Uniwersytet Przyrodniczy w Poznaniu
ul. Wojska Polskiego 28
60-637 Poznań
tel. +48 61 848 70 93
e-mail: dziekwrl@up.poznan.pl

FACULTY OF AGRICULTURE, HORTICULTURE AND BIOTECHNOLOGY
Department of Soil Science and Microbiology

Poznań 30.06.2026

dr hab. inż. Bartłomiej Glina, Prof. UPP
Poznań University of Life Sciences
Faculty of Agriculture, Horticulture and Biotechnology
Department of Soil Science and Microbiology
ul. Szydłowska 50
60-656 Poznań

REVIEW

of the doctoral dissertation by

MSc Tianjing Ren

pt.: Factors controlling content and transformations of dissolved organic matter components in agricultural soils at field and global scales

prepared at the Department of Soil Science and Environmental Analyses, Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy,

under the scientific supervision of

dr hab. Bożena Smreczak, prof. IUNG-PIB – supervisor

dr hab. Aleksandra Ukalska-Jaruga – co-supervisor

1. Basis for the Preparation of the Review

- Letter from the Chair of the Scientific Council of the Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy, dated 22 May 2026, issued in connection with Resolution No. 18/IUNG-PIB/2026 adopted by the Scientific Council on 20 April 2026;
- A copy of the doctoral dissertation by MSc Tianjing Ren entitled Factors Controlling the Content and Transformations of Dissolved Organic Matter Components in Agricultural Soils at Field and Global Scales;
- The Act of 20 July 2018 – Law on Higher Education and Science (consolidated text: Journal of Laws of 2021, item 478).

2. Assessment of the Choice of Research Topic

The research addressed in the doctoral dissertation concerns the dynamics of dissolved organic matter (DOM) and its principal components—dissolved organic carbon (DOC), dissolved organic nitrogen (DON), and dissolved organic phosphorus (DOP)—in agricultural soils. The choice of this research topic deserves a very high assessment, both in terms of its scientific relevance and its practical significance. Dissolved organic matter is the most active and readily transformable fraction of soil organic matter, playing a key role in carbon and nutrient cycling, the functioning of soil microorganisms, and the processes responsible for carbon sequestration. At the same time, DOM is regarded as a sensitive indicator of changes occurring in the soil environment under the influence of anthropogenic and climatic factors. In the context of contemporary challenges associated with climate change, increasing nitrogen deposition, and the need to implement sustainable soil management systems, research into the mechanisms regulating the quantity and quality of DOM is of particular importance. It should be emphasized that the Doctoral Candidate has accurately identified significant research gaps in the international literature. Previous findings concerning the effects of nitrogen fertilization, climate warming, and agricultural practices on DOC and DON contents remain inconclusive. The direction of the observed changes depends on climatic conditions, soil properties, land use, and soil profile depth. The dissertation appropriately highlights the insufficient understanding of interactions among different drivers of global environmental change and the limited number of studies addressing the combined effects of climate warming, nitrogen inputs, and agricultural practices on DOM dynamics. Of particular value is the inclusion of not only quantitative changes in DOC, DON, and DOP concentrations, but also the qualitative characteristics of dissolved organic matter. The analysis of parameters such as aromaticity and degree of humification provides deeper insight into the mechanisms of organic matter transformation and enables an assessment of soil carbon stability. This approach goes beyond traditional studies focused solely on determining organic carbon content and is consistent with current research trends in soil science. The comprehensive concept of the dissertation, combining global meta-analyses with field investigations conducted within a long-term experiment, also deserves a high assessment. This approach enables both the identification of general patterns at the global scale and their verification under specific site conditions. A particularly important aspect of the study is the assessment of the vertical variability of DOM within the soil profile to a depth of 90 cm, as most available studies are limited to the surface soil layer. The dissertation therefore addresses a still insufficiently explored issue that is highly relevant to the assessment of long-term carbon stabilization and the downward transport of organic compounds within the soil profile.

In conclusion, the choice of the research topic should be regarded as fully justified, timely, and important from the perspective of both the advancement of soil science and agricultural practice. The issues addressed are aligned with the principal directions of contemporary research on the functioning of agroecosystems under conditions of global environmental change. The results obtained may provide a valuable contribution both to the development of knowledge concerning the functioning of organic matter in soils and to the improvement of sustainable soil management strategies aimed at mitigating the adverse effects of climate change.

