GT 01 - 263 - F + P

SALT-AFFECTED, GYPSUM, AND CARBONATE RICH SOILS UNDER THE COMMON AGRICULTURAL POLICY AND NEW IRRIGATION IN THE CENTRAL EBRO BASIN

GT 01. SOIL GENESIS, EVOLUTION AND CLASSIFICATION / GT 11. SOIL DEGRADATION, DESERTIFICATION, CONTAMINATION - CONSERVATION, MITIGATION, REMEDIATION

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Inland soil salinity occurs in the Central Ebro Basin (CEB), Spain, together with gypseous soils, uncommon in Europe. Both characteristics happen in Monegros area, in the CEB, where life-threatening soils share biodiversity conservation and rainfed winter cereal. We aim to highlight the soil features governing the soil behaviour under the imminent transformation into irrigation.

We opened 17 pits in 11 plots of barley or wheat, guided by a detailed geomorphological map. The pedons were described and sampled to determine soil salinity of the saturated paste extract (ECe), calcium carbonate equivalent (CCE), gypsum, and organic matter concentrations.

The soils represented 3 landforms: infilled valleys, colluvial deposits, and structural surfaces. Soils were classified as Typic or Sodic Haplogypsid, Typic Torriorthent, Typic Haplocalcid and Lithic Torriorthent in the structural surfaces; Gypsic Haplosalid were also in the valleys and Xeric or Sodic Haplogypsid in colluvial deposits. The moisture regime is aridic and the temperature regime is thermic. The sequence of horizons was different in the three geomorphic units showing a limited maturity, especially in the structural surface. We reached the limestone, lutite, or gyprock (R horizon) in 9 pedons at depths ranging from 33 to 180 cm. Gypsic horizons were dominant in the three landforms, at depths from 27 to 220 cm, with crystal, vermiform, nodules, fibrous, lenticular, and flour-like gypsum accumulations. Calcic horizons were limited to the structural surface, with carbonate nodules predominant.

In general, soils were saline. Sodic soils (SAR values of 12-92) occur in the valleys, where ECe ranged from 3.4 dS/m to 40 dS/m (mean = 14 dS/m). The lower ECe values were found in the colluvial deposits and structural surface (mean = 4 dS/m). Considering the ECe for the upper 50 cm, soils were strongly saline (up to 8.4 dS/m) in the infilled valley, slightly saline (up to 3 dS/m) in the colluvial deposit and non-saline (up to 0.7 dS/m) in the structural surface. Only two pedons were non-saline along the whole profile.

Gypsum content was very variable with soil depth, regardless of landform, reaching a maximum of 95% (mean = 22%). For the upper 50 cm, the mean gypsum content is 18%. CCE reached 74% in soils of the structural surface (mean = 40%) with a high vertical variability along the soil profile. The sum of gypsum and CCE ranged from 21% to 100%. The mean OM content of Ap horizons was 1.7%, being slightly higher in the valley soils (2%).

The soil salinity and composition of the studied soils 1) evidence the extreme conditions and limitations that the rainfed crops and the protected habitats are facing in the study area and 2) warn about the constraints regarding water holding capacity, and fertilizer and nutrient uptake that will arise when implementing irrigation.

KEYWORDS

Aridity, Gypsum, Salinity.

ACKNOWLEDGEMENTS

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GT 09 - 426 - 0

INTERCROPPING AND BIOPESTICIDE USE IMPACT SOIL MICROBIAL, MYCORRHIZAL RESPONSES AND PLANT DAMAGE IN ORGANIC MAIZE–COTTON SYSTEMS IN WEST AFRICA

GT 09. SOIL HEALTH / GT 04. SOIL BIOLOGY

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Intensive agriculture has led to strong soil degradation and the build-up of pests and pathogens. These issues are especially critical in developing countries, where agriculture faces low profitability, climate risks, and poor access to mechanization. Intercropping, known as the cultivation of two or more crops on the same land, has shown potential to improve resource use, maintain yields, and build more resilient systems.

