

Two decades of no-till in the Oberacker long-term field experiment: Soil porosity and gas transport parameters

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Abstract

No-till is practiced for various environmental and economic reasons, but the absence of soil loosening by tillage affects soil structure and associated soil functions such as gas transport and crop growth. The main objective of this study was to investigate the impact of two decades of no-till on soil gas transport properties in the Oberacker long-term field experiment in Switzerland. This trial was established in 1994 on a loam soil and compares two tillage systems, mouldboard ploughing (MP) and direct drilling (DD). We further sampled the permanent grass (PG) strips located between the experimental plots as references. Undisturbed soil cores were collected at 0.15 (topsoil) and 0.4 m depth (subsoil) from all three treatments. The soil cores were used for measurements of air-filled porosity (ε_a), air permeability (k_a) and gas diffusivity (Dp/D_0) at five matric potentials ranging from -30 to -500 hPa. Our results reveal that the soil pore system and gas transport properties of the DD soil are similar to those under PG. In these systems, the difference in gas transport properties and pore characteristics was small between topsoil and subsoil. In contrast, the soil under MP showed a clear stratification: ε_a, k_a and Dp/D_0 were higher than in DD and PG in the topsoil, but lower in the subsoil. Interestingly, the Dp/D_0 vs. ε_a relationship did not differ between treatments and could be described by a model obtained from percolation theory. A linear relationship between log k_a and log ε_a was found, but the slope was much smaller than could be expected from percolation theory for all treatments and depths. We conjecture that this is because of the dominant, vertically-oriented macropores of arable soil. The pore system showed a higher specific diffusivity and higher specific air permeability in the topsoil of MP than in DD or PG, but the relations were reversed in the subsoil. This shows that it is highly important to consider the whole soil profile when evaluating tillage systems.

Keywords: No-till; Gas transport properties; Soil structure; Long-term field experiment

Less stressed plants enhance soil methane oxidation

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Abstract

Methane (CH_4) is the second important greenhouse gas and has been responsible for approximately 20% of Earth's warming. Aerobic soils in upland ecosystems act as only the terrestrial CH_4 biological sink, offsetting large amounts of anthropogenic CH_4 emissions, but this capacity of CH_4 oxidation is subject to environmental stresses. Understanding how upland ecosystems uptake atmospheric CH_4 and underlying mechanisms involved in this process is therefore fundamental to predicting how the carbon cycle will mitigate or accelerate climate change. We previously proposed a hypothesis [1] that root stress-stimulated ethylene production could inhibit this capacity of CH_4 oxidation in soils. Here we selected maize crop as model plant and carried out a field study to test this hypothesis. We compared soil CH_4 oxidation rates of drought-stressed & mitigated via application of ethylene inhibitor, irrigation and biochar. We found that less stressed plants markedly increased CH_4 uptake, which supported this hypothesis. Our results also have significance in explaining the positive relationships between plant aboveground biomass and CH_4 uptake, which have important implications for estimating global CH_4 uptake.

[1] X. Zhou, S. Smaill, P. Clinton. Methane oxidation needs less stressed plants. Trends in Plant Science, 18, 2013, 657-659.

Keywords: Methane uptake, Drought, Ethylene, Stresses, Climate Change

Effect of redox condition on water retention of deformable paddy soil

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Abstract

Paddy soil is subject to alternative flooding and drying conditions, inducing cyclic reduction and oxidization of soil component such as iron and manganese. Although the change in forms of such components may affect soil physical and mechanical properties, quantitative approaches on this issue has not been widely studied. Present study aimed to illuminate importance of redox state on change in water retention of paddy soil accompanied by volumetric shrinkage and swelling, and seek potential methodology modelling the dynamic change in paddy soil structure under cultivation of rice or other crops.

Core specimens of plowed soil and subsoil under rotational cropping of rice and soybean were sampled in three plots where input of organic matter differs to each other: incorporation of approximately 5 tons ha^{-1} rice straw (R plot), incorporation of 20 tons ha^{-1} rice straw manure (M plot) and no organic matter input (N plot), respectively. The specimens were first immersed in tap water to be saturated and then dehydrated in pressure chamber to -80kPa. Then they were immersed in water at 4 ℃ for 22 days and then at 30 ℃ for more 72 days, with being monitored change in gravimetric water content. The dehydration process showed retained water between saturation and -80kPa was highest in M plot followed by R plot. Although rewetting by immersing at 4℃ induced water absorption till 10th day, more immersion in water for 12 days at the same temperature did not change water content. However after increasing the temperature to 30 ℃, additional immersion in water caused clear increase in retained water in the soil at R and M plots, while no more water absorption was observed in the soil at N plot. Decrease in oxidation-reduction potential, Eh was observed in all plots. But the progress in reduction is much more rapid in the plots where organic matter was input. These experimental results suggests that progress in reduction alters mechanical properties of the soil and induces swelling. Thus time-dependent: viscous component is necessary to model shrinkage and swelling behaviour of paddy soil depending on the period during which soil is submerged.

Keywords: Soil shrinkage and swelling, Redox potential, Paddy soil, Soil mechanical properties, Soil structure

Speciation and distribution of P associated with Fe (Al) oxides in aggregate-size fractions of an arable soil

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Abstract

To maximize crop productivity fertilizer P is generally applied to arable soils, a significant proportion of which becomes stabilized by mineral components and in part subsequently becomes unavailable to plants. However, little is known about the relative contributions of the different organic and inorganic P bound to Fe (Al) oxides in the smaller soil particles. The alkaline (NaOH-Na_2EDTA) extraction with solution ^{31}P-nuclear magnetic resonance (^{31}P-NMR) spectroscopy is considered as a reliable method for extracting and quantifying organic P and (some) inorganic P. However, any so-called residual P after the alkaline extraction has remained unidentified. Therefore, in the present study, the amorphous and crystalline Fe (Al) oxide minerals and related P in soil aggregate-size fractions were specifically extracted by selective dissolution with oxalate and dithionite treatments, respectively, and then sequentially extracted by alkaline extraction prior to solution ^{31}P-NMR spectroscopy.

The results showed that overall P contents increased with decreasing size of the soil fractions. However, the relative distribution and speciation of varying P forms were found to be independent of soil aggregate-size. The majority of alkaline extractable P was in the amorphous Fe (Al) oxide fraction, most of which was orthophosphate. Furthermore, still significant amounts of particularly monoester P were bound to the oxides. Intriguingly, however, Fe (Al) oxides were no main bonding sites for pyrophosphate. Residual P contained similar amounts of total P associated with both amorphous (10-13% of total P) and crystalline (10-12% of total P) Fe oxides in various soil fractions, suggesting that it was likely occluded within the amorphous and crystalline Fe oxides in soil. This implies that under reducing condition (i.e., soil anoxic condition), these P may be released and thus available for plants.

Keywords: phosphorus, particle-size fractions , arable soil ,amorphous and crystalline iron oxides ,31P-NMR

Effect of drying, reduction, and puddling on pore size distribution of clayey soil from observation with mercury intrusion porosimetry

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Abstract

The paddy rice (Oryza sativa L.) upland crop rotation is a major cropping system in Japan. The essential factors that affect soil structure in this system are drying, soil reduction, and puddling. This study focused on the changes in pore size distribution in response to these factors, using the mercury intuition porosimetry technique. A clayey paddy subsoil (HC) was used in this study. The soil was drained to –98 and –4900 kPa, using the porous pressure plate and vapor pressure methods, respectively. To impose the reduced treatment, the drained soil was incubated at 30 ºC for 35 days. Concurrently, as a control, other soils were incubated at 4 ºC. For the puddling treatment, both the incubated and control soils were puddled, using a rubber rod, until no clods were observed. After these treatments, the soil samples were collected and saturated with methanol, and then dried by the critical point drying. The soil sample pore size distribution was measured using mercury intrusion porosimetry. The cumulative pore volume (CPV) was estimated as the sum of pore volumes in the ranges of 200 μm to 3.6 nm. The data were summarized by plotting the differential pore volume (DPV) versus the geometric mean of diameter. As the soil was dried from –98 to –4900 kPa, the pore diameter at the peak of DPV shifted from 600 to 66 nm, while CPV decreased from 0.49 to 0.36 mL^3 g^{-1}. These results suggest that compression by drying irreversibly reduces the volume of larger pores. The reducing treatment after drying increased pore volume, with sizes uniformly larger than 120 nm. These results suggested that soil reducing caused relaxing of soil bonding and water saturation of soil samples during the incubation period increased pore volume. The softening was consistent with destruction of the soil structure. Soil puddling caused convergence of the pore size to around 1μm. This response to puddling was more evident in reduced soils than in oxidized soils. In conclusion, the results using the mercury intrusion technique suggest that soil reduction is an important factor in the paddy rice upland crop rotation. “Softening by reducing” might contribute to the unique structure in paddy soil formed by puddling.

Keywords: Pore size distribution; Redox; Drying, Puddling, Rice paddy – upland crop rotation

Phosphorous species distribution in water dispersible nanoparticles from arable soils

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Abstract

It is important to understand the P-bonding in soils for forecasting the as yet unquantified water dispersible nanoparticles (NP) losses from agricultural systems. We therefore isolated water dispersible nanoparticles from topsoil of an arable wheat field (Haplic Luvisol, Germany). We assessed nano-particulate P forms after field-flow fractionation coupled to an ultra violet detector and inductively coupled plasma mass spectrometer (AF4-UV-ICP-MS). The NP isolation was done with and without removal of amorphous and crystalline Fe oxides with oxalate and dithionite treatments, respectively. Finally, NP fractions were analyzed using solution ^{31}P nuclear magnetic resonance (NMR). We found that nano-particulate P was present in two dominant sizes and in both the organically bound P predominantly comprised orthophosphate monoesters. Approximately 65% of P in the nanoparticles was liberated after the removal of Fe oxides (especially amorphous Fe oxides). The crystalline Fe oxides contributed significantly to soil P sequestration. The current results of Haplic Luvisol will be compared to those of a paddy soil with 50 years rice cropping derived from tidal wetland sediments in the Yangtze River delta, China. The combined information on soil P-bonding speciation and distribution of NP (fractions) in such soils with different cultivations (i.e. wheat and rice) should provide new valuable insights on P bioavailabilty and help to optimize P fertilizer use for sustainable food production.