3. Formal evaluation of the work

The doctoral dissertation of MSc Tianjing Ren was prepared in the form of a series of four scientific publications under the common title Factors Controlling the Content and Transformations of Dissolved Organic Matter Components in Agricultural Soils at Field and Global Scales. The scientific achievement submitted as the basis for the application for the doctoral degree comprises the following articles:

1. Ren, T., Smreczak, B., Ukalska-Jaruga, A., Li, X., Hassan, W., Cai, A. (2025). Differential impacts of nitrogen addition on soil dissolved organic carbon in humid and non-humid regions: A global meta-analysis. Journal of Environmental Management, 377, 124744.

2. Ren, T., Smreczak, B., Ukalska-Jaruga, A., Hassan, W., Cai, A. (2025). Asymmetric responses of soil dissolved organic carbon and dissolved organic nitrogen to warming: A meta-analysis. Catena, 252, 108871.

3. Ren, T., Ukalska-Jaruga, A., Smreczak, B., Cai, A. (2024). Dissolved organic carbon in cropland soils: A global meta-analysis of management effects. Agriculture, Ecosystems & Environment, 371, 109080.

4. Ren, T., Debaene, G., Ukalska-Jaruga, A., Smreczak, B. (2025). Depth-dependent effects of crop rotation and monoculture on dissolved organic matter quantity and quality. Frontiers in Plant Science, 16, 1668092.

The total number of points in accordance with the list of scientific journals issued by the Polish Ministry of Science and Higher Education and applicable in the year of publication of each article amounts to 640, while the combined Impact Factor is 25.9. Following positive peer review, all publications appeared in reputable scientific journals: Journal of Environmental Management, Catena, Agriculture, Ecosystems & Environment, and Frontiers in Plant Science. The articles were published between 2024 and 2025 and are co-authored works. In addition to the Doctoral Candidate, the author teams include the supervisor, Bożena Smreczak, DSc, Associate Professor at IUNG-PIB; the co-supervisor, Aleksandra Ukalska-Jaruga, DSc; and other researchers affiliated with the Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy, the Chinese Academy of Agricultural Sciences, and MNS University of Agriculture in Pakistan. In all four publications, the Candidate is both the first author and the corresponding author. The co-authors' statements clearly demonstrate that the Doctoral Candidate served as the lead author of all the publications. Her contribution included preparation of the initial manuscript drafts, revision and editing of the texts following peer review, development of the research methodology, conduct of the investigations, data analysis and validation, data visualisation, project administration, funding acquisition, and conceptualisation of the research. This extensive range of responsibilities confirms the Doctoral Candidate's leading contribution both to the preparation of the publications and to the implementation of the overall research programme.

It should also be emphasised that MSc Tianjing Ren is a co-author of a total of 15 scientific papers published in journals with an Impact Factor. According to the Web of Science database, as of 22 June 2026, the Doctoral Candidate's h-index was 8, and her publications had received 251 citations (excluding self-citations). These achievements deserve particular recognition, as they represent an impressive scientific record, especially at such an early stage of her research career.

The series of four publications constituting the scientific achievement was supplemented by a descriptive synthesis presenting the research conducted and its principal findings. The doctoral dissertation of MSc Tianjing Ren comprises 86 pages of typescript, excluding copies of the scientific publications included in the dissertation. The document contains all the elements formally required of a doctoral dissertation, including a title page, authors' declarations, a table of contents, a list of publications with the corresponding point scores according to the ministerial list, abstracts in Polish and English, an introduction, research objectives and hypotheses, materials and methods, presentation and discussion of the results, final conclusions, and a list of references.

The title of the dissertation, *Factors Controlling the Content and Transformations of Dissolved Organic Matter Components in Agricultural Soils at Field and Global Scales*, is accurate, clear, and fully reflects the scope of the research presented. The dissertation has been carefully edited and prepared in accordance with the standards applicable to this type of scientific work. The structure of the descriptive section is logical and coherent and appropriately reflects the content and findings of the publications constituting the scientific achievement.

4. Assessment of the Scientific Quality of the Doctoral Dissertation

4.1 Abstracts

The abstracts in Polish and English have been prepared correctly. They contain the key information necessary to introduce the reader to the subject of the doctoral dissertation, including the research objective, a brief description of the methodology applied, the principal results obtained, and the most important conclusions arising from the study.