This research explores the agroecological benefits of intercropping cotton-maize rotations with soybean under organic management in Benin. The experiment followed a randomized complete block design with several treatments, such as soybean intercropped with maize and biopesticide applications, and focused on two main aspects: soil health and pest management. Soil health was evaluated through microbial functional diversity (MicroResp™), enzymatic activity, arbuscular mycorrhizal fungal colonization, labile carbon, soil organic carbon, and mineral nitrogen. Pest management was evaluated using the Score Davis Scale based on plant injury metrics.

Preliminary results show that, after two cropping seasons, maize-soybean intercropping improves soil microbial activity (microbial catabolic profile and enzymatic activity) compared to monocropping, especially in absence of biopesticides. However, arbuscular mycorrhizal fungal colonization increased in monocropping compared to intercropping. Biopesticides reduced mycorrhizal fungal colonization in intercropped systems, but not in monocropping. Soil organic carbon levels was higher in intercropping compared to monocropping. In addition, a negative correlation was observed between arbuscular mycorrhizal fungal colonization and plant injury: mycorrhizal fungal colonization increased as the plant injury level decreased, particularly in intercropping plots. This relationship suggests a potential role of arbuscular mycorrhizal fungi in enhancing plant protections against pests.

Further analysis on plant damage and pest pressure will help clarify the trade-off between pest management and soil health under organic management. Continued long-term research on maize-cotton intercropping will offer valuable knowledge for adapting sustainable practices to smallholder farming systems in developing countries.

GT 09 - 61 - P

EFFECTS OF SOIL MANAGEMENT ON ENZYME ACTIVITIES IN AGRICULTURAL FIELDS OF THE EBRO VALLEY (NE SPAIN)

GT 09. SOIL HEALTH / GT 04. SOIL BIOLOGY

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Agricultural soils perform essential functions besides food production. Consequently, improving soil quality is key to guarantee the sustainability of the agrosystems and mitigate the negative effects of climate change. Enzyme activities are considered reliable indicators of soil quality, as they react rapidly to changes in agricultural management practices. In this context, an evaluation of the long-term (> 10 years) of no-tillage on soil enzyme activities was carried out in field crops located in three municipalities of the Ebro Valley (NE Spain): Castejón del Puente, Pina de Ebro, and Sádaba. In the three locations, a non-tilled (NT) field was compared to a field in which conventional tillage (CT) was consistently carried out. In addition, in Castejón del Puente, two soil types with different gypsum contents were considered, while in Sádaba, a tilled treatment but with organic management was also considered. The fields compared in each municipality were adjacent to each other, thus minimizing differences in soil type, slope, etc. Each field was divided into four zones (replicates) and, in each of them, 4 to 6 soil samples were collected to obtain a composite sample per zone. Then, physico-chemical properties were determined using standard methods: texture, pH, field capacity, permanent wilting point, organic carbon, total nitrogen, available phosphorus, and cation exchange capacity (CEC). Moreover, biochemical properties including soil microbial biomass and enzyme activities (dehydrogenase, urease, alkaline phosphomonoesterase, and β-glucosidase) were determined. There was a trend to higher contents of organic carbon, total nitrogen, CEC and microbial biomass in NT fields, but significant differences with tilled fields were only detected in some locations. Enzyme activities were more sensitive to soil management, as most of them were higher under NT, except for urease (Table 1). However, there were some different behaviours among locations. Gathering data from all sites, some significant correlations were detected among enzyme activities and soil physico-chemical properties, for instance: urease vs. pH (r = 0.61), and alkaline phosphomonoesterase vs. available phosphorus (r = 0.59). In contrast, β-glucosidase was not related to any physico-chemical property. These results suggest that, apart from tillage, other agricultural practices are affecting the response of soil quality indicators; these aspects may include the destination and amounts of plant residues or the type of fertilizers used.