Keywords： phosphorus, water dispersible nanoparticles, amorphous and crystalline iron-oxide, field flow fractionation, arable soil

Linking soil shrinkage behavior and cracking in two paddy soils under wetting and drying cycles

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Abstract

Soil cracks develop in paddy soils during wetting and drying (WD) cycles. The cracking-related changes in soil structure have often been described as soil shrinkage, but the relationship between soil shrinkage and cracking has not been clarified. The objectives of this study were to investigate how WD cycles affect soil shrinkage and cracking, and to determine the relationship between them. Two paddy fields, one cultivated for 20 years (young paddy field, YPF) and the other cultivated for over 100 years (old paddy field, OPF), were subject to multiple WD cycles during rice growing. Soil cracks were photographed in the field, and the crack area density (Dc), compactness (CP), and equivalent width (EW) were analyzed. The soil cores were taken from the two fields, and their shrinkage curves were determined after they experienced different laboratory-based simulated WD cycles (including variations in intensity, frequency, and sequence). The YPF soil presented greater Dc and CP than the OPF soil ($P < 0.05$), whereas the OPF soil exhibited greater EW and shrinkage capacity (coefficient of linear extensibility, COLE) ($P < 0.05$). The difference in soil shrinkage and cracking was mainly due to the different soil structures of the two paddy soils. The Dc was negatively correlated with soil water content, which was affected by previous WD cycles. The EW generally increased but CP decreased with increasing number of WD cycles. Irreversible soil shrinkage was observed in the two paddy soils as indicated by the decrease in shrinkage magnitude with WD cycles. The intensity of the WD cycles affected shrinkage more significantly than the frequency or sequence. The Dc values were more accurately estimated by using soil shrinkage curves that included the intensity of the WD cycles. Our results demonstrate that the soil shrinkage curve can better predict cracking when the WD cycles are taken into account.

Keywords: Image analysis; Paddy soil; Soil cracks; Soil structure; Soil shrinkage;

A Current status of residue-handling techniques for no/strip-till seeder

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Abstract

The development of sustainable agriculture promotes the adoption of conservation agriculture (CA) in the world. No/strip-till seeding is the key technique for the application of CA. Globally, there are lots of agro-machinery enterprises manufacturing no/strip-till seeders, and only in China the number of these enterprises is about 200. Additionally to the basic functions of a traditional seeder, the no/strip-till seeder also needs to have a strong ability and function of residue-handling in operation. This is the key ability for high-quality opening and seeding in residue cover fields. This paper reviews the features of no/strip-till seeders at global scale, and classifies current seeders into three types based on their anti-blocking or residue handling technique: (1) disc opener residue-cutting, (2) tine opener residue-flowing and (3) powered anti-blocking type. For the first type, these seeders use disc openers to cut residues and open the furrow in the seeding row. Tractor equipped with such seeders are required to work at a high speed, and the seeder is big and heavy to produce the required heavy down-pressure to penetrate the soil and cut crop residues. For the second type of tine openers, crop residues flow away naturally between the tine openers

with/without non-powered residue-clearing components while seeding. More space between neighbour openers can be achieved for residue flowing by arranging the openers on more than one beam, or by increasing the beam height. The third type, powered anti-blocking technique, can compulsively remove the residues (positioned before or around the openers), and clear the seeding zone, with the special working components powered by tractor's PTO shaft. This technique is commonly used in multi-cropping or double cropping systems without fallow seasons.

Keywords: No/strip-till seeder, anti-blocking, residue-cutting, opener

Are the Objectives of ISTRO, Soil Health and Soil Security Compatible?

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Abstract

As your Secretary General for the past six years, it is my honor to begin this keynote address by welcoming all of you as delegates to our 20th Triennial International Soil Tillage Research Organization (ISTRO) Conference. I regret that I cannot be there in person to present this lecture. Hopefully, technology will succeed and my recorded remarks will impart the challenges that I was looking forward to discussing with you.

My absence at the ISTRO Conference is due to my selection as the USDA-ARS Distinguished Senior Research Scientist for 2015 and the unexpected overlap of my Agency's Annual Award Ceremony with this Conference. I am greatly humbled by this recognition and very aware that the career which led to my prestigious award would not have been possible without getting to know and being able to conduct soil management research with many ISTRO colleagues.

Unfortunately, due to this very honor, I will not be able to join you in Nanjing to discuss these critical issues in person or to be able to greet our award winners and new ISTRO Board members. Since participating in my first ISTRO Conference in 2000, I always look forward to renewing old friendships and making new ones as part of ISTRO Triennial Conferences. Let's all begin planning now to accomplish this goal in Paris in 2018.

My rather unusual title for this keynote address evolved as the result of collaborating with several ISTRO members while serving as Guest Editor for the special issue of the journal Sustainability entitled "Enhancing Soil Health to Mitigate Soil Degradation." The term "Soil Security" is included in the title because like many issues we encounter through ISTRO, our Australian colleagues have chosen a slightly different term for what I have referred to as either "soil quality" or "soil health" for the past two decades. Another contributing factor was that while gathering feedback on draft versions of our revised ISTRO Constitution and By-Laws, which the ISTRO Board and I have been working on since our last meeting in Montevideo, Uruguay and for which you will be asked to vote up or down at the General Assembly Meeting, one of our long-term ISTRO members suggested, somewhat tongue-in-cheek, that we should consider changing our name to the International Soil No-Tillage Research Organization or "ISN-TRO". The Board discussed this recommendation, but decided that proposing a name change would undoubtedly result in major legal complications and a potential loss in public recognition regarding the ISTRO

"Brand" and perhaps our relationship with Elsevier and the journal we initiated – Soil and Tillage Research. Those issues were simply too complex to pursue at this time. However, as concluded in the special issue of Sustainability, soil degradation is a growing global problem, especially as our population marches steadily towards 9.5 billion. Furthermore, two factors – soil erosion and loss of soil organic carbon were identified in every contribution from around the world as the two major causes of soil degradation.

With this focus in mind, my objectives for this plenary presentation are to: (1) review the history of ISTRO; (2) assess whether our objectives, journal publications, Branch and Working Group activities are supporting global soil health, soil quality, soil security, and soil renaissance activities; and (3) provide a vision for ISTRO to pursue as we strive to meet food, feed, fiber, and fuel needs of a rapidly expanding population who, with or without their knowledge, are dependent upon our finite soil, water, and air resources for their livelihoods. My conclusions are optimistic and I hope you agree that the dedicated members of ISTRO are more than capable of meeting 21st Century soil health and soil security challenges.

Keywords: Sustainable Development, Conservation Agriculture, Soil Tilth, No-tillage, Soil Management

The impact of soil compaction and freeing-thawing cycles on soil structure and yield in Mollisol region of China

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Abstract

Agricultural machinery tillage and alternating freezing and thawing are two critical factors associated with soil structure change and accelerates soil erosion in the black soil region of Northeast China. Combining practical machinery operation and natural freeze-thaw cycles with artificial machinery compaction in the field and artificial freeze-thaw cycles in the lab, the plus and minus benefits of machinery tillage, characterization of seasonal freeze-thaw cycles, and their effects on soil structure and yield were studied. Firstly, the effects of machinery type and antecedent water content on soil structure and soil available nutrient were investigated by measuring soil bulk density, soil strength, soil porosity, soil aggregate distribution and stability, and three soil phases. The results showed that: Machinery tillage had positive and negative influence on soil structure, soil in top cultivated layer can be loosened and ameliorated however the subsoil accumulation of compaction was resulted. For heavy and medium machinery, subsoil compaction formed in the soil depth of 41~60cm and 31~40cm, respectively; however during the soil depth of 17.5~30cm under medium machinery operation there was a new plow pan produced because of the depth difference between harvesting and subsoiling. Antecedent water content had a significant effect on soil structure under machinery operations. Higher water antecedent resulted in deeper subsoil compaction at 40cm，which was deeper by 10cm than lower water content and soil compaction accumulation occurred at the first pass under higher water content condition. Besides water content and bulk density, soil organic matter is another key factor for affecting compressive-resilient performance of tillage soil. Secondly, based on the soils sampled from fields of the black soil region, the effects of freeze-thaw cycles on soil structure at different soil depths (0—40 cm, 40—80 cm, 120—160 cm) and size scales (field core sampling scale of seasonal freeze-thaw cycles, computerized tomography [CT] scale of artificial freeze-thaw cycles, and scanning electron microscope [SEM] scale of artificial freeze-thaw cycles) were studied. The results showed that: At three scale of seasonal freeze-thaw cycles, soil structure of sub soil (40—80 cm) changed more significantly comparing to the top soil and underling soil, this may be contributed by the higher clay content in soil. Soil compaction accelerated and subsoiling relieved dynamics condition of seasonal freezing and thawing process, resulting to a deeper and a lower frost depth, respectively. Soybean yield was not changed by compaction or subsoiling, or their interaction effects; however, interestingly hundred-gain weight of soybean increased after appropriate compactions but decreased when subsoiling was implemented on compacted soil.

Keywords: Mollisol, Subsoil compaction, Freeze-thaw cycles, Soil structure

Effect of Three Tillage Depths on Sugarbeet Response and Soil Penetrability Resistance

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Abstract

Tillage can alter soil properties and affect crop yield and quality. A 4-yr study was conducted on a Lihen sandy loam soil to evaluate the effect of tillage depth on sugarbeet (*Beta vulgaris* L.) root yield, root quality, and soil penetration resistance (PR). Tillage treatments consisted of no-tillage (NT), shallow tillage (ST), and deep tillage (DT). Soil PR was measured with a penetrometer in 2.5-cm increments to a 40-cm depth at three locations within each plot. Roots were hand harvested from each plot and each sample consisted of roots of two adjacent rows. Sugarbeet root yield and adjusted sucrose yield were not significantly affected by the depth of tillage in 2008, 2009, and 2011. In 2010, root yield was significantly greater (16.5%) in DT than in NT. The average sugarbeet yields across 4 yrs were 58.77, 60.30, and 63.03 Mg ha^{-1} for NT, ST, and DT, respectively. Root yield was lower in 2011 than other three years due to cold and wet weather conditions in the spring. Soil PR values were significantly lower in DT than in ST and NT from 5- to 30 cm depth. However, significant differences were found between ST and NT at the 5- to 7.5 cm depth. Overall, DT enhanced soil physical environment but on average across 4 yrs had no statistically significant effect on sugarbeet root yield and quality compared to both ST and NT practices, though a trend was noted that as tillage depth increased root yield increased.

Keywords: Tillage, soil compaction

Finite element model of the compaction of a Luvisol due to traffic under different tillage systems

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Abstract

The negative effects of soil compaction on crop production and on the environment have been put into evidence by several studies. The main problematic situations occur (i) in the topsoil in presence of reduced tillage, i.e. without ploughing and (ii) in the subsoil whatever the tillage system. This paper aimed to compare the behaviour of both kinds of tillage under wheel traffic. A finite element model (FEM) based on a modified Cam Clay formulation was used to compute the propagation of stresses in the soil and the deformation. It expresses that the soil deforms elastically in stress state within an elliptical yield surface and deforms plastically out of this surface. The parameters of elastic and plastic deformations required by the model (namely the slope of the normal compression line and of the swelling line, the precompression stress Pc) were determined in laboratory from soil samples taken at five depths up to 0.5m under conventional tillage (CT) and reduced tillage (RT). The model was implemented with a non-uniform grid with 4486 elements and 13631 nodes on a 2D cross-section of 4 x 2 m^2. The vertical stresses at the wheel-soil interface created by an agricultural tractor (maximum vertical stress = 100 kPa) and a sugar beet harvester (maximum vertical stress = 150 kPa) were computed by the FRIDA model (Keller, 2005) and introduced in the FEM model. The complete model was validated by comparing the computed values of rut depth and porosity distribution vs depth with the values measured after the traffic. The results showed a good agreement between the calculated and observed values (relative root mean square ≅ 0.05). They also suggested a higher decrease in porosity in the layer comprised between 10 and 50cm under RT than CT.