4.2 Introduction

In this chapter, the Doctoral Candidate presented a broad context for research on dissolved organic matter (DOM), including dissolved organic carbon (DOC), dissolved organic nitrogen (DON), and dissolved organic phosphorus (DOP). She correctly indicated that, despite accounting for only a small proportion of the total soil organic matter pool, DOM represents its most mobile, dynamic, and biologically available fraction. She discussed its importance for microbial activity, nutrient cycling, organic carbon stabilisation, and the transport of substances from soils to aquatic systems. Particular attention was devoted to the functioning of DOM in agroecosystems and its responses to nitrogen inputs, climate warming, and agricultural practices. The Doctoral Candidate correctly noted that the direction and magnitude of changes in DOC and DON depend, among other factors, on soil moisture, temperature, nitrogen application rate, soil pH, initial organic carbon content, and soil mineral properties. The Author also considered the qualitative properties of DOM, assessed using the SUVA and E4/E6 indices, as well as the importance of deeper soil profile layers. On the basis of the literature review, the principal research gaps were correctly identified. These included the inconsistent responses of DOM to nitrogen fertilization and increasing temperature, insufficient understanding of the interactions among climatic, edaphic, and biological factors, the limited number of studies addressing DOC, DON, and DOP simultaneously, and the insufficient knowledge of DOM dynamics in deeper layers of agricultural soils. The concept of the dissertation is based on a logical, multiscale approach combining three global meta-analyses with a long-term field experiment comparing crop rotation and monoculture at depths of 0–30, 30–60, and 60–90 cm. This approach enables global patterns to be integrated with a detailed assessment of processes occurring throughout the profile of agriculturally managed soil. The main objective, specific objectives, and research hypotheses are generally coherent, logical, testable, and consistent with the identified research gaps. The chapter is based on an extensive body of literature and provides a convincing justification for the importance of the research problem addressed.

4.3 Materials and methods

The "Materials and Methods" chapter comprises two principal parts: global meta-analyses concerning the effects of nitrogen inputs, climate warming, and agricultural practices on dissolved organic matter components, and investigations conducted within a long-term field experiment. This structure is logical and consistent with the objectives of the dissertation, as it enables global patterns to be combined with an assessment of processes occurring throughout the profile of agriculturally managed soil. In the global meta-analysis section, the Doctoral Candidate described the data sources, literature search strategy, and study eligibility criteria. Searches were conducted using the Web of Science, Google Scholar, and CNKI (China National Knowledge Infrastructure) databases. Studies were included if they contained a control treatment, an appropriate number of replicates, and available measures of variability. The resulting dataset is extensive, comprising more than one thousand observations concerning the effects of nitrogen inputs on DOC, several hundred observations related to warming, and more than three thousand observations concerning agricultural practices. The size of the database represents a major strength of the dissertation. The inclusion of numerous climatic, soil, microbial, and agricultural variables, together with the application of the natural logarithm of the response ratio, regression analyses, model selection procedures, and machine-learning methods, also deserves a positive assessment. This approach enabled the Doctoral Candidate not only to determine the overall direction of changes, but also to identify the principal factors differentiating DOM responses. However, the description of the meta-analytical methods requires further clarification. The dissertation should provide complete information on the publication selection process, procedures for removing duplicates, assessment of heterogeneity, and evaluation of publication bias. The method used to account for multiple observations derived from the same publication should also be specified, as treating such observations as independent may result in pseudo replication. Further clarification is required regarding the conversion of results obtained using physical soil-solution sampling methods into values corresponding to chemical extractions.