ACKNOWLEDGEMENTS

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Treatment	Urease	Alkalyne phosphomonoesterase	Dehydrogenase	β-Glucosidase
	μmol NH_3 g^{-1} h^{-1}	μmol p-nitrophenol g^{-1} h^{-1}	μmol INTF g^{-1} h^{-1}	μmol p-nitrophenol g^{-1} h^{-1}
Castejón del Puente				
NT – Chesa	1.54 ± 0.14 a	1.27 ± 0.06 a	0.069 ± 0.006 a	0.602 ± 0.021 a
CT – Chesa	3.04 ± 0.37 b	1.70 ± 0.17 b	0.141 ± 0.013 b	0.709 ± 0.063 ab
NT Valley	2.88 ± 0.35 b	1.69 ± 0.04 ab	0.134 ± 0.015 b	0.776 ± 0.033 b
Pina de Ebro				
NT	10.81 ± 0.61 b	2.50 ± 0.05 b	0.104 ± 0.015 b	0.774 ± 0.043 b
CT	4.92 ± 0.10 a	1.79 ± 0.05 a	0.061 ± 0.004 a	0.520 ± 0.029 a
Sádaba				
Organic	6.67 ± 0.15 a	1.87 ± 0.02 b	0.193 ± 0.010 b	0.722 ± 0.015 b
NT	6.88 ± 0.61 a	1.42 ± 0.01 a	0.132 ± 0.002 a	0.554 ± 0.031 a
CT	8.96 ± 0.48 b	1.56 ± 0.17 ab	0.154 ± 0.016 ab	0.656 ± 0.027 b
Analysis of variance				
Treatment	< 0.001	< 0.001	< 0.001	< 0.001
Location	< 0.001	< 0.001	0.090	< 0.001

Table 1. Mean (± standard errors) of four enzyme activities of agricultural soils from three locations in the Ebro Valley (NE Spain) subjected to different agricultural practices (NT = no tillage; CT = conventional tillage). Different letters in the column within each location indicate significant differences between agricultural practices according to the Tukey's test (? < 0.05).

GT 11 - 397 - P

CROPPING SYSTEM EFFECTS ON SOIL GREENHOUSE GAS EMISSIONS IN RAINFED SEMIARID AGROECOSYSTEMS

GT 11. SOIL DEGRADATION, DESERTIFICATION, CONTAMINATION - CONSERVATION, MITIGATION, REMEDIATION / GT 03. SOIL BIOGEOCHEMISTRY & GLOBAL CHANGE

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Traditional agricultural management in the semi-arid areas of the Ebro Valley (NE Spain) is characterized by conventional tillage and long-term bare fallow, where the soil is intensively tilled. In contrast, conservation agriculture uses minimum or no-tillage practices and integrates cover crops during the fallow period. These different soil management approaches influence greenhouse gas (GHG) emissions, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Factors such as direct seeding, increased soil organic matter, improved soil conservation, or improved moisture retention associated with conservation agriculture play a key role in regulating GHG production and potentially changing emission levels. The main objective of this research was to evaluate the effect of different cropping systems based on the use of cover crops and no-tillage, to replace long-term bare tilled fallow, on soil GHG emissions. Management treatments included long-term bare fallow (BF) and two systems with cover crops, one with a vetch crop with mechanical termination (CC) and the other with spontaneous vegetation with herbicide termination (CF). Soil GHG samples were collected using the closed chamber method and measured by gas chromatography. The effect of nitrogen fertilizer application on soil GHG emissions was evaluated by analyzing how these emissions increased right after the application. Our results showed that the cumulative emissions of CO_2 and N_2O from the soil were significantly higher ($p < 0.05$) in the CC. The CO2 and N2O cumulative emissions decreased in the following order: CC > CF > BF. No significant differences were observed in soil CH_4 emissions. These preliminary results suggest that conservation agriculture practices (reduction in tillage intensity and the use of cover crops), result in greater soil emissions of CO_2 and N_2O. However, these practices could have other positive effects on other aspects of soil health.

KEYWORDS

Carbon, carbon dioxide, crops, emissions, extensive, fertilization, GHG, metane, Nitrogen, nitrous oxide, semiarid, Soil.