Keywords: Subsoil compaction, Finite element method, Conventional tillage, Reduced tillage

Horizontal stresses below two agricultural vehicles

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Abstract

Deformation of the pore system in the subsoil due to mechanical stress applied by agricultural machinery is persistent for at least decades. Application of normal stress exceeding subsoil strength leads to a reduction of capacity soil properties (i.e. air-filled porosity) by compaction, while shear stress larger than soil strength may affect intensity soil properties (i.e. air permeability) by soil deformation not necessarily associated with compaction. In previous experiments in field conditions, isotropic compaction was observed below the center of tires, while shearing took place below the edge of tires. Stress distribution at the tire/soil contact is not uniform. Dimensions and inflation pressure are key factors for the ability of agricultural tires to distribute the wheel load. Our hypothesis was that the risk of shearing increases with the tire inflation pressure and the number of wheels. We measured horizontal stress at two depths (0.3 and 0.5 m) below tires of two slurry spreaders: one self-propelled machine equipped with wide tires (1.050 m) and low inflation pressure (150 kPa) but carrying a high wheel load (120 kN), and one tractor towing a three-axle slurry spreader equipped with 0.7 m wide tires, loaded with 73 kN and with high inflation pressure (300 kPa). Effect of traffic on soil structure was assessed by air permeability measurements on soil cores sampled at nine locations across the tracks (within as well as outside the tire-soil contact area) and at three depths (0.3, 0.5 and 0.7 m). The maximum rooting depths of spring barley was recorded below the center of the tire, below the edge of the tire, and outside the tracks. Horizontal stresses had about the same magnitude for 0.3 and 0.5 m depths for the self-propelled machine, while it was much higher at 0.3 than at 0.5 m for the tractor-trailer combination. At 0.3 m depth it was significantly higher for the tractor-trailer system than for the self-propelled machine. Generally, air permeability was reduced in the track of the tractor-trailer system, while no significant reduction was observed for the self-propelled system. Outside but close to the tracks, the latter system increased the air permeability (significantly at 0.3 m). Also the tractor-trailer system tended to increase the air permeability outside the track (significant when compared to the in-track values). Both systems reduced significantly the maximum rooting depth below the center and at the edge of the tire as compared to non-trafficked soil, while there was no difference between machinery systems. This study was only an appetizer for further research on the effect of horizontal stress on soil structure, as many factors were confounded (wheel load, inflation pressure, number of axles).

Keywords: horizontal stress, shearing, compaction, agricultural soil, root growth

Effects of different tillage modes on soil carbon, water use efficiency and crop yield

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Abstract

Tillage methods have great impact on water use efficiency and crop yield. The tillage methods varied in different districts in Guanzhong Plain area, where is the agricultural production centre in Shaanxi Province. In order to find out the optimal tillage method in Guanzhong Plain area, we studied the effects of 4 different tillage methods on soil bulk density, water use efficiency, crop yield, soil organic carbon (SOC) and particulate organic carbon (POC) in a winter wheat-summer maize rotation system. The tillage methods included rotary tillage, sub-soiling, no-tillage and the conventional tillage method, combined with straw returning procedures. Our results showed that no-tillage method increased soil bulk density at 0-20 cm compared to the conventional tillage method. Rotary tillage, sub-soiling and no-tillage methods increased SOC at 0-30 cm compared to the conventional method, while the increase of SOC appeared mainly at top soils (0-10 cm). Sub-soiling with pulverized straw returning increased SOC (by 19.52%), water use efficiency (16.88%) and anniversary yield (by 20.45%), which is more effective than other methods. In addition, compared to the conventional method, straw returning effectively increased the mass of POC in soils. Rotary tillage with straw returning increased POC in soils by 22.98%. Therefore, sub-soiling or rotary tillage with straw returning was the best tillage method in the Guanzhong Plain area.

Keywords: Tillage, Soil bulk density, Water use efficiency, Crop yield, Soil organic carbon, Particulate organic carbon

Effects of wheeling with agricultural machinery on the anisotropy of the soil pore system

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Abstract

This study quantified the impact of soil deformation caused by agricultural vehicle traffic on the anisotropy of the soil pore system and gas transport properties (air permeability, gas diffusivity). An experiment was conducted with five repeated passes of a two-axle self-propelled agricultural vehicle (wheel load 8 Mg, tyre size: 1050/50 R32, tyre inflation pressure: 100 kPa) in May 2014 on an arable clay soil (crop at the time of the experiment: grass ley) in North-Western Switzerland. Soil stress using Bolling probes and vertical displacements using the hydrostatic principle were measured at various depths below the centreline of the wheel rut. Undisturbed cylindrical soil cores were collected in non-wheeled areas (N), at the edge (i.e. at 0.5 m lateral distance from the centreline of the wheel track) of the wheel rut (EW) and at the centreline of the wheel track (CW). The soil cores (0.06 m in height) were taken in two directions (vertical and horizontal) at three depths (0.1, 0.2 and 0.4 m). A total of 270 cores were collected. Air-filled porosity (εa), water content, air permeability (ka) and gas diffusivity (Dp/D_0) were measured at three different soil matric potentials (-30, -100, -300 hPa). A factor of anisotropy (FA) was determined as the ratio of a property measured in the horizontal direction to that in the vertical direction. Mean normal stresses were around 100 and 60 kPa at 0.2 and 0.4 m depth, and vertical displacements were ca. 20, 5 and 1 mm at 0, 0.2 and 0.4 m depth. The vehicle-induced deformation resulted in significantly reduced εa, ka, Dp/D_0 in the topsoil (0 and 0.2 m depth). Air permeability was highly anisotropic with higher ka in vertical direction, especially at wet conditions (-30 hPa) when only macropores are air filled, suggesting that the anisotropy is largely due to biopores. Compaction mainly affected macropores and hence ka at the wet end (-30 hPa), and decreased the vertical ka more than the horizontal ka, and consequently, ka became less anisotropic due to compaction. Gas diffusivity, Dp/D0, that is a function of air-filled porosity, was not direction dependent. Our results show that soil compaction due to vehicle traffic not only decreases the soil gas transport capacities but also changes the anisotropy of air permeability, which will have consequences on soil aeration and soil-atmosphere gas exchange.

Keywords: Air-filled porosity; Air permeability; Gas diffusivity

Does heavy traffic have long term implications for crop yields?

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Abstract

Danish soils are subject to increasingly heavier traffic. Today, wheel loads of 6-12 tons are common on e.g. slurry tankers, combines and sugar beet harvesters. Field trials were started in Denmark in spring 2010 to answer the question: "does heavy traffic have long term implications for crop yields?" The trials are placed on three sandy loam soils. The experimental treatments were carried out in early spring at field capacity in four consecutive years (2010-2013). Six levels of compaction, ranging from 0-12 tons wheel load, were applied prior to sowing with spring barley. A tractor - slurry trailer (Samson PG 25) combination was used for treatments up to 8 tons, while a Vervaet self-propelled slurry tanker was used for treatment with 12 tons. The design of the two machines is fundamentally different and influences the number of passes on the soil .The inflation pressure for the tyres on the tractor-trailer combination ranged from about 2.4-3.0 bars (~2-3 times recommended for field traffic at 10 km h^{-1} for the tyres used), while the tyres mounted on the Vervaet machine were inflated to 1.5-2.5 bars (~0.6-1.0 times recommended). These pressures were chosen based on commonly used practice by the contractors delivering the machinery for the experimentation. Each year, spring barley (*Hordeum vulgare* L.) was established after the compaction treatments. Since 2013, investigations on biological tillage (root growth by pioneering crops) have been added to the trials. Significant yield losses up to 12.5 dt ha^{-1} have been measured on average for the four years with experimental treatments, except for the Vervaet tanker treatment. In 2014, tractor - slurry trailers with 6 and 8 ton wheel load and repeated loadings caused average yield reductions up to 4.9 dt ha^{-1}.More results, including measurements on plant physiology and soil physics, are given at the conference.

Keywords: Soil compaction, Crop yield, Biological tillage, Soil Physics, Plant physiology.

The future of using horizontal penetrometer for field mapping of soil compaction: Is soil degree of compactness measurable on-the-go?

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Abstract

Comparison of soil compaction status across soil types needs a texture-independent index of the state of soil compactness. This study aimed at investigating empirical models to predict the soil degree of compactness (i.e. ρ_{rel} calculated by actual field bulk density as a percent of a reference density) from horizontal penetrometer resistance (PR) and soil water content (θ_g) in a wide range of soil textures. Field measurements were conducted using a horizontal penetrometer at a depth of 0.25 m on ten different fields with different soil textures. At selected locations, cylindrical samples were cored within the working depth of the horizontal penetrometer for determination of soil texture, OM, θ_g and ρ_d. Proctor density was used as reference density, and could be well described as a function of CC and OM (R^2= 0.97, RMSE= 0.046 Mg m^{-3}). The results revealed the exponential function as the most accurate model to describe ρ_d (R^2= 0.95, RMSE= 0.047 Mg m^{-3}) and ρ_{rel} (R^2= 0.66, RMSE= 3.2%). It was found that the ρ_d models were texture dependent but ρ_{rel} models not. Further investigations indicated a strong relationship between ρ_{rel} and the calculated S-index (the slope of the water retention curve at its inflection point) that has been proposed by Dexter (2004a) as an index of soil physical quality or 1/S as a measure of soil degree of compactness. This suggested that the relative density (degree of compactness) could be used as an easily-measurable index of soil physical quality. The findings of this study would help to develop prediction functions that can be implemented by on-the-go sensor fusion systems for field mapping of soil degree of compactness.

Keywords: Soil compaction, Within-field variability, Relative density, Penetrometer, On-the-go

Development and Experiment on small loosening and fertilizing machine for low-tree orchard

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Abstract

Aimed at the traits of Nanfeng mandarin orchard such as hilly lands planting, low tree and high planting density, a small loosening and fertilizing machine has been developed. The article introduced the working principle, whole layout and main part structure of this kind of machine. The structure features are listed as follows. The height in front of whole machine was controlled within 600 millimeter limit to adapt crown height. In order to reduce the weight , the materials of gearbox and frame are improved. Hard blades are employed to loosen quickly for clods of hilly land. The walking-steering mechanism and armrest-adjusting mechanism are designed to realize turning and adjusting flexibly. The inconvenience of operation can be solved in the region of planting dense. The fertilization institution is placed on the wheels which the rate of fertilization is controlled by the movement of wheels. Meanwhile, the experiments are implemented aimed at the performance of loosening and fertilizing. The experiment results indicated that small loosening and fertilizing machine for low-tree orchard had reasonable structure and good performance. During the course of operation, it had high work-precision and low labor-strength.