An interesting aspect of the study is the proposed DOC efficiency index, which relates changes in DOC to changes in crop yield and CO_2 emissions. This index has potential practical value, but it requires a more detailed mathematical justification and cautious interpretation, particularly when the effect size for DOC is small or close to zero. The field investigations were conducted within a long-term experiment in Osiny, comparing crop rotation with continuous winter wheat monoculture. The collection of samples from three soil layers down to a depth of 90 cm and the determination of DOC, DON, and DOP deserve particular recognition. This approach directly addresses the limitations of the meta-analyses resulting from the predominance of studies focused on surface soil layers and the scarcity of data concerning DOP. The range of soil properties analysed was broad and appropriately selected in relation to the objectives of the dissertation. It included basic physical and chemical soil properties, nutrient contents, and DOM quality indicators such as SUVA and E4/E6. A concern arises, however, from the use of air-dried samples for DOM extraction, since drying may alter organic matter solubility and increase the release of DOC, DON, and DOP. The potential effect of this procedure should be discussed as a methodological limitation. Furthermore, for the statistical analysis of the field experiment, a model simultaneously accounting for the cropping system, soil depth, their interaction, and the block design would have been more appropriate than a one-way analysis of variance.

In conclusion, the research methodology is extensive, modern, and generally well suited to the objectives of the dissertation. Particular strengths include the size of the global database, the integration of classical meta-analysis with machine-learning methods, and the inclusion of deeper soil layers and the complete set of DOM components in the field study. The recommended additions primarily concern the transparency of the meta-analytical procedures, data standardization, the methods used to determine DON and DOP, and the selection of the statistical model.

4.4 Results and Discussion

The Author discusses here the findings of each study separately and relates them to the corresponding research objectives and hypotheses. This structure should be regarded as logical and clear, as it preserves the link between the individual stages of the research and the publications in which their results were presented. It also facilitates the assessment of the original contribution of each study to the achievement of the overall objective of the dissertation.

4.4.1 Impacts of nitrogen addition on soil dissolved organic carbon (DOC) across humid and non-humid regions – paper I

In the first study, the Doctoral Candidate assessed the effect of nitrogen addition on dissolved organic carbon (DOC) content and identified the factors differentiating its response in humid and non-humid regions. The results revealed opposing trends: in humid regions, nitrogen addition reduced DOC and microbial biomass carbon (MBC), whereas in non-humid regions it increased both parameters. Soil organic carbon (SOC) increased in both groups, although the response was stronger in humid regions. These findings support the hypothesis that the response of DOC to nitrogen inputs is conditioned by climatic factors. The most important achievement of the study is the demonstration that the effect of nitrogen on DOC depends on moisture conditions, which partly explains the inconsistencies reported in the literature. The combined analysis of DOC, SOC, and MBC also provides significant scientific value. The identification of different factors controlling the DOC response deserves a positive assessment. In humid regions, the most important factors were initial SOC content, precipitation seasonality, and soil microbial properties, whereas in non-humid regions, nitrogen application rate and water availability played a greater role. The study also demonstrated the importance of soil pH for DOC sorption, desorption, and transport. Some reservations arise, however, from the occasionally overly far-reaching interpretation of the mechanisms underlying the observed relationships. Meta-analysis can identify associations and the importance of moderators, but it does not directly confirm changes in root exudation, enzyme activity, macroaggregate formation, or mineral-associated carbon stabilization. These processes should therefore be presented as plausible explanations rather than mechanisms unequivocally demonstrated by the results. The relationship between DOC response and MBC also requires cautious interpretation, as the low coefficients of determination indicate limited explanatory power. Furthermore, although the division of the study areas into two broad moisture categories is analytically useful, it simplifies the considerable climatic, soil, and vegetation variability within each group. The results may also have been influenced by differences among biomes, methods of DOC determination, and the form, rate, and duration of nitrogen application. These limitations should be taken into account when formulating the conclusions.