ACKNOWLEDGEMENTS

Proyect SintMed

GT 03 - 70 - O

ASSESSING THE EFFECT OF INTRODUCING LEGUMINOUS SPECIES ON SOIL N2O EMISSIONS UNDER IRRIGATED CONDITIONS IN THE EBRO VALLEY (NE SPAIN)

GT 03. SOIL BIOGEOCHEMISTRY & GLOBAL CHANGE / GT 11. SOIL DEGRADATION, DESERTIFICATION, CONTAMINATION - CONSERVATION, MITIGATION, REMEDIATION

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Almost 70% of global N2O emissions, a gas with a high global warming potential, are linked to the agriculture sector and mainly associated to the use of nitrogen fertilisers [1]. It is crucial to design resilient agricultural systems with lower dependencies of external inputs such as nitrogen (N) fertiliser but simultaneously decreasing soil greenhouse gas emissions (GHG). Introduction of leguminous species can provide a non-expensive source of nitrogen to the crops, reducing the higher GHG emissions related to the industrial production of synthetic nitrogen. However, their impact on soil nitrous oxide emissions under irrigated Mediterranean conditions is not well established. The objective of this study was to assess the impact of different cropping systems that included leguminous crops on N2O emissions under sprinkler irrigated conditions at the Ebro valley (NE Spain). The systems compared were: (1) monocropping (MC) long-season maize preceded with a vetch cover crop during the winter period (CC-LSM), (2) MC long-season soybean preceded with a barley cover crop during the winter period (CC-LSS), (3) double-cropping (DC) of peas with short-season maize (P-SSM), and (4) DC of barley with a short-season soybean (B-SSS). The size of the experimental plots was 18x18 m and the soil was managed by conventional tillage. The N fertiliser rates were adjusted considering the soil mineral nitrogen available before planting. Thus, a total dose of 132, 57, 237, and 223 kg N ha-1 were applied to the CC-LSM, CC-LSS, P-SSM and B-SSS, respectively. Soil N2O fluxes were periodically measured (<2 weeks) during the second rotation year, from October 2023 to October 2024 using static closed chamber technique [2]. N2O concentrations were determined by gas chromatography. Noticeable peak N2O fluxes were observed after nitrogen fertilizer applications. The accumulated emissions of N2O during the whole growing period were lower in the two MC systems of CC-LSM (1.83 kg N-N2O ha-1 year-1) and CC-LSS (2.0 kg N-N2O ha-1 year-1) compared to the two DC systems (P-SSM: 5.79 kg N-N2O ha-1 year-1; B-SSS: 5.00 kg N-N2O ha-1 year-1). No significant differences were observed in N2O emissions within MC and within DC systems. The CC-LSM presented a significant lower percentage of N2O losses relative to the nitrogen applied with the fertilizer (1.4%) compared to the CC-LSS (3.5%), but no differences were found among any other pairwise comparisons. Considering the four cropping systems, a positive, but non-lineal relationship was observed between the rate of nitrogen fertilizer and the total N2O emissions.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Crippa et al., 2024. JRC/IEA 2024 Report, Luxembourg, JRC138862.

[2] Holland et al., 1999. Standard soil methods for long-term ecological research, pp. 185-201.

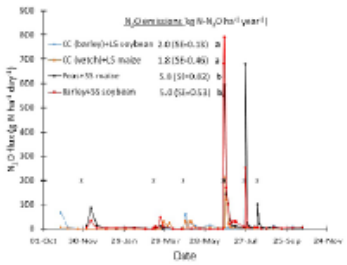

Figure 1. Evolution of daily N2O fluxes from october 2023 to October 2024 in the four cropping systems evaluated. The average cumulative N2O emissions (kg N ha-1 year-1) are presented for each system. Values followed by the same letter are not significantly different (p=0.05). The asterisks indicate the moments of nitrogen fertiliser applications.

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GT 03 - 704 - P

EVALUATING THE IMPACT OF COVER CROP AND NITROGEN APPLICATION RATE ON SOIL N_2O SMISSIONS, COMBINING AN AUTOMATIC CHAMBER SYSTEM AND THE DAYCENT MODEL.

GT 03. SOIL BIOGEOCHEMISTRY & GLOBAL CHANGE / GT 07. SOIL AMENDMENTS & FERTILIZERS

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Agricultural soils are the main source of nitrous oxide (N_2O) emissions due to various farming practices. Management practices such as adjusting nitrogen fertilizer rates or introducing cover crops, particularly legume-based mixtures during fallow periods, can improve agricultural system efficiency by reducing nitrogen losses in the form of N_2O. The objective of this study was to evaluate the impact of two agricultural practices on soil N_2O emissions: the use of cover crops and the adjustment of nitrogen fertilization rates.