Keywords: Loosen; Fertilize; Low tree; Development; Experiment

Does SOC sequestration relate to P activation in Brown soil under different tillage systems of peanut field?

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Abstract

One of the key targets for soil fertility improvement is to activate the nutrient, which could reduce the input of resources and also the risks of environmental pollutions. Due to the low soil organic carbon (C) content and low phosphorus (P) fertilizer use efficiency in many peanut fields, rational field management is critical for improve soil C&P fertility. In previous study, we have confirmed that soil organic carbon (SOC) accumulation increased the soil available P and the ratio of soil available to total P under long-term P and no-P fertilizations. This study is based on the peanut field experiment with the same application of P under different tillage systems. We try to find the rational tillage measures improving the SOC sequestration while activating the P availability in Brown soil. Changes in soil P and organic C in 0–10, 10–20 and 20–30cm soils were studied under five tillage treatments: deep tillage (DS), shallow tillage (ST), deep subsoiling (DS), no tillage (NT), and fallow. By analyzing the change in soil particle composition and C&P fractions, the cooperative promotion mechanisms of SOC and available P will be explored in Brown soil of peanut field. Our findings will enrich the basic theory of soil C&P interaction, and provide a scientific basis for soil fertility cultivation.

Keywords: Brown soil; Fraction; Nutrition; Soil particle composition; Tillage system

Effect of different nitrogen fertilizer types and application rates on yield of winter wheat and summer maize in the North China Plain

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Abstract

This paper reports on the Chinese component of the 'Nutrient Use Efficiency' (NUE-CROPS) project conducted under the auspices of the European Union Framework 7 program. This paper is concerned with the effects of nitrogen fertilizer type and rates on the yield and NUE of four Chinese varieties of wheat and maize grown in an intensive winter wheat-summer maize rotation commonly practised in the North China Plain. The trial was a factorial experiment consisting of 4 varieties × 4 organic manures × 6 inorganic fertilizers × 3 replications from 2009 to 2012. This trial was irrigated (well watered) with two to three irrigations for wheat and one or no irrigation for maize depending on the amount of summer rainfall. The results showed that when N application rates were below optimum (maximum yield), wheat displayed a fertilizer use efficiency (FUE) from urea that was three times that of cow manure, while maize displayed a FUE from urea that was 1.5 times from cow manure. These results shows that manure releases 1/3 of its N as available N under the winter wheat crop and 2/3 under the summer maize crop. However, when compared on the basis of available soil N, there were no differences in yield response to additional N (Nitrogen Use Efficiency) from urea or manure or a mixture of the two. The method used to derive this information is proposed as a novel and simple method to estimate the cumulative seasonal field based availability of N from organic fertilizer which is previously not easily measured. There were significant differences in the potential yield amongst the wheat and maize varieties. In wheat, Shimai15 displayed the highest yields, followed by Kenong9204 and Jimai19, with Weimai8 displaying the lowest yields. In maize, Xianyu335 displayed the highest yields, followed by Zhongnonog99 and Lainong14, with NE9 displaying the lowest yields. For both crops, these differences were largely associated with the development of the photosynthetic sink or the number of grains/ha. In wheat, maximum yields were achieved with 125 kg of

available N/ha/crop and may consist of a mixture of urea and/or manure. In maize, maximum yields were achieved with 100 kg of available N/ha. This implies that current farmers' agronomic practice use too much fertilizer and can be reduced without grain yield losses while reducing potential losses and pollution of the environment.

Keywords: Inorganic and organic fertilizer; winter wheat; summer maize; nitrogen use efficiency.

Effect of fertilization systems on root characteristics, yield and quality of maize (*Zea mays* L.) under subtropical conditions in red soil of China

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Abstract

A field study since 1998 were to explore the effects of fertilization systems on root characteristics, yield and quality of maize in red soil, to investigate the effects of a control (CK), application of chemical fertilizers (NPK), application of organic manure (OM), and NPK fertilizers plus straw returning (NPK+S). Results showed that the plant height, stem diameter, leaf area and leaf area index increased significantly with organic and inorganic treatment than in the control ($P < 0.05$). The NPK+S treatment has positive effect on grain yield followed by OM and NPK treatments when compared with CK ($P < 0.05$). In contrast, OM treatment has higher effects on biological yield than in NPK+S and NPK treatments. The application of fertilization gained the highest ear characteristics of maize. The fertilization treatments has also positive effect on root mass density and root layer depth during growing season than in CK ($P < 0.05$). NPK+S have higher effects on root dry weight than OM, NPK and CK. OM had greater in P and N concentration than in NPK+S, NPK and CK ($P < 0.05$). The highest dry matter was obtained with fertilization systems in maize root, stem and leaf. OM has positive effect on dry matter, followed by NPK+S and NPK compared with CK ($P < 0.05$). OM and NPK+S improved the root characteristics, yield and quality of maize in red soil of China.

Keywords: Fertilization systems; Red soil; Root mass density; Leaf area index; P and N concentration

Effect of repeating passes of middle weight tractors with single and addition wheels on soil density in topsoil and hard pen

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Abstract

Observed in the literature ambiguity of results obtained in different tests conditions, inspire research continuation for the purposes of knowledge extension and verification of modified ideas and ascertainments. Present investigations include to that context. Their goal is to determine the impact on the soil density, in topsoil and hard pen, of the repeated passes of selected middle weight tractors, with single and addition wheels, in the ploughing soil tillage system.

Tractors impact of following weight were investigated: 52.1 kN, 62.8 kN i 71.8 kN equipped with single wheels, tractors with weight 52.1 kN i 71.8 kN equipped with addition wheels (dual and triple wheels) on the density of loosened soil (loamy sand) in topsoil on the two depth: to 0.15 m and in 0.15-0.25 m, as well in the hard pen on the depth 0.30-0.35 m.

Besides, the effect on the density in the above three depths, the standard wheels and adjacent addition wheels of 71.8 kN weight tractor equipped in the triple wheels only at the rear axis, was determined.

The field experiment proved various changes of soil density at the three depths, caused by tested factors. General statistical formulas, describing different effect of investigated factors on the soil density after repeated tractor passes in the same tracks – confirming the hypothesis, was elaborated and proposed. The annunciated hypothesis has been confirmed - density altitude and its increase, at the all investigated depth, caused by repeated tractor passes, are determined by the soil compaction level done in the first pass.

Keywords: Tractors, Single wheels, Addition wheels, Repeated passes, Soil density, Topsoil, Depth, Hard pen

Effects of Elevated Atmospheric CO2 and N Fertilization on a Bahiagrass Pasture in the Southeastern U.S.

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Abstract

In the Southeastern US both managed and unmanaged pasture systems remain understudied agro-ecosystems in terms of the effects of elevated atmospheric CO_2 concentration. Therefore, we initiated a long-term study of bahiagrass (*Paspalum notatum* Flüggé) response to elevated CO_2 using open top field chambers in 2005 on a Blanton loamy sand (loamy siliceous, thermic, Grossarenic Paleudults). The study has run for 9 years with biomass production and tissue carbon and nitrogen assessed. Plants were exposed to ambient or elevated (ambient plus 200 ppm) CO_2. After a one-year establishment period, an N treatment was applied where half of all plots received N [$(NH_4)_2SO_4$] at 90 kg ha^{-1} three times yearly; the remaining plots received no N fertilization. These two treatments represent managed and unmanaged pastures, both of which are common in the Southeast. Prior to N treatment initiation (establishment phase) biomass production was unaffected by CO_2 treatment. Harvests after N treatment initiation (Summer 2006) showed a strong effect of N treatment on cumulative biomass production (>300% increase with N); the main effect of CO_2 was also significant (16% increase with high CO_2). A significant interaction between treatments showed that CO_2 had no impact on bahiagrass production with no N added (as observed in establishment year); however, biomass production was increased by 21% under high CO_2 with N added. In general, this same pattern of treatment response has been observed in subsequent years. Tissue C concentration was unaffected by CO_2 treatment, while N concentration was slightly reduced under high CO_2. However, total C content was usually higher under elevated CO_2 while total N content was unaffected by CO_2. For C:N ratio, a treatment interaction indicated that high CO_2 grown plants had lower C:N in the no N treatment, but the opposite was observed with N fertilization. As with biomass, this same general pattern was observed in subsequent years. Results to date show that N fertilization can increase biomass productivity under elevated CO_2, but forage quality (in terms of C:N ratio) may decline slightly. Efforts are also underway to assess impacts of these treatments on belowground biomass, soil trace gas efflux, and soil carbon storage.

Keywords: carbon dioxide, pasture, bahiagrass, nitrogen fertilization, global change

Effects of flue gas desulphurization gypsum on the heavy metals availability in sodic soil

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Abstract

Increasing salinity and sodicity are serious land degradation issues worldwide. The use of gypsum is main chemical strategies for saline-sodic soil remediation. Few studies have directly examined the effect of flue gas desulphurization gypsum (FGDP) on the metals availability of saline-sodic soil. Field and incubation experiments were performed to examine the effect of FGDP on the metals (Pb,Cr,and Cd) availability of sodic soil in Ningxia China. Chemical species of metals were analyzed by modified BCR sequential extraction schemes under anoxic and oxidized conditions. The results indicated that acid extractable fraction of Pb added FGDP 7.5t/ha and 15 t/ha treatments were 17.2mg/kg,16.7 mg/kg, respectively, were lower than control. The addition of FGDP decreased the concentration of oxidizable fraction of Cr compared to control. In addition, there were no significant difference between the total concentrations of metals (Pb, Cr,and Cd)for various treatments. It is concluded that added FGDP effect metals (Pb,Cr,and Cd) availability of soil by changing soil pH, exchangeable sodium percentage, total salinity. Changing in metals availability of sodic soil may influence the uptake and bioaccumulation of heavy metals in vegetables, which needed further researches.

Keywords: Sodic soil; Remediation, Heavy metals; Availability

Effects of land-use change from pasture to agricultural lands on several soil quality charactristics under different soil texture classes

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Abstract

Evaluation of the long term effects of the land-use change on soil quality indexes would supply valuable information for soil sustainable management and prevention of intensive soil degradation. In this regard, the current research was aimed to evaluate the effects of land-use change from pasture to agricultural lands on soil wet-aggregate stability (WAS) and organic carbon (OC). The study was carried out on Northwestern slopes of Mount Sahand, northwest of Iran. The study area including three soil texture classes of loam, sandy clay loam, and sandy loam was pasture land which is partially changed to either irrigated and rain-fed agricultural lands or bare soil. Results showed that regardless of soil texture, pasture conversion to agricultural lands resulted in reduction of soil OC which will deteriorate soil quality. The reduction was more considerable in pasture conversion to irrigated farmlands due to mismanagements which reduced soil OC content to the nearly half (0.54 *vs.* 0.98 %) and also led to 11 percent reduction in WAS of soil (WAS of 59 % *vs.* 70 %). The mismanagements also resulted in destruction of pasture and converted them to unprotected bare soils. It is concluded that appropriate and detailed surveys and investigations are needed to conserve studied pasture lands.

