ORG Project Details

Award Year 2024

5 Research Projects

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Asd Weed Manage - Anaerobic Soil Disinfestation Weed Management for a Successful Transition to Organic Specialty Crop Production

Contract / Grant No.	2024-51106-43166
Grant Year	2024
Investigator(s)	Francesco DiGioia
Performing Institution	Pennsylvania State University

NON-TECHNICAL SUMMARY

Weeds are among the major factors limiting yield in organic vegetable and other horticultural crop systems and their management is particularly challenging in organic crops. The lack of effective biological weed management solutions is a major obstacle to the adoption of organic farming practices and represents a key limitation to the expansion of the industry despite the continuous growth of the U.S. organic market.Anaerobic Soil Disinfestation (ASD) is emerging as a broad-spectrum biological soil treatment for the management of soilborne pests and pathogens, including weeds. Anaerobic Soil Disinfestation also known as Biological Soil Disinfestation is a microbial-driven process based on the use of organic amendments.Integrated a series of research and extension activities, the primary goal of this project is to increase the profitability and sustainability of organic vegetable and other specialty crop production systems and to facilitate the transition from conventional to organic production practices by optimizing and integrating the use of Anaerobic Soil Disinfestation as a biological weed management tactic in specialty crops systems, while promoting soil health.Coordinated research activities and on-farm demonstration trials will be conducted to optimize and integrate Anaerobic Soil Disinfestation into organic specialty crop systems and evaluate the efficacy of ASD in suppressing key weed species in Florida and Pennsylvania, two states representative of the U.S. Northeast and Southeast regions.Besides assessing the efficacy of Anaerobic Soil Disinfestation in suppressing specific weeds, the project will allow us to investigate the impact of ASD on the soil-plant nutrient dynamics and investigate the mechanism of suppression examining the impact of the treatment on the soil microbiome. To ensure the viability of ASD we will assess its economic sustainability and will assess any obstacle to the adoption of this new biological solution. The research-based knowledge generated through the project on ASD will be disseminated via local, regional, and national level Extension activities (on-farm demonstrations, field days, presentations at growers\' meetings, in-service training, seminars, webinars), along with the publication of educational material (fact-sheets, newsletters, magazine, and research articles), contributing to the transfer of ASD principals and practical application to organic specialty crop growers as a sustainable weed management strategy.

OBJECTIVES

The primary project goal is to increase the profitability and sustainability of organic specialty crop production systems and to facilitate the transition from conventional to organic production practices by optimizing and integrating the use of Anaerobic Soil Disinfestation (ASD) as a biological weed management tactic in specialty crops systemswhile promoting soil health.The specific objectives proposed are to:1) Optimize and evaluate the efficacy of ASD as a biological solution for the management of weeds in organic and transitioning to organic specialty crops systems representative of the U.S. Northeast and Southeast.2) Evaluate the impact of ASD applied using alternative organic amendments on soil ecology and microbiome dynamics and seed-associated microbiome in organic and transitioning to organic specialty crops systems examining the effect on nutrient dynamics and overall soil health.3) Investigate the mechanism of weed suppression using targeted and non-targeted soil metabolomic analysis techniques.4) Evaluate the economic viability and identify barriers to the adoption and integration of ASD in organic and transitioning to organic specialty crop systems.5) Conduct on-farm ASD demonstrations for weed management and a range of outreach activities employing multiple extension delivery methods to transfer science-based knowledge on ASD and promote its adoption for the management of weeds while promoting soil health in organic and transitioning to organic specialty crop systems.