An experimental trial was conducted at the Aula Dei Experimental Station (EEAD-CSIC, Zaragoza), comparing a tilled fallow (F) with a cover crop (CC) consisting of an oat-vetch mixture, and three nitrogen fertilization rates: a control (C) with 0 kg N ha^{-1}, a medium rate (M) of 150 and 200 kg N ha^{-1} for CC and F, respectively, and a high rate (H) of 350 and 400 kg N ha^{-1} for CC and F, respectively, during the maize growing season. Soil N_2O emissions were continuously monitored using an automatic chamber system. Additionally, the data collected were used to parameterize the DayCent model.

Cumulative soil N_2O emissions and yield-scaled N_2O emissions showed significant differences depending on the nitrogen fertilizer rates. In contrast, the implementation of cover crops did not have a significant impact. Similarly, neither grain yield nor the nitrogen emission factor (EF) showed significant differences between treatments. Nevertheless, it is worth noting that the EF values obtained did not exceed 0.25%, which is lower than the 1% threshold established by the IPCC. The DayCent model showed satisfactory performance in simulating soil N_2O emissions.

This study highlighted that the introduction of cover crops, combined with optimized nitrogen fertilization, are effective strategies for reducing external nitrogen inputs and N_2O emissions without compromising the viability of agricultural systems.

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GT 07 - 178 - 0

BALANCING FERTILITY AND CONTAMINATION IN THE MEDITERRANEAN: TRACE ELEMENTS AND NUTRIENT DYNAMICS UNDER 12 YEARS OF CONTRASTING SOIL MANAGEMENT

GT 07. SOIL AMENDMENTS & FERTILIZERS / GT 11. SOIL DEGRADATION, DESERTIFICATION, CONTAMINATION - CONSERVATION, MITIGATION, REMEDIATION

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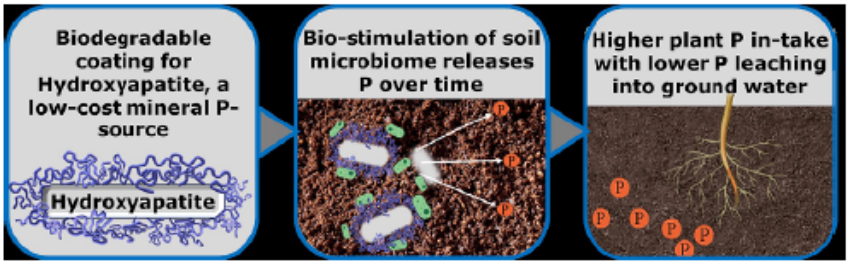
Soil health is critical for sustainable agriculture, particularly in Mediterranean calcareous soils susceptible to degradation under long-term management. This study assessed the long-term (12 years) impact of tillage (conventional vs. no-tillage), fertilization type (organic vs. mineral), and fertilization dose on soil nutrient dynamics and trace element distribution in a rainfed barley field in Monegros, NE Spain. Soil sampling was performed in the 0-5, 5-10,10-25, 25-50 and 50-75 cm soil layers. Results showed that phosphorus (P) concentrations increased significantly with higher doses of organic amendment, suggesting improved nutrient retention. Potassium (K) was more strongly affected by tillage, with consistently higher levels under no-tillage, likely due to reduced leaching and organic matter conservation. Electrical conductivity (EC) displayed no consistent pattern, though values were generally higher and more variable in conventionally tilled plots, potentially reflecting greater salt accumulation from increased mineralization. Trace elements (TMs), though beneficial for plant growth, can present environmental and human health risks. These elements may accumulate in surface layers or leach from the soil system, leading to contamination, ecotoxicity, and potential entry into the food chain. In this study, trace elements, including copper (Cu), zinc (Zn), sulfur (S), and strontium (Sr), showed a treatment effect related to fertilization, with organic fertilization and higher doses influencing their concentrations. Cu and Zn, which are strongly associated with organic matter and clay, accumulated more in the surface layers, especially under organic treatments. Sulfur and Sr exhibited more mobility, likely due to their ionic forms and affinity with calcium. In contrast, the results for tillage were less consistent, with no clear effect on trace element distribution, suggesting that tillage practices may not significantly influence the mobility or accumulation of these elements in the studied soil. Other trace elements, including lead, cadmium, and arsenic, showed no depth-related variation, indicating limited vertical movement under the studied conditions. These findings support the role of organic amendments and fertilization doses in improving soil fertility and influencing the behavior of trace elements. The element-specific responses highlight the need for tailored management strategies to optimize soil quality and mitigate potential environmental risks in Mediterranean agroecosystems.