Keywords: land-use change, soil degradation, soil organic carbon, soil quality

Effects of Livestock Manure on Heavy Metal Fractionations of Cu and Pb Contaminated Red Soil and Chao Soil

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Abstract

Livestock manures are wildly used as a major organic fertilizer in China, as they improve the soil fertility and water holding capacity for better crop production. However, the effects of different manures on heavy metal fractionations of Cu and Pb contaminated soil are less reported. In this paper, we applied four kinds of livestock manures (horse manure, chicken manure, pig manure, cow dung) to Cu and Pb polluted red soil (Ultisol) and chao soil (Cambisol). The main results are as follows:

(1) After application of livestock manures in Cu and Pb contaminated red soil, the content of $CaCl_2$ extractable Cu and Pb significantly reduced, and the content of DTPA extractable and residual Cu and Pb significantly increased. These indicated that application of livestock manures decreased the availability of Cu and Pb in red soil, and the reduction of available Cu and Pb content was positive with the application amount of manures. For different manures, the effects of chicken manure were more significant than others'.

(2) After applying livestock manures in single Cu polluted chao soil, the content of $CaCl_2$ extractable Cu increased significantly. When application amount was 1% of soil (w/w, same below), the largest content of $CaCl_2$ extractable Cu appeared in chicken manure treatment, in comparison to CK, it almost increased by 2.3 times. Application of horse manure, chicken manure, and pig manure at 0.2% or 0.5% significantly reduced the content of DTPA extractable Cu in chao soil, and increased residual Cu content; meanwhile, application horse manure and pig manure at 1% significantly increased the content of DTPA extractable Cu in chao soil. In chao soil, application of cow dung at 1% had the most significant impact on DTPA extractable Cu, which increased by 6.2% compared with CK.

(3) After application of livestock manures in Cu-Pb compound contaminated chao soil, the content of $CaCl_2$ extractable Cu significantly increased, and the changes were similar with that in the single Cu polluted chao soil. When application amount was 1%, cow dung had the most significant effect on DTPA extractable Cu, and the content of DTPA extractable Cu increased by 15.9% in comparison to CK. However, the $CaCl_2$ extractable Pb was undetectable in compound contaminated chao soil, and the effects of livestock manures on DTPA extractable Pb were different, depended on the application amount.

Keywords: livestock manure; Cu; Pb; soil pollution; red soil; Chao soil

Impact of slurry strip-till and full-surface slurry application on NH_3 and N_2O emissions

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Abstract

Fertilizers containing nitrogen are one of the main sources of emissions on agricultural soils. The aim is to investigate whether applying the strip-till method can contribute to minimising these emissions. This study observed ammonia (NH_3) and nitrous oxide (N_2O) fluxes in a plot trial with maize beginning in March 2014 as well as in the lysimeter. The study area is located in the German federal state of Saxony-Anhalt. The chosen variants were a full-surface application of slurry with and without nitrification inhibitor (NI), slurry strip-till, also with and without NI, and an unfertilized control. The lysimeters used for nitrous oxide measurement had a surface area of 1 m². They were managed under the same conditions as the plot trial. NH_3 measurement was performed using the Dräger tube method. The closed-chamber method was used to measure nitrous oxide, with the nitrous oxide measurements on the lysimeters being performed both in and between rows.

In the case of full-surface slurry application, ammonia emissions were almost one-third higher than in the strip-till variant, albeit at a very low level. The highest nitrous oxide emissions occurred between May and July. Emissions were far lower in the unfertilized intermediate rows than in the maize row. Unexpectedly, though, the unfertilized control emitted far more than all other variants. The results show that variations in tillage also affect the emission level. There were no significant differences between variants during the vegetation period. However, the strip-till variant with NI displayed the highest emission peaks. Some of these peaks were caused by weather conditions such as rainfall and temperature.

Keywords: Gas emission; Strip till; Lysimeter

Impact of soil cultivation systems on soil properties, root system and technological features of sugar beet

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Abstract

Soil cultivation systems and passes of agricultural tractors wheels are important factors influencing the soil properties and plants yield. In the catena of above issues, the one that still needs recognition is root system during the time of plants growth and its influence on yield quality and quantity. Accomplished research had one special goal: estimation of influences of varied cultivation systems and tractors wheel passes on light soil compaction, root systems in soil, shape of tap-roots and on the sugar beet crop. The research was conducted on the cultivation field within the time of 3 years on the light soil - loamy sand. Research factors were as following: four soil cultivation systems: conventional with manure fertilization, conventional with mineral fertilization, conservation system and direct sowing; tractor passes; 3 soil layers situated on the depth 0-0.35 m. Following soil properties were measured: density, porosity and penetration resistance; distribution of the root system in the soil: diameter and length of roots of I, II and III type in the growth phase of five leaf; shape parameters of tap-root during the harvest: length, diameter and bulb root height; yield and sugar content. Following effects were determined: impact of the investigated factors on the soil properties, impact of these properties on the parameters of the root systems in the soil, and, in consequence, their influence on the shape of tap-roots and the technological properties of sugar beet.

Keywords: Sugar beet; Tillage systems; Tractor passes; Soil properties; Root systems; Tap-root dimensions; Yield

Improved general plant pathogen suppressiveness by agricultural management practices

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Abstract

In winter, the crop cover of field is an effective mean of water protection in agriculture adapting to climate change. In the agricultural area of annual crops, the essential tools in order to increase the crop cover outside the growing season are direct sowing and minimum tillage. They may, however, favor plant diseases transmitted through soil and plant residues, and to increase the use of pesticides.

The overall project objective was to develop innovative agro-environmental technology appropriate for practice in arable farming, which reduces the need for chemical control of plant diseases, and increases the crop cover of arable fields outside the growing season for farming of annual crops. The project examined the impact of autumn tillage method (zero tillage, stubble cultivation, plowing) and crop rotation (continuous spring barley (*Hordeum vulgare*) vs. barley-faba bean (*Vicia faba*) –oats (*Avena sativa*)-rapeseed *(Brassica napus*) -rotation) especially on the occurrence of the soil and plant residue transmitted plant diseases, as well as on the development of the general plant pathogen suppressiveness. The project focused on finding solutions for the management of plant diseases (particularly pathogenic *Fusarium* fungi; test species *F. culmorum*), for which the pesticides available have a low response. The soil physical conditions (temperature, moisture) were measured continuously in the fields during and out of the growing season.

Based on the results, cultivation methods can have an impact on the general plant disease suppressiveness in arable soil. Reduced tillage improved the suppressiveness compared with plowinging. The improved disease suppressiveness was related to the increase of the soil microbial biomass. In the treatments where the disease suppressiveness was the highest, the frequency of the pathogenic test fungus was the lowest.

Keywords: Spring crops, Autumn tillage, Crop rotation, Fusarium, Plant pathogen suppressiveness

Improving soil health and crop productivity by utilizing diverse and high-residue cover crops on sandy loam soils.

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Abstract

On the coast plain of Virginia, sandy loam soils generally contain low organic matter (~0.5%) concentrations and may be conventionally tilled depending on crops in rotation. The overall goal of this project was to document benefits of transitioning land from traditional high intensity and low biomass production to systems utilizing high-residue, diverse cover crop species, or alternative summer cover crops. In fall 2014, we initiated a long-term study testing 12 different treatments that host a combination of cash crop sequence changes and cover crop species; which were compared to a conventionally tilled corn monoculture. Species ranged from no-cover to cover crop mixes with 10 different species present; which contained different functional groups (i.e. nitrogen scavenging, nitrogen producing, and tillage). We will demonstrate soil quality improvements by measuring soil moisture, total carbon (C), total nitrogen (N), total sulfur (S), and organic matter concentration. Plant parameters will include total cover crop biomass produced, plant N concentration, total N uptake, emergence, disease incidence and severity, and overall plant yield. In December prior to winter kill, biomass from plots ranged from 230 to 1131 kg biomass ha^{-1}. By spring growth initiation in mid-March, aboveground biomass ranged from 764 to 2022 kg biomass ha^{-1}, while biomass production reached 8787 kg biomass ha^{-1} by late April at termination. In all cases, mixed species cover crops had more biomass produced than simple single species. In conclusion, cover crop mixes may provide more biomass additions to sandy loam soil production systems to increase overall soil organic matter concentrations.

Keywords: cover crops, organic matter, nitrogen, high-residue biomass

Influences of tillage and straw management on microbial biomass, residues and community in North China Plain

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Abstract

Soil microbial biomass and communities regulate soil organic carbon (SOC) turnover and stabilization processes. This study was conducted to examine the effects of 10-yr contrasting tillage and straw management on soil microbial biomass, residues, community structure, and their underlining mechanisms with SOC sequestration under a wheat-corn double cropping system. Soil samples were collected at 0-5, 5-10, and 10-20 cm depths from three treatments: conventional tillage with no straw (CK), conventional tillage with straw (CT), and no tillage with straw crop residue covered on soil surface (NT). Soil phospholipid fatty acid (PLFA), amino sugar content, and microbial community composition were determined. Compared to CK and CT, NT increased soil microbial biomass and residues but decreased the availability of substrates (microbial biomass per SOC) in the 0-5 cm soil layer. In the plough layer (0-20 cm)， however， NT showed insignificant effects on soil microbial biomass and residues. Also in the plough layer, no significant SOC content differences were observed among NT, CT, and CK, but NT had a higher microbial residue accumulation relative to SOC, indicating that NT decreased the mineralization of microbial residue, and therefore led to a potential long-term SOC sequestration. Fungal amino sugars accounted for more than 50% of total amino sugar pool, manifesting that fungi might make more relative contribution to microbial-derived organic matter than bacteria. In addition, conversion from CT to NT promoted fungal dominance in the upper 0-5 cm layer, but did not shift the overall soil microbial community structure in the plough layer. A positive correlated relationship between microbial community and SOC contents, suggested that fungal dominated community might associate with the SOC sequestration. Overall, combining PLFA indicator and amino sugar indicator for characterizing microbial community structure is helpful to understand soil microbial dynamics and functions in SOC cycling. We concluded that no tillage with straw management was a beneficial practice for improving SOC sequestration.