APPROACH

Coordinated research and on-farm demonstration trials will be conducted to optimize and integrate Anaerobic Soil Disinfestation (ASD) into organic specialty crop systems and evaluate the efficacy of ASD in suppressing key weed species in Florida and Pennsylvania, two states representative of the U.S. Northeast and Southeast region.A set of trials will be conducted under controlled environment, protected environment, and field conditions. A coordinated pot-in-pot study will be conducted under controlled environmental conditions following the same protocol in PA (at the Penn State Greenhouse Facilities) and FL (at the US Horticultural Research Laboratory Greenhouse Facilities). Using soils representative of each state (sandy for FL and heavier/clayey soil for PA) and targeting weed species that represent critical issues in each state (including some that are an issue in both states), alternative C sources characterized by different C:N ratios like sugarcane molasses, wheat middlings, spent brewery grain, or soybean meal will be tested and applied at different rates to assess their efficacy in suppressing different weed species under controlled conditions in comparison to the untreated control.A field study will be conducted at the Penn State Russell E. Larson Agricultural Research Center at Rock Springs, PA to compare the effect of selected ASD treatments on \"organic certified\" and \"conventional land transitioning to organic production\" side-by-side under the same environmental conditions. The field ASD treatment application will be conducted in the spring season on raised beds testing the best two treatments identified through the pot study, combined or not with over-wintering cover crop residues of 2-3 species (including species like triticale, crimson clover, snow pea, canola, or daikon radish) mix. An untreated control and cover crop by itself, will be compared to the ASD treatments on organic and conventional land transitioning to organic production. This study will allow us to evaluate the efficacy of ASD against spring weeds.A high tunnel study will be conducted at the Penn State Russell E. Larson Agricultural Research Center at Rock Springs, PA to compare the effect of selected organic amendments characterized by different C:N ratios as ASD C sources on \"organic certified\" land. The high tunnel ASD study will be conducted in the fall with a flat-bed application, using a silage tarp as TIF, to test the efficacy of the ASD treatment on fall/winter weeds in a fall/winter cropping system.For all the studies weed seed decay over time under different ASD treatments with the mesh bag method. In this method, a known quantity of weed propagules is placed inside polyethylene mesh bags mixed with the media of interest and then buried with soil. After pre-determined time intervals, the propagules will be recovered to quantify decay.The impact of ASD on soil and weed seed-associated microbial communities will be assessed in samples from each trial. These assessments will be carried out for each experiment to profile changes in soil microbial communities (microbiome) across ASD treatments. Data on the soil microbiome will be correlated with the respective soil environmental parameters and nutrient data across systems and locations. For the same studies, we will evaluate the effects of the ASD treatment on the nutrient dynamics. Plant growth will be monitored and at harvest, biometric assessments will be conducted measuring yield and quality components. Fresh and dry biomasswill be measured along with leaf area and dry matter content. Oven-dried samples will be milled and analyzed for their mineral profile (P, K, Ca, Mg, S, Na, Fe, B, Cu, Mn, Zn) and total N.To better understand the role that known and other unknown metabolites generated during the ASD treatment may play in the suppression of weeds, starting in the second year of the project, samples of soil collected from the pot-in-pot experiments will be analyzed for the content of organic acids, volatile organic compounds (VOCs) and other potentially unknown metabolites using chromatography and mass spectrometry techniques as well as Nuclear Magnetic Resonance (NMR) spectroscopy.Standard enterprise budget templates will be used to collect yield data, produce sale prices, and standard production costs along with costs associated with ASD from open field and high tunnel experiments.The research-based knowledge generated through the project on ASD will be disseminated via local, regional, and national level Extension activities (on-farm demonstrations, field days, presentations at growers\' meetings, in-service training, seminars, webinars), along with the publication of educational material (fact-sheets, newsletters, magazine, and research articles), contributing to the transfer of ASD principals and practical application to organic specialty crop growers as a sustainable weed management strategy.An external evaluation of the results and outcomes of the project activities will be solicited through the grower\'s surveys on the occasion of workshops, presentations, and webinars. Once the project is funded, a project Advisory Board will be formed including at least one organic grower, one extension educator, and a representative of the professional grower associations or private industry who will be invited to one of the monthly meetings to discuss the yearly progress of the project and receive feedback on the work done and the activities planned. The success of the project will be evaluated also considering: i) the number of research goals achieved and the number of peer-reviewed publications produced for the Research component; ii) the number of Extension articles, presentations, and activities generated/conducted through the project and the number of downloads/participants recorded for the Extension component; and iii) the number of undergraduate and graduate students trained/exposed to the project and the number of guest lectures and outreach activities conducted for the Education component of the project. -- -- -- --------- -- --

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Harnessing the Power of Suppressive Soils to Manage Root-knot Nematodes in Organic Vegetable Production

Contract / Grant No.	2024-51106-43054
Grant Year	2024
Investigator(s)	Lei Zhang
Performing Institution	Purdue University