GT 07 - 177 - P

VALORIZING BIOCHAR AS A FERTILIZER IN MEDITERRANEAN AGRICULTURE: EFFECTS ON SOIL FERTILITY, NITROGEN DYNAMICS, AND SOIL GREENHOUSE GAS EMISSIONS

GT 07. SOIL AMENDMENTS & FERTILIZERS / GT 10. SOIL CARBON DYNAMICS AND STABILIZATION

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Biochar is increasingly considered a promising amendment to improve soil fertility and reduce the environmental impacts of agriculture. This is particularly relevant in Mediterranean semiarid regions, where soils often suffer from low organic matter, limited nutrient retention, and high risk of degradation under intensive cropping systems. To explore its agronomic potential, a field experiment was established at the research farm of the Aula Dei Experimental Station (EEAD-CSIC, Zaragoza, Spain) over two wheat-growing seasons (2025–2026). The soil is a Typic Xerofluvent with silty loam texture, basic pH, low carbon and nitrogen contents, and more than 30% $CaCO_3$. The experiment consists of six treatments: control (C), mineral fertilizer only (MF), low biochar (2 t/ha, LB), medium biochar (6 t/ha, MB), and combinations LB+MF and MB+MF.

Soil nitrogen dynamics showed that MF and LB+MF treatments led to the most pronounced increases in nitrate availability, over 3 to 4 times higher than the control, indicating greater risk of leaching. Biochar-only treatments displayed more stable N profiles with lower peaks, suggesting better retention. In terms of soil greenhouse gas emissions, the MF treatment increased both CO_2 and N_2O emissions compared to the control. In contrast, the combination of medium-dose biochar with fertilizer reduced cumulative N_2O emissions by over 140% relative to MF alone, while moderating CO_2 release. These preliminary outcomes suggest that moderate biochar doses combined with mineral fertilizer may support more sustainable nitrogen management in calcareous Mediterranean soils.

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GT 09 - 62 - O

SOIL MICROBIAL BIOMASS AND ORGANIC CARBON IN AGRICULTURAL FIELDS OF THE EBRO VALLEY (NE SPAIN) UNDER DIFFERENT MANAGEMENT PRACTICES

GT 09. SOIL HEALTH / GT 04. SOIL BIOLOGY

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Inadequate agricultural management is one of the main causes of soil degradation. Soil management, use of agrochemicals and fertilisers affect the soil environment and can cause a progressive loss of soil quality. Biological and biochemical properties of the soil respond rapidly to environmental disturbances and serve as indicators of soil quality. However, these properties might be related to the soil organic carbon content, which may mask the impact of agricultural management on them. In this work, the relationships between soil organic carbon, microbial biomass and basal respiration were assessed in agricultural fields subjected to different management practices (tillage, no tillage, green covers) in Aragón. Paired plots, either tilled or managed under conservation agricultural practices including cover crops were selected in seven municipalities of Aragón: Bolea, Castejón del Puente, Épila, Muel, Pina de Ebro, Sádaba, and San Martín del Río. Crops were different in each location, including cereals, olive groves, almond and fruit orchards, and vineyards. Each plot was divided into 4 zones from which a composite sample (composed of 4 to 6 soil cores) was collected, amounting to a total of 62 samples. When gathering all data, Pearson's correlation coefficients (r) between soil organic carbon, microbial biomass and basal respiration, despite being significant, ranged between 0.36 to 0.53. When calculated on samples from field crops, they remained within the former range. However, when calculated on samples from perennial orchards, they substantially increased, ranging from 0.74 to 0.81. Clear differences in the slopes of the regression lines were detected between samples from field crops and perennial orchards (Figure 1). These results suggest that, despite the significant correlations observed, additional factors might be considered when evaluating the response of soil biochemical properties to agricultural management.