Keywords: Microbial biomass; Microbial residue; Microbial community composition; Tillage; SOC sequestration

Land use effects on soil magnetic properties and its environmental significance in Tubingen of southwest Germany

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Abstract

The magnetic properties of soil profiles in Tubingen of southwest Germany were investigated to distinguish agricultural soils and meadow soils under similar climatic and pedogenic conditions. Magnetic susceptibility (χ), anhysteretic remanence (ARM), isothermal remanent magnetization (IRM_{-300mT}) and saturation isothermal remanent magnetization (SIRM) were measured. Results indicated that mean χ for cultivated agricultural soils was no different from uncultivated meadow soils, whilst ARM $14.63\times10^{-5}Am^2kg^{-1}$, IRM_{-300mT} $909.87\times10^{-6}Am^2kg^{-1}$ and SIRM $1683.20\times10^{-6}Am^2kg^{-1}$ values were higher for uncultivated meadow soils compared to cultivated agricultural soils $7.73\times10^{-5}Am^2kg^{-1}$, $412.98\times10^{-6}Am^2kg^{-1}$, $563.03\times10^{-6}Am^2kg^{-1}$ respectively. Meadow soil exhibited larger enhancement of χ in the 5-10cm topsoil, which was about three times higher than the level of agricultural soils. Surface magnetic susceptibility was strongly affected by land use. The frequency dependent susceptibility values were larger than 5% suggested that agricultural soils contain a significant proportion of super paramagnetic grains, whilst meadow soils dominated by a mixture of stable single domain and multiple domains, as tillage probably promotes the formation of fine grains. Soil magnetic properties can be effective interpreting the effects on land use.

Keywords: Agricultural soil; Meadow soil; Magnetic properties; Environmental significance

Long-term effect of no-tillage and cover crops on carbon and nitrogen stocks in a Southern Brazilian Oxisol

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Abstract

The transformation of natural biomes of subtropical regions in agro-ecosystems with inadequate soil management has dramatically reduced the soil carbon stock. Only with the elimination of soil disturbance and by maintaining soil under constant plants cultures can recover the original carbon stocks. This paper aimed to investigate the changes in soil C and N stocks under long-term tillage systems and winter crops rotations. A very clayey and highly weathered soil under native vegetation was maintained until 1976; after that the forest was cut down, burned and started farming with intensive soil disturbance. In 1986, an experiment was installed to compare two soil management i. e. conventional tillage (CT) and no-tillage (NT), with eight winter crops. After 26 years, soil sample was collected up to a meter depth i.e. (0– 5, 5–10, 10–20, 20–30, 30–40, 40–60, 60–80, 80–100 cm layer) during 2012 and soil C and N stocks were quantified. The results demonstrated that even with the adoption of all recommended conservation practices over 26 years, the original C content and C stock was not recovered when compared to the natural adjacent forest due to heavy top layer soil losses and crop residues burning over a decade (1976 -1986). However, the adoption of NT, with all the recommended practices is recovering the original carbon stock at rates higher than CT in the surface soil layers (0-20 cm) and this difference tends to express to the ground deeper layers over time. The C stock of soil under CT also increased even when plowed twice and harrowed four-time annually, it might be due to the contribution of crop residues and mainly by the high content of inorganic colloids (> 70% clay and predominance of kaolinite and ironoxides), exceeding the NT at soil layer 20-30 cm. The remaining fallow land during the winter period, regardless of the soil management system adopted expressed lower C and N accumulation in the surface soil layers.

Keywords: No-tillage; Crop rotation; Anthropic activity; Carbon sequestration

Long-term effects of fertilizer application rate and type on soil structural properties

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Abstract

The vital importance of soil organic carbon (SOC) for soil structure and tilth characteristics is well-known. In spite of this, knowledge on critical low levels of SOC and rates of organic carbon (OC) application is lacking. The aim of this study was to investigate the long-term effects of fertilizer type and application rate on soil structural properties. Sampling took place in autumn 2014 after harvest of winter wheat in the long-term field experiment at Askov (since 1894) on a sandy loam. Samples were taken in the 6- to 15-cm soil layer at water contents corresponding to a water potential at -300 hPa. The fertilizer types were mineral fertilizer (NPK) and animal manure (AM). The fertilizer application rate was tested within the mineral fertilized soil: unfertilized (UNF), half the amount of mineral fertilizer normally applied (½NPK) and the amount of mineral fertilizer normally applied (1NPK). The 1NPK treatment was compared with AM at a level of 1½ to compensate for the lower nitrogen availability in animal manure. In this way the same yield level were obtained in both treatments. We measured clay dispersibility, wet aggregate stability, soil pore characteristics, and air permeability. The UNF soil had little SOC, low aggregate stability and was dense. In contrast the 1NPK and AM treatments had more stable aggregates and higher soil porosity. The ½NPK soil generally had intermediate properties. The pore size distribution changed so that the amount of plant available water was higher in the AM treatment than in the 1NPK and UNF treatments, whereas the soil pore volume >100 μm was higher in the 1NPK treatment than in the other treatments. Air permeability at high water content corresponding to a matric potential at -30 hPa decreased in the order 1NPK=AM≥UNF≥½NPK. The same level of aggregate stability in the 1NPK and AM treatments indicates that the biotic bonding and binding mechanisms were at the same level independent of fertilizer type. The relatively small differences in soil structural properties in spite of 120 years of contrasting fertilization may be due to the versatile crop rotation, including a one-year grass-clover ley and the graded, coarse-textured soil type. Our results indicate that the 1NPK treatment can sustain soil structure just as well as AM, which probably can be ascribed by root related effects. In contrast ½NPK and UNF could not sustain soil structure illustrating the long-term consequences of fertilization far below optimum.

Keywords: Fertilization; Manure; Clay dispersibility; Wet aggregate stability; Pore characteristics; Sandy loam

Method and Application of Modular Design for Small Agricultural Machinery

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Abstract

Global agricultural manufacturing is taking on challenges that farmers' demands are responded rapidly such as multiple functions. In order to reduce the costs in multi-varieties and single function production, it has practical significance to study the theory and method of modular design for small agricultural machinery, and can improve customized services on agricultural machinery industry. Based on the systematic principle and multi-granularity hierarchical principle, the key technology and implementation method for small agricultural machinery were studied. The module information model for small agricultural machinery was created in view of tabular layouts of article characteristics. Meanwhile, the module partition approach was proposed. Based on structural configuration and function requirements, the interface parameters between modules were optimized to reduce the structural conflicts and realize multi-function configuration quickly. The applications were developed aimed at tillers which analyzed the method of module division and interface correlation such as power module, transmission module, walking module and execution module. The study provides quick customized services for small agricultural machinery to satisfy the multifunctional configuration requirements, shorten the design cycle and reduce total manufacturing costs.

Keywords: Small Agricultural Machinery; Modular design; Configuration

No-tillage System: Does it matters when and where to sample?

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Abstract

The action of the seedler in no-tillage systems can decrease bulk density and increase porosity within the crop row, as well as break-up denser surface layers. These actions allow root systems to exploit deeper into the soil, with root expansion during crop growth promoting further soil structure amelioration. Therefore, the action of the seedler in no-tillage promotes two different environments within the field: the row and interrow. The hypothesis of this work was that no-tillage areas should not be considered homogeneous and, therefore, when sampling to assess soil quality the position and time of sampling can affect the outcome of soil structural quality assessments. The objective of this experiment was to evaluate how soil quality, evaluated by the visual evaluation of soil structure (VESS) method, changes through a soybean crop cycle under no-tillage system. VESS samples were collected at different periods: post-seeding, blooming and post-harvest; and at two different positions: row and interrrow. For each period 10 VESS samples were taken from each position, totaling 60 soil slices. The evaluations attributed a structural quality score (Sq) to the top soil (first 25cm in depth). Further to this, the top soil samples were separated into upper (0-10cm) and lower (10-25cm) layers and each attributed a Sq score. The soil scores were based on attributes such as shape, strength, colour and porosity of aggregates among others such as root development. The results showed that soil quality changes with sampling position, however, this was not observed for the sampling period. Soil structural quality decreased following the sequence row 0-10 (Sq2.2)> interrow 0-10 (Sq2.9)> row 10-25 (Sq3.4)> interrow 0-10 (Sq3.7). When evaluating the overall score for the 25cm deep slice the row displayed a better quality (Sq2.9) when compared with interrow (Sq3.7). When looking at the post-seeding depth of good quality soil (Sq1-2.9) the row had 10cm of Sq2 available to the crop, while the interrow only had 5cm of Sq2. The results indicate that sampling position is more important than time when making soil structural assessments in crops under no-tillage. The interrow samples showed that the soil was of a poorer quality and in need of long-term amelioration, while the row samples demonstrated that the soil directly available to the plants was of a good quality and in need of no improvement, which highlights the affect that soil sample position can have on decision making.

Keywords: Aggregates; Soil quality; VESS; Soil structure

Relationships between soil compaction and compositions

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Abstract

Soil compaction reduces crop yield, increases N and P requirements, and affects hydraulic properties. Soil compaction models are required to develop soil-specific management strategies. The objective of this study is to define relationships between soil compaction and compositions. Surface and sub-surface soil samples from 32 sites were analyzed for soil texture, organic carbon (OC), bulk density (BD), aggregate size distribution, and compaction using a modified Proctor Test for maximum bulk density (MBD). Degree of compaction characterizing the state of soil compactness was computed as the ratio between bulk density and Proctor density. To avoid methodological biases inherent to the analysis of compositional data, soil aggregation was expressed as log-ratio balances between macro-(>2 mm and 0.25-2 mm) and micro-aggregates (<0.25 mm) ([macro-aggregates | micro-aggregates]) and between larger (>2mm) and smaller (0.25-2 mm) macro-aggregates ([larger macro-aggregates | smaller macro-aggregates]). Likewise, soil texture was expressed as log-ratio balances between clay (< 0.002 mm), silt (0.002 - 0.05 mm) and sand (0.05 - 2.0 mm) ([clay, silt | sand]), and between clay (< 0.002 mm) and silt (0.002 - 0.05 mm) ([clay | silt]). Correlation analyses revealed that BD was related positively to [clay | silt] in surface layers, and negatively to [clay, silt | sand] and OC in both surface and sub-surface layers. MBD was correlated positively with the [larger macro-aggregates | smaller macro-aggregates] balance, and negatively with the [clay, silt | sand] balance and OC in surface layer. MBD and the [clay, silt | sand] balance were linearly related (R^2 = 0.74, P <0.001). In sub-surface layers, MBD showed no correlation with other soil parameters. Degree of compaction was related negatively to OC content in both layers, and negatively to the balance [clay, silt | sand] in sub-surface layers. The [clay, silt | sand] and [macro-aggregates | micro-aggregates] balances were the two most important factors in predicting the degree of compaction in sub-surface layers (R^2 = 0.71, P <0.001). Organic carbon content, the balance between soil fine and coarse particles, and the balance between the larger soil aggregates were determinant in modelling soil compaction.