4.4.2 DOC–DON response to climate warming– paper II

In this study, the Doctoral Candidate assessed the effects of experimental warming on dissolved organic carbon and nitrogen (DOC and DON) contents and on related soil processes. Warming did not significantly affect DOC or microbial biomass carbon, but reduced SOC stocks by 3.36%. At the same time, it increased DON by 8.84% and nitrate nitrogen by 13.1%, while decreasing the DOC ratio by 10.8%. A reduction in soil moisture and increases in β-glucosidase activity and soil respiration were also observed. These findings support the hypothesis that warming causes a divergence in the responses of dissolved carbon and nitrogen forms. The principal strength of the study is its comprehensive analysis of carbon and nitrogen cycling. The inclusion of SOC, mineral nitrogen, microbial biomass, stoichiometric indices, soil moisture, enzyme activity, and respiration demonstrated that the absence of a significant change in DOC does not imply an absence of changes in soil functioning. The decline in SOC and soil moisture accompanied by increased respiration may indicate accelerated carbon losses, whereas the increases in DON and nitrate may suggest greater nitrogen mobility and an increased risk of nitrogen loss through leaching or N_2O emissions. The application of boosted regression tree models deserves a positive assessment. These models explained 64% of the variability in the DOC response and 76% of the variability in the DON response. Soil moisture was the most important predictor of DOC, whereas nitrate nitrogen content was the principal predictor of DON. The results indicate that the effect of temperature on DOM is modified by water availability and the availability of mineral nitrogen forms. Some reservations arise from the occasionally overly causal interpretation of the observed relationships. BRT models and regression analyses identify covariation and the relative importance of predictors, but they do not demonstrate that changes in soil moisture directly cause the divergence between DOC and DON dynamics. Similarly, the unchanged DOC content was attributed to simultaneous increases in its production and consumption, while the increase in DON was explained by reduced decomposition, although these processes were not measured directly. Alternative mechanisms should therefore also be considered, including changes in DOM release, uptake by plants and microorganisms, and sorption. The relationships between the DOC ratio and ammonium and nitrate nitrogen contents also require cautious interpretation, as the coefficients of determination of 0.07 and 0.12 indicate limited explanatory power. Another limitation is the unequal number of observations available for the individual parameters. The paper II provides important information on the contrasting responses of DOC and DON to warming. Its main achievement is the demonstration that warming may alter DOM stoichiometry and increase nitrogen mobility despite the absence of a significant change in DOC, as well as the identification of soil moisture and nitrate content as the main moderators of these responses. Despite the interpretative and editorial limitations, the study should be assessed positively.

4.4.3 Effects of agriculture management practices on soil DOC – paper III

In the third study, the Doctoral Candidate compared the effects of seven agricultural practices on dissolved organic carbon (DOC) content, the DOC-to-SOC ratio, crop yield, and CO_2 emissions. The analysis included nitrogen fertilization, the application of straw, manure, and biochar, the combined application of nitrogen with straw or manure, and conservation tillage. All the practices increased DOC content, with the strongest effect observed for the combined application of nitrogen and manure, followed by manure alone and nitrogen applied together with straw. The principal strength of the study is its comprehensive comparison of practices differing in the manner in which carbon and nitrogen are supplied and in the degree of soil disturbance. The results indicate that the combined application of mineral and organic nutrient sources may increase DOC more strongly than their separate application. The simultaneous analysis of DOC and its proportion in SOC also provides considerable scientific value. It demonstrated that biochar increased DOC content but reduced its share in total soil carbon stocks, which may indicate a greater accumulation of more stable forms of organic matter. This interpretation should, however, be treated with caution, as carbon stabilization was not measured directly. The identification of the importance of treatment intensity and duration also deserves a positive assessment. Treatment intensity was the principal factor differentiating the DOC response to manure, nitrogen combined with manure, and biochar, whereas experiment duration was more important for nitrogen fertilization, straw application, nitrogen combined with straw, and conservation tillage. An original aspect of the study is the examination of relationships between changes in DOC, crop yield, and CO_2 emissions. All the agricultural practices increased crop yields, while most fertilization treatments also increased CO_2 emissions. The results therefore indicate that an increase in DOC may support soil productivity but may simultaneously be associated with intensified mineralization and carbon losses. However, directly attributing increases in crop yield to changes in DOC is debatable, since improved nitrogen availability may be the predominant factor following nitrogen fertilization. Similarly, the correlation between DOC and CO_2 emissions does not demonstrate a causal relationship, as both parameters may respond independently to an increased input of organic matter. The combined application of nitrogen and manure produced the greatest increases in DOC and crop yield, whereas conservation tillage resulted in the smallest increase in DOC. In my opinion, the limitations of the study include the uneven size of the datasets, particularly the relatively small number of studies concerning CO_2 emissions, as well as considerable variation in climatic and soil conditions, application rates, and experiment duration. Nevertheless, paper III constitutes a valuable and practically relevant component of the dissertation. Its principal achievement is the comprehensive comparison of agricultural practices and the demonstration of the particular effectiveness of the combined application of nitrogen and manure. Despite the interpretative and methodological limitations, the study should be assessed positively.