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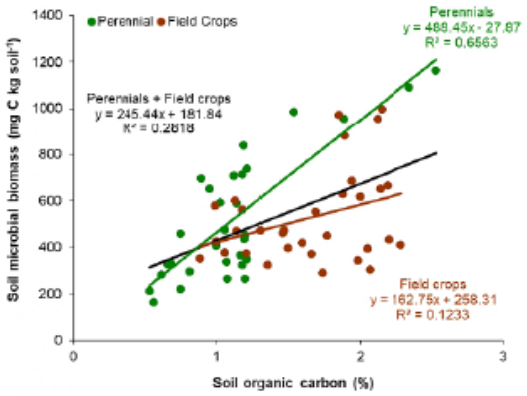

Figure 1. Relationships between soil organic carbon and microbial biomass in samples collected from field crops and perennial orchards located in Aragón (NE Spain) and subjected to different agricultural practices.

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GT 09 - 426 - O

INTERCROPPING AND BIOPESTICIDE USE IMPACT SOIL MICROBIAL, MYCORRHIZAL RESPONSES AND PLANT DAMAGE IN ORGANIC MAIZE–COTTON SYSTEMS IN WEST AFRICA

GT 09. SOIL HEALTH / GT 04. SOIL BIOLOGY

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Intensive agriculture has led to strong soil degradation and the build-up of pests and pathogens. These issues are especially critical in developing countries, where agriculture faces low profitability, climate risks, and poor access to mechanization. Intercropping, known as the cultivation of two or more crops on the same land, has shown potential to improve resource use, maintain yields, and build more resilient systems.

This research explores the agroecological benefits of intercropping cotton-maize rotations with soybean under organic management in Benin. The experiment followed a randomized complete block design with several treatments, such as soybean intercropped with maize and biopesticide applications, and focused on two main aspects: soil health and pest management. Soil health was evaluated through microbial functional diversity (MicroResp™), enzymatic activity, arbuscular mycorrhizal fungal colonization, labile carbon, soil organic carbon, and mineral nitrogen. Pest management was evaluated using the Score Davis Scale based on plant injury metrics.

Preliminary results show that, after two cropping seasons, maize-soybean intercropping improves soil microbial activity (microbial catabolic profile and enzymatic activity) compared to monocropping, especially in absence of biopesticides. However, arbuscular mycorrhizal fungal colonization increased in monocropping compared to intercropping. Biopesticides reduced mycorrhizal fungal colonization in intercropped systems, but not in monocropping. Soil organic carbon levels was higher in intercropping compared to monocropping. In addition, a negative correlation was observed between arbuscular mycorrhizal fungal colonization and plant injury: mycorrhizal fungal colonization increased as the plant injury level decreased, particularly in intercropping plots. This relationship suggests a potential role of arbuscular mycorrhizal fungi in enhancing plant protections against pests.

Further analysis on plant damage and pest pressure will help clarify the trade-off between pest management and soil health under organic management. Continued long-term research on maize-cotton intercropping will offer valuable knowledge for adapting sustainable practices to smallholder farming systems in developing countries.

GT 10 - 564 - F + P

LEGUME COVER CROPS AND NON-TILLAGE ENHANCE SOIL MICROBIAL FUNCTIONAL DIVERSITY IN A SEMI-ARID BARLEY SYSTEM UNDER SUMMER RAIN PULSES

GT 10. SOIL CARBON DYNAMICS AND STABILIZATION / GT 09. SOIL HEALTH

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Rain water pulses in semi-arid systems trigger peaks in soil microbial activity that enhance nutrient mineralization and directly influence carbon (C) cycling. Understanding how contrasting agricultural management systems in semi-arid regions respond to water pulses is essential to evaluate agroecosystems functioning and predict C dynamics.