Key words: Bulk density, Organic matter, Soil aggregates, Soil compaction, Soil texture, Proctor

Risk of soil compaction in energy crop rotations with and without sugar beet

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Abstract

When producing biogas it is beneficial to cultivate crops that achieve the highest methane yields – and thus the highest dry matter yields – across a given area. With this in mind, given the conditions in Central Europe sugar beets represent an alternative to silage maize. However, cultivating these crops to produce biogas must fulfil the criteria of sustainable agricultural production. In terms of soil conservation this means ensuring soil fertility, which not only requires equilibrium as far as humus and nutrient balances are concerned, but also the avoidance of soil erosion and soil compaction damage. The crops mentioned are highly susceptible to soil compaction damage; on the one hand, when cultivating sugar beets and silage maize in spring, soil water content is high and the soil structure's inherent stability against mechanical stress is low, and on the other hand the harvester's high overall mass means the soil structure is subjected to high levels of mechanical stress when the crops are harvested. The risks of soil compaction damage associated with particular working methods have already been published several times in related literature. So far, few studies have been devoted to the risks of soil compaction damage associated with entire crop rotations. This article therefore deals with evaluating the risks of soil compaction damage associated with entire crop rotations. It is based on cultivation data from field trials at three highly productive sites in Germany. Using the data, model farms are drawn up whose size and machinery are regionally adjusted. The article presents the methodology used and initial results.

Keywords: Crop rotation; Soil compaction; Sugar beet

Rubber tracks are still not good enough!

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Abstract

Subsoil compaction is persistent. Elasticity theory and recent studies have confirmed the elasticity theory and established wheel load as the primary source of high stress in the subsoil. In contrast, stresses at the tire/soil interface are determined primarily by the tyre inflation pressure and the primary cause of direct damages to crops and topsoil compaction. However, very low contact stress without reduction of wheel load would also help reducing stress in the deep subsoil, and thereby the risk of subsoil compaction of relevance to plant growth. Using tracks instead of tires is a technical solution to increase contact area. However, how well are the stresses distributed across the contact area under tracks? We measured contact stress below a sugar beet harvester equipped with either a large tire (1050/50R32) with low inflation pressure (150 kPa; load rated for 10 km h^{-1}) or equipped with a track (0.9 m width and 2.0 m long). The wheel load was 100 kN in both cases. The tests took place in November 2013 on an arable field with 20% clay and the soil water potential close to -10 kPa. Seventeen stress transducers were installed at 0.1 m depth and covered with loose soil. Measured stress distributions and the theoretical uniform stress distribution were used as input to calculate vertical stress in the soil profile using the analytical solution based on the elasticity theory. The results showed that the contact area was larger and the maximum stress was smaller below the track than below the tire. Nevertheless, the stress distribution below the track was far from uniform, presenting much higher stresses below the front, rear and the two mid-wheel rollers. Despite this, the calculated vertical soil stress was lower below the track than below the tire. The calculations using a theoretical uniform stress distribution under the track indicated that the contact area was too small to distribute the wheel load of 100 kN in order to prevent subsoil compaction. We conclude that there are still some technical issues to be solved to get a uniform stress distribution below tracks (positioning of mid-wheel rollers, spring stiffness at attachment points, track stiffness, dynamic weight transfer when under drawbar load, etc.). Also, the contact area should be considerably increased to prevent subsoil compaction if wheel loads as high as in this study are applied.

Keywords: contact stress, compaction, agricultural soil, agricultural machinery

Sampling deeper reveals no net effect of no-till system on soil organic carbon storage in China: a meta-analysis

Running title: no-till and soil organic carbon in China

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Abstract

Adopting no-till (NT) has been widely recommended as a potential strategy to enhance soil organic carbon (SOC) sequestration and thus mitigate climate change. However, recent studies suggest that earlier estimates of SOC sequestration under NT are probably too high due to the fact that measurements were restricted to the soil's surface layer. In China, the overall trend and magnitude of changes in SOC storage in response to NT adoption remain inconclusive and uncertain. Here, we use meta-analysis to assess the response of SOC storage to conversion from conventional tillage (CT) to NT based on 70 paired studies covering a range of soil types and climatic regions of China. Our analysis revealed that adopting NT stored more SOC in the surface 0-10 cm of soil, but the positive effect over CT diminished in the deep soil profile. When the whole soil profile (≥30 cm) was assessed, there was no net effect of no-till system on SOC storage. Disregarding the changes in soil bulk density (BD), using the fixed-depth (FD) method overestimated SOC storage under NT, particularly if soil samples were limited to a depth of 20 cm or less. Alternatively, the equivalent soil mass (ESM) method, with elimination of the confounding effect of BD, was more accurate in clarifying the changes in SOC response to tillage systems. Overall, both shallow sampling and FD approach overestimated the benefit of SOC stored in NT soils, which deserves additional care to calculate SOC storage on ESM basis together with deeper sampling. Our analysis concluded that the conversion to NT system did not increased SOC storage over whole soil profile and the factors controlling soil organic C accumulation in no-till soil need future investigate.

Keywords: No-till; Soil organic carbon; Equivalent soil mass; China; Meta-analysis

Screening for *Pseudomonas* and *Bacillus* strains antagonistic to wheat wilt caused by *Fusarium graminearum* and *Microdochium nivalae*

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Abstract

The purpose of the study is to compare the richness and abundance of soilborne fungi carried out under conservation and conventional cropping systems, also the screening of antagonistic strains of Pseudomonas and bacillus in the rhizosphera of symptomatic wheat plants. The inventory reveals the presence of two species responsible of wilt cereals disease namely *Fusarium graminearum* and *Microdochium nivale*. Other fungal species were also identified five *Aspergillus* species and three *Penicillium* species*, Beauveria bassiana, Curvularia sp., Fusarium graminearum, Geotricum, Microdochium nivale, Mucor sp., Rhyzopus sp., Sclerotinia sclerotiorum, Verticillium sp.* and *Alternaria alternate*. The bio-control of *Fusarium graminearum* and *Microdochium nivale* through the use of several isolates of *Pseudomonas* and *Bacillus*, gave an efficiency inhibition of mycelia growth varying between 65,91% % and 13.11%. Results of the direct *In vitro* antagonism shows that the maximum of inhibition of mycelia growth is reached after five days of incubation at 28 °C in the case of *Bacillus* strains, however this increased with time and it is more significant after ten days of incubation in the case of *Pseudomonas* strains.

Keywords: Fusarium graminearum, Microdochium nivale, antagonism, Bacillus, Pseudomonas, conservation agriculture.

Sensors and control for consistent drill coulter seeding depth

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Abstract

The even placement of seeds at the correct depth is vital for achieving the optimum yield of agricultural crops. The depth of drill coulters on state-of-the-art seeding machines is normally set manually by creating the downforce using springs or weights. On these machines, the drill coulters will react to different soil resistances derived from changes in soil compaction and/or texture, and consequently variations to drill coulter depth will occur. The aim of the research was to develop instrumentation for standard drill coulters for stabilising the coulters at, an even depth in soil. An absolute angle sensor for measuring the angle of the drill coulter arm was used for sensing the seeding depth. A hydraulic cylinder varied the spring force via a controller unit, for actuating the downforce, based on the coulter arm angle. To carry out the experiment, a prototype seeder with one drill coulter was constructed and tested in a rotational soil bin. Different control algorithms were studied. The results showed a strong correlation between the angle of the coulter arm and coulter depth under static and dynamic operations, verified by a sub-millimetre accurate positioning system (iGPS, Nikon Metrology NV, Belgium) mounted on the drill coulter. The sources of uncertainty were related to the system's kinematics and the hall sensor linearity. An experimental result demonstrated that the soil resistance influenced the drill coulter depth when it was forced down by a spring in the fixed position (without control). By using the controller and angle sensor, this deviation was nearly eliminated. The PID control was found to be able to control the depth for various soil compactions and textures. The most cost efficient controller was found to be the 3-position control, which was faster for settling, although not as accurate as the PID controller. A FFT analysis showed that the control systems also provided damping effect on the coulter depth variations. The control systems were able to eliminate the dominant coulter depth vibrations. An inappropriate hydraulic dead time and various response times were found for the control systems. The research concluded a potential of minimizing the low frequent drill coulter depth variations and a solution for providing of even coulter depth in soil, using the low cost 3-position control system under dynamic conditions.

Keywords: drill coulter depth, angle sensor, control systems

Snow Distribution in Rolling Landscapes under Agriculture and Forestry Land Uses in Atlantic Canada

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Abstract

Snowmelt events are essential to surface runoff and sediment and nutrient loadings in cold climate regions. Snow is not evenly distributed in landscapes, which often lead to spatial variations in snowmelt-induced landscape hydrological or biophysical processes. To better understand the variability of snow distribution, a snow survey was carried out in the Black Brook watershed in New Brunswick, Canada in Feb, 2014. Snow cores were sampled from 118 predetermined locations along a total of 21 transects, covering different land uses and slope positions. A Ground Penetrating Radar (GPR), calibrated with the snow core data, was used to provide detailed snow depth data at around 0.5 meter intervals along the transects.

Our results show that the snow depth ranged from 0.15 m to 1.29 m and averaged at 0.41 m. The water equivalent depth of the snow ranged from 0.06 m to 0.47 m and averaged at 0.15 m. Forested area had significantly deeper snow than cropped area. Points on the edge of the forested area had the deepest snow. The variability of snow depth was high and the variation did not correlated well with terrain attributes extracted from a 30 m grid DEM. The GPR was not only effective in detecting the soil surface under the snow, but also plough pan layer under agricultural land. The GPR results, surveyed on the agricultural land, illustrate a plough pan layer around 20 to 30 cm underneath the soil surface, and this layer is only observed in the surveys of agricultural land, not in forested area.

Keywords: Snow Distribution; Snowmelt; Snow Depth; Ground Penetrating Radar

Soil moisture derivation using triangle method in the Lighvan Watershed, North Western Iran

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Abstract

Soil moisture determination plays a major role in water and crop management. In this research, the accuracy of the Triangle Method (TM) was evaluated to predict surface soil moisture content using Moderate Resolution Imaging Spectro-radiometer (MODIS) satellite images with 1km resolution. The investigation was carried out within an area of 76 km^2 in Lighavn watershed in East Azerbaijan, North West of Iran. The analysis were based on ground measurements of soil moisture at 225 points (45 pixels) across the catchment on 2 different days. Ground measurements from the first day were used to train the models, while those from the second day were used for validation. A range of polynomial regressions from 1st to 4th orders were established between the ground measured soil moisture and MODIS Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST). The best results were obtained for the 4th order polynomial of the TM with the efficiency error (ER) and adjusted determination coefficient (R^2_{adj}) criterions, respectively, equal to 11.0% and 0.63 for calibration and 15.9% and 0.60 for validation stage. Therefore, the TM was found to provide reliable estimates of soil moisture, without the need for prior information of the soil surface roughness or the vegetation type and water content.