4.4.4 Effects of crop rotation vs monoculture and soil depth on DOMC – paper IV

In this study, the effects of the cropping system and soil profile depth on the quantity and properties of dissolved organic matter were evaluated. The investigation included DOC, DON, and DOP in the 0-30, 30-60, and 60-90 cm soil layers under crop rotation and long-term continuous winter wheat monoculture. The principal strength of the study is the simultaneous consideration of all three DOM components and soil layers extending to a depth of 90 cm. A marked decline in DOC, DON, and DOP with increasing depth was observed, indicating that position within the soil profile had a stronger influence on DOM distribution than the cropping system. The increase in $SUVA_{280}$ and decrease in E4/E6 may indicate a greater proportion of aromatic and humified compounds in the deeper soil layers. These findings highlight the importance of the subsoil as a zone of DOM transport and retention. The analysis of the relationships among carbon, nitrogen, and phosphorus cycling also deserves a positive assessment. However, the results of the random forest models should be interpreted with caution because of the limited number of samples and the associated risk of model overfitting. A significant difference between crop rotation and monoculture was found only for DOC in the 60-90 cm layer, whereas DON and DOP did not differ between the cropping systems. The research hypothesis was therefore supported with respect to the dominant role of soil depth, but only partially with regard to the effect of the cropping system. The higher DOC content in the deepest layer under monoculture cannot be attributed unequivocally to slower decomposition, reduced aggregate stability, or enhanced DOC transport, as these processes were not measured directly. Other possible explanations include differences in root distribution, preferential flow, and the mineral properties of the subsoil. The interpretation of SUVA, E4/E6, and VIS–NIR spectra also requires caution, as these are indirect indicators and do not provide unequivocal evidence of DOM molecular structure or stability. The discussion should also acknowledge the limited number of replicates and the absence of a direct statistical test of the interaction between soil depth and cropping system. Nevertheless, the study constitutes a valuable and original component of the dissertation. Its main achievement is the demonstration of the dominant role of soil depth in shaping DOC, DON, and DOP and the inclusion of poorly investigated subsoil layers.

4.5 Summary and Conclusions

In this chapter, the Doctoral Candidate provided a synthetic summary of the principal findings of the four studies constituting the dissertation. The structure of the chapter follows the successive research themes, including the effects of nitrogen inputs, climate warming, and agricultural practices on dissolved organic matter, as well as the significance of the cropping system and soil profile depth. This organization should be regarded as logical and consistent with the objectives of the dissertation. The Author supplemented the text with numerous figures that clearly summarize the results, illustrate the principal relationships, and facilitate an understanding of the connections among the individual parts of the dissertation. The conclusions are concise, logically linked to the four studies, and accurately reflect the main findings of the research. In their present form, however, some of the conclusions present the underlying mechanisms too categorically, even though these mechanisms were not measured directly but were inferred from statistical relationships and the available literature.

4.6 Limitations and future directions

A particular strength of this chapter is the direct linkage between the limitations of the meta-analyses and those of the field experiment. The issues identified the scarcity of data on DOP, the predominance of studies focused on surface soil layers, methodological heterogeneity in DOM determination, the prevalence of single-factor experiments, the use of only one field study location, reliance on optical indices, and the lack of seasonal sampling—are indeed among the most important factors limiting the scope and generalizability of the conclusions. The proposed directions for future research are also appropriately selected.

4.7 References

The reference list comprises 143 publications. The vast majority of the cited literature was published within the last 10-20 years, confirming the timeliness and relevance of the research undertaken by the Doctoral Candidate. Moreover, the broad scope of the literature reviewed demonstrates her extensive familiarity with the subject and a thorough analysis of the current state of knowledge in the field.

5. Discussion Points and Critical Remarks

A careful examination of the dissertation gave rise to the following questions and discussion points and critical remarks:

1. In some cases, the databases included multiple observations derived from the same publication or experiment. Please explain how the dependence among such observations was accounted for and how the risk of pseudoreplication was minimised. Could the use of a hierarchical meta-analytic model, with publication or experiment included as a random effect, affect the estimated mean effect sizes and the width of the confidence intervals?

2. The meta-analyses combined results obtained from soil solution collected using physical sampling methods with those obtained through water or salt extractions. Please explain the basis for converting these results to a common scale and assess whether this procedure may have introduced systematic bias. Can DOC concentration in the soil solution and the amount of extractable organic carbon be regarded as directly comparable measures of the same carbon pool?