In this study, we monitored the effects of summer rain pulses on soil microbial activity in the fallow period of contrasting barely (Hordeum vulgare) based management systems in a semi-arid region of Spain. The tested management systems included: i) a traditional cropping system with one season of barley followed by 16-18 months of tilled fallow (Barely-Tilled Fallow), ii) a no-till system of barley followed by 16-18 months of chemical fallow (Barley – Chemical Fallow) and iii) a no-till system of barely/vetch (Vicia sp.) rotation with 6 months of chemical fallow between each crop (Barley-Vetch). A randomized complete block design was used, incorporating both phases of each crop rotation simultaneously.

Microbial activity was assessed by characterizing the microbial catabolic profile using substrate induced respiration (MicroResp™) across a range of carbon substrates. Soil bacterial and fungal biomass were quantified via qPCR targeting 16S rRNA and ITS genes. Additionally, soil pore water content, available mineral nitrogen, and labile carbon fractions were analyzed.

Preliminary results revealed clear differences in soil microbial functionality across management systems. The Barely-Vetch rotation consistently showed higher substrate induced respiration particularly for labile carbon sources (glucose, citric acid, N-acetyglucosamine), indicating enhanced microbial functional diversity and resilience during summer periods. In contrast, microbial activity in the Barely-Tilled Fallow system was significantly lower, indicating reduced microbial functionality.

Our results demonstrate the detrimental effects of physical soil disturbance on microbial functional diversity, and highlight the positive influence of legume cover crops and reduced tillage on maintaining microbial functionality under fluctuating soil moisture conditions

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GT 07 - 287 - F + P

LEACHED NITRATE QUANTIFICATION IN MAIZE: MICROPLOT, PLOT AND BASIN LEVEL.

GT 07. SOIL AMENDMENTS & FERTILIZERS / GT 07. SOIL AMENDMENTS & FERTILIZERS

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Nitrogen leaching is the movement of surplus fertiliser-derived nitrogen into groundwater, representing a serious threat to water quality in irrigated agriculture [1]. Sustainable fertilisation strategies are essential to reduce nitrogen losses and minimise environmental impact [2]. Although regulations address return flows at the basin level, assessing fertilisation effects at smaller scales—plots and microplots—is crucial to understand these dynamics and extrapolate results.

This study aims to evaluate nitrate concentration and environmental impact at microplot, plot, and basin levels during an irrigated maize crop. Specific objectives include quantifying fertilisation, monitoring maize growth, estimating nitrate leaching, and identifying optimal fertilisation strategies.

The research takes place in the 2,000 ha Reguero basin (Pertusa, Huesca) focused on plots nº16 and 17 of polygon 503 (5.5 ha), where maize is cultivated. Two nitrogen fertilisation strategies are compared: pig slurry and mineral fertilisers, applied at usual and best-practice rates [3].

Given the basin's lack of previous study, it is first delimited, and the plot characterised by identifying crops and fertilisation strategies. Return flows are sampled biweekly, and nitrate concentration and electrical conductivity (EC) are measured. The plot is equipped with a drainage system (depth: 80–1500 cm), collecting leachates into the basin. These drainage flows are also characterised by the same frequency.

Microplots with different fertilisation treatments are arranged in randomized blocks with three replicates, based on five years of crop response data (NDVI). Full-Stop sensors are placed below the maize root zone and sampled weekly for EC and nitrate. Crop monitoring is performed every 2–5 days using satellite imagery (3 m pixel size) to extract NDVI.

Results allow quantification of nitrate concentrations at the three levels. However, estimating flow rates is needed to determine nutrient mass export at each scale.

REFERENCES

[3] Ahmed, S., Farida, D., Skhiri, A., 2017. A modeling approach to evaluate the impact of BMPs for minimizing the phosphorus transport under sprinkler irrigation system, in: Scientific Days of Medjerda .

[1] Jiménez, M.T., 2017. Impacto de la modernización del regadío sobre la cantidad y calidad de los retornos de riego. Doctoral Thesis, Universidad de Zaragoza, 236 p. Zaragoza.

[2] Maresma, Á., 2017. Improvement of the nitrogen fertilization in irrigated Mediterranean environments. Doctoral Thesis, Universitat de Lleida, 145 p. Lleida.