Keywords: Soil moisture; NDVI; Land surface temperature; Moisture monitoring

Temperature and straw quality affect the microbial community composition associated with straw decomposition

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Abstract

The management of straw residues has become a vital aspect of sustaining long-term fertility and soil organic carbon stabilization in agroecosystems. Incorporation of straw can alter the microbial processes and influence the nutrient availability. However, The effect of temperature on microbial communities during straw decomposition process is poorly understood. The bacterial community composition associated with wheat straw decomposition at three different temperatures (15, 25 and 35°C) was examined in a laboratory experiment using bar-coded pyrosequencing. Higher temperature increased the mass loss and nitrogen (N) content of wheat straw, but showed inconsistent effect on carbon (C) content at different stages of decomposition. The abundance of *Alphaproteobacteria* and *Actinobacteria*, which were sensitive to increasing temperature, were found to contribute the most during straw decomposition process. The bacterial community composition was significantly corrected with soil microbial biomass C, dissolved organic N and straw N and phosphorus (P) contents. We observed inconsistent responses of certain taxa to increasing temperature, likely resulting from the differences in nutrient responsiveness between bacterial ecotypes. Our results suggest that temperature as well as straw quality are important factors determining the straw decomposition process and the bacterial community composition related to straw decomposition.

Keywords: Bacterial community; Pyrosequencing; Straw decomposition; Temperature; Wheat straw

Temporal changes of carbon input and soil carbon sequestration under different tillage management in a Wheat–Corn Double-cropping System

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Abstract

Knowledge about the changes in carbon (C) concentration and mechanism under different tillage is necessary to assess the feasibility of adoption of conservation practices for sustaining productivity and protecting the environment. This study was conducted to determine the temporal effects of different tillage systems management on carbon input and distribution, storage of SOC under wheat (Triticum aestivum L.) – maize (Zea mays L.) cropping systems in the North China Plain (NCP). The experiment was initiated in 2001 on a Loam with three tillage treatments: no-till (NT), rotary tillage (RT) and full inversion tillage (FT). The results showed that the carbon input by residues return were the lowest under NT, and were the highest under the CT in majority years. The content of SOC in the 0-5 cm depth under NT was higher than the CT in every year. However, the content in10-30cm depth was lower significantly than the CT after 7 years. In the 0–30 cm depth, stocks of SOC had increased under NT and RT at the first 4 -7 years compared with CT, but reversed in next 8 years. This study highlights the interest of diachronic approaches to understand the effect of tillage and its interaction with crop growth and management factors. And it is recommended that full inversion tillage is applied intervals in 3-5 years to keep higher content of SOC in deeper soil.

Keywords: No-till; Carbon storage; Dynamic; Double- crop system;

Temporal soil reconsolidation of an Brazilian Oxisol loosed by Chisel Plow

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Abstract

The Brazilian agriculture, in the past years, has seen over 30 million ha been converted to no-tillage systems whereas surface compaction has been the main concern. To alleviate this conservation tillage has been used to loose surface soil. Tillage loosing up soil decreases bulk density and resistance and increase macro and total porosity, water infiltration and significantly affects water and air fluxes. These effects have a dimension at beginning and gradually change toward initial conditions by natural reconsolidation and traffic by agricultural operations. With objective to have a temporal measurement of how soil physical properties changes with time after soil loosening by Chisel Plow down to 25 cm a long term experiment was set up in a tropical soil (typic Haplorthox) having around 55% clay, under consolidated soybeans no-tillage system. The set up was in the way that every 6 months one additional treatment with soil chiseling was added, having at end of third year 8 treatments with following times after chiseling: 0, 6, 12, 18, 24, 30 and 36 months. Plots under continuous no-tillage were used to serve as control. In the experimental years corn and soybean were grown as summer crops and cereals as winter crops. Soil physical properties connected to form and stability of structure as well as related to fluxes of water and air in the soil were measured in three soil layer: 1) approximately 0 to 7 cm - loose and granular soil; 2) 7 to 15 cm a compact layer and; 3) 15 to 25 cm layer below compacted layer. The study findings conduced to following conclusions: The not regularly use of Chisel plow to alleviate compactions do not affect soil structural stability, however has differential temporal effects on other soil physical conditions. Soil bulk density, porosities and water retentions quickly return to condition similar to before tillage, probably in time less than six months. Soil resistance to penetration last more and the residual effects was around 18 months. On the other hand, hydraulic conductivity of saturated soil and water infiltration, which integrate several factors associated to soil structure, last for time around 24 months. There are strong evidences that none soil physical properties changed by soil loosening up by tillage have state different than the initial state after 24 months, implying in no more residual effects.

Keywords: compaction; soil structure; Oxisol, conservation tillage

The lysimeters-rain shelter facility and the growth and water use of Chinese wheat

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Abstract

Excessive application of N fertilizer contributes substantially to high levels of nitrate (NO_3^--N) in surface and groundwater on Northern China. A trial was set up to quantify the fate of N within intensive wheat maize rotation system with a view to improve N and water use efficiencies. This paper describes the construction and testing of a lysimeter facility used for this trial. A 44 lysimeter/rain shelter facility was constructed at Shandong Agricultural University in 2005. Each lysimeter (2.5 m length × 2.5 m width × 2 m depth) was equipped with a neutron access tube for soil water monitoring and ceramic solution samplers (two ceramic suction cups were installed in each lysimeter at soil depths of 0.10, 0.30, 0.50, 0.75, 1.00, 1.50, and 2.00 m) for soil solutions collection. In order to precisely quantify water input, two rain shelters were used to exclude rainwater. The water balance showed that water outputs and inputs agree within 10% for all lysimeters, and that the average water used being 5% less than the total irrigation water supplied was considered as an acceptable error for such large lysimeters. Wheat grown in these devices was consistently higher than those grown with similar fertilizer management in a field located in Ling Xian due to enhanced soil fertility and irrigation in the devices. Thus, despite differences in yield, it can be concluded that the wheat crops grown in the lysimeters/rain shelter facility were comparable to those grown in an agricultural field with similar soils and climatic conditions. The facility was shown to be suitable for investigating water and nutrient balances of the root zone.

Key words: Lysimeter; Rain shelter; Water use; Soil solution samplers; Wheat yield

The response of soil organic carbon pool to long-term fertilization in red soil and its relationship with yield and carbon input

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Abstract

A long-term experiment beginning in 1986 in Jinxian county of Jiangxi Province, subtropical China, was conducted in a red soil under a double corn cropping system with different fertilization regimes. In the study, six treatments were selected for the present investigation: (1) unfertilized (CK); (2) inorganic nitrogen fertilization (N); (3) balanced fertilization with inorganic nitrogen, phosphorus, and potassium (NPK); (4) higher amounts of inorganic nitrogen, phosphorus, and potassium (HNPK); (5) inorganic NPK application combined with manure (NPKM); and (6) manure application (OM). Then, SOC content and pool were analyzed, and the relationship between grain yield, SOC pool and carbon input were assessed. The result was showed that: the SOC content and pool of NPKM were highest among all treatments.. Compared with CK, Combined with NPK and manure or manure alone in 27 years could increase SOC content by 51.5% and 42.0%, SOC pools were increased by 6.36 t ha^{-1} and 4.26 t ha^{-1}. SOC increment of NPKM and OM were 2.26 g kg^{-1} and 1.53 g kg^{-1}, and their rates were 0.08 g kg^{-1} yr^{-1} and 0.06 g kg^{-1} yr^{-1}, especially. Their SOC pool rates were 0.24 t ha^{-1} yr^{-1} and 0.16 t ha^{-1} yr^{-1} in 27 years. Compared with CK treatment, SOC pool rates of NPKM and OM were improved by 57.1% and 45.7%, respectively. This showed that manure application was an effective way to improve SOC content and pool in red soil. The relationship between C input amounts and corn yield could be fitted by revised Michaelis-Menten equation, which was $y = 8.38 + 25.15 x / + x (0.67)$, $R^2 = 0.9017$, $p = 0.0308$). It indicated that there was biggest value on the grain yield of corn in red soil (15.62 t ha^{-1} yr^{-1}). On the other hand, the relationship between C input amounts and SOC pool was fitted by linear equation ($R^2 = 0.9828$, $p < 0.0001$). And SOC pool of red soil achieved the balance point when C input was 2.46 t ha^{-1} yr^{-1}.

Keywords: SOC, long-term fertilization, red soil, C input, grain yield

Tillage effects on Hydraulic Soil Properties in a Sandy Environment

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Abstract

Hydraulic soil properties can be used for the prediction of physical water flow processes in soils. The tillage practices adopted were disc ploughing (DP), disc harrowing (DH) and zero tillage (ZT). The three tillage practices were replicated thrice in a randomised complete block design. Hydraulic properties such as water content, infiltration rate, sorptivity, hydraulic conductivity, macroscopic capillary length, mean pore size and characteristic time in relation to gravity in the sandy environment were investigated for two years (2009 and 2010). Infiltration parameters and hydraulic properties were determined using the disc permeameter. Soil physical properties such as particle size distribution, bulk density, moisture content and porosity related to the tillage practices were also investigated. Mean bulk density were 1.54, 1.38 and 1.39 g cm^{-3} for DH, DP and ZT respectively. Saturated hydraulic conductivity ranged from 14.94 to 28.38 mm hr^{-1} for ZT, 17.77 to 19.35 mm hr^{-1} for DP and 11.44 to 46.24 mm hr^{-1} for DH. Mean sorptivity values for ZT, DP and DH under saturated flow condition were 10.05, 8.23 and 10.34 mm hr^{-1} respectively ($P<0.05$). It was observed that the tillage practices had no significant effect on the soil physical and hydraulic properties investigated.

Keywords: saturated hydraulic conductivity, sandy soil, sorptivity, mean pore size, tillage

Will the existence of channels affect the amount of soil movement by tillage? --- A laboratory experiment on a soil bin facility

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Abstract

Tillage and water erosion both play important roles in total soil erosion occurring in cultivated fields. Water erosion induced channels are often observed on sloping farmlands and these channels are mostly smoothed by tillage operations, a form of tillage erosion that is largely ignored. Due to the changes in surface morphology, it is likely that the presents of channels may affect the movement of soil by tillage. However to date no research has been conducted to quantify such effects. During this study, tracer plots were established in a soil bin facility located in the soil landscape laboratory of the University of Manitoba, to examine tillage translocation under three treatments: no channel (control), 10 cm × 10 cm channel and 20 cm × 20 cm channel. The soil bin was set at 10% slope gradient. Plots were tilled for upslope and downslope directions. After tillage, tracer redistribution along the path of tillage was used to generate a summation curve to quantify the movement of soil particles along the tillage path. Results show that both up and downslope tillage operation can move vast amount of soil and are potentially erosive in all treatments. In addition, linear-plateau function method was used to generate hypothetical data to simulate soil movement under different conditions. Simulated data indicated that gravity is the largest contributor in translocation distance in both tillage directions, but lateral translocation is more prevalent during the downslope tillage. These effects increase as channel size becomes larger. Overall, it was concluded that the existence of channels can affect tillage erosion due to potential energy consumptions. However, the effect is not linear and there appear to be an optimum channel size for the interactive effect to be maximized.

Keywords: Water erosion; Tillage erosion; Erosion Interaction; Soil bin experiment