3. In the discussion, some statistical relationships were interpreted as confirming specific mechanisms, including carbon stabilisation in mineral-associated organic carbon (MAOC), accelerated DOC turnover, reduced heterotrophic NH_4^+ uptake, and enhanced nitrification. Please indicate which of these processes were directly demonstrated by the results and which represent only plausible interpretations based on the literature.

4. The division into humid and non-humid regions revealed contrasting responses of DOC to nitrogen inputs, but it also simplifies the considerable climatic, edaphic, and biological variability of the ecosystems analysed. Please assess the extent to which the observed differences were actually attributable to moisture conditions and the extent to which they may have resulted from differences in the representation of biomes, soil types, vegetation, and the forms and application rates of nitrogen.

5. Soil moisture was identified as the most important factor controlling the response of DOC to warming. Please explain whether this result allows soil moisture to be regarded as a mediating mechanism or merely as the most important statistical predictor. Could mediation analysis or experiments in which temperature and moisture are controlled independently alter the interpretation of the results?

6. The original index linking changes in DOC with changes in crop yield and CO_2 emissions is an interesting aspect of the study, but its values may become unstable when the DOC effect is small or changes sign. Please explain the mathematical and biological basis of this index. Does a negative value

actually indicate a reduction in CO_2 emissions, or does it merely indicate a smaller relative increase in emissions compared with the increase in DOC? How could the uncertainty associated with this index be quantified?

7. The field experiment included two cropping systems, three soil depths, and a block design, with samples from different depths collected from the same plots. Please justify the use of one-way analysis of variance. Would a mixed-effects model accounting for the cropping system, soil depth, their interaction, and block effects not have been more appropriate?

8. DOM was extracted from air-dried samples over a period of 24 hours. Drying may cause microbial cell lysis and increase the release of DOC, DON, and DOP, whereas prolonged extraction may allow further biological transformations to occur. Please assess the extent to which the values obtained reflect actual DOM concentrations in fresh soil and the extent to which they represent an operationally defined extractable fraction.

9. An increase in $SUVA_{280}$ and a decrease in E4/E6 were interpreted as indicating increased DOM aromaticity, humification, molecular size, and stability. Please specify which of these properties can be reliably inferred from optical indices and which would require advanced molecular analyses.

10. The field study was conducted at a single location and involved only one sampling campaign, while a significant effect of the cropping system was found only for DOC in the 60-90 cm soil layer. Please assess the extent to which broader recommendations concerning monoculture, crop rotation, and subsoil management are justified. How should the next stage of the research be designed to verify these relationships under different climatic and soil conditions and to account for seasonality, hydrological events, and actual DOM fluxes?

6. Final Assessment and Recommendation

The comments presented in this review do not undermine the substantive value of the doctoral dissertation submitted by MSc Tianjing Ren and are intended primarily as points for discussion. The evaluated series of publications is scientifically interesting and is characterized by a comprehensive approach to the research problem. The Author has fully achieved the objectives formulated in the dissertation and has presented original conclusions. Pursuant to Article 187 of the Act of 20 July 2018 – Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended), a doctoral dissertation should constitute an original solution to a scientific problem and demonstrate the Candidate's general theoretical knowledge in the relevant scientific discipline, as well as the ability to conduct independent research. I conclude that the submitted doctoral dissertation demonstrates that the Doctoral Candidate has acquired the scientific research skills required at this stage of academic development. **The dissertation fulfils the requirements applicable to doctoral dissertations under the above-mentioned Act and therefore qualifies the Candidate for the award of the doctoral degree in the field of Agricultural Sciences, in the discipline of Agriculture and Horticulture.** I therefore request that the Scientific Council of the Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy admit MSc Tianjing Ren to the subsequent stages of the proceedings for the award of the doctoral degree.

In view of the high scientific quality of the dissertation, its significant contribution to knowledge, the originality of the research problem, the methodological soundness of the study, and the Author's substantial contribution to the advancement of the discipline, I also request that the Scientific Council of the Institute of Soil Science and Plant Cultivation – State Research Institute in Puławy award the submitted doctoral dissertation with distinction.

Poznań, dnia 30 czerwiec 2026 r.

prof. UPP dr hab.
Bartłomiej Glina