NON-TECHNICAL SUMMARY

The increasing demand for organic foods in the US is creating an opportunity for conventional vegetable growers to transition to organic production. However, pests and diseases are major barriers for transitioning growers since chemical pesticides are no longer options for pest management on transitioning and organic farms. Root-knot nematodes (RKN; Meloidogyne spp.) are among the critical yield-limiting pests of conventional and organic vegetable production in the US and around the world. When RKN populations reach damaging levels in fields, effective management approaches become imperative. However, as RKN continues to spread under the changing climate and emerging virulent RKN populations overcome host resistance, lack of effective methods for managing RKN post a significant barrier during transition to organic vegetable farming. This project focuses on research and extension activities to explore suppressive soils as a resource for growers to manage RKN in organic vegetable farming by (1) identifying suppressive soils against RKN at organic vegetable farms in Indiana and Kentucky and assessing the impacts of soil management practices on suppression via closely working with growers; (2) investigating microbial communities of representative suppressive soils to identify groups of microbes associated with RKN-suppressiveness. The microbes identified may serve as bioindicators of RKN suppressiveness of soils; (3) developing grower-friendly procedures to create RKN-suppressive soils by scaling up the identified suppressive soils or through de novo methods; (4) developing a new method for managing RKN in organic vegetable farming by transplantation with suppressive soils; (5) creating a knowledge-generating and sharing platform as a hub to guide growers for effective RKN management. With the collaborations between Purdue University, University of Kentucky, growers, conservation groups, organic industry, and other stakeholders, the multidisciplinary team aims to provide vital assistance to transitioning and organic vegetable growers with effective RKN management strategies and practices to facilitate smooth transition and successful organic vegetable production.

OBJECTIVES

The long-term goal of the project is to manage root-knot nematodes (RKN) by optimizing soil management in transitioning and organic vegetable farming. This project will conduct both research and extension activities to discover suppressive soils against RKN and explore suppressive soils as a resource for growers to manage RKN in organic vegetable production. Specific objectives include: 1. Exploring suppressive soils against RKN at organic vegetable farms and assessing the impacts of soil management practices on suppression; 2. Investigating microbial communities of suppressive soils to identify groups of microbes associated with RKN-suppressiveness; 3. Creating RKN-suppressive soils by scaling up the identified suppressive soils and through de novo methods; 4. Developing a new method for managing RKN in organic vegetable production by transplanting with suppressive soils; and 5. Creating a knowledge-generating and sharing platform among organic vegetable growers and the scientific community.

APPROACH

Objective 1: Exploring suppressive soils against RKN at organic vegetable farms and assessing the impacts of soil management practices on suppression. We aim to collect soil samples on \~ 100 organic and transitioning vegetable farms, including open fields and high tunnels, in Indiana and Kentucky, approximately 50 farms in each state to identify soils with natural suppression against RKN in Year 1. In Years 2 and 3, representative farms with suppressive soils identified in Year 1 will be followed up to monitor the changes in soil suppression efficacy against RKN. The presence of RKN species and population density will also be checked and documented for each soil sample collected. We will collect and analyze soil properties and farm management information. We aim to identify soil properties and/or management practices that are significantly correlated with soil suppressiveness to RKN. The plant-parasitic nematode report and results of soil suppressiveness against RKN will be shared to each participating grower. Objective 2: We aim to identify core groups of microbes associated with RKN suppressive soils. These core microbe groups will be used as indicators of soil suppressiveness on RKN during this project. We will select 18 representative suppressive soils identified in Obj. 1 based on efficacy on RKN suppression, soil texture, and years the soils have been in organic management. Similar criteria except for RKN suppressiveness will be used to select 6 conducive soils as controls for microbiome analysis. For each soil or nematode sample, DNA will be extracted and 16S and ITS-amplicon metagenomic sequencing will be carried out o to study bacterial and fungal communities, respectively. Alpha and Beta diversity analyses, and comparative analyses, including differential abundance and core microbiome analysis to identify the groups of bacteria and/or fungi that are specifically present or highly associated with the suppressive soil samples. We will study the dynamic changes of microbiome in suppressive soils in Year-2 and 3 to confirm the association of core microbes identified with RKN suppressiveness. Objective 3: We propose to create RKN-suppressive soils by scaling up the identified suppressive soils (Obj. 3.1) and through de novo methods (Obj. 3.2). Obj. 3.1: based on the preliminary data, our hypothesis is that by mixing identified suppressive soils from organic farms with the widely available conducive soils on organic farms and nurturing the microbial growth in the mix, the mixed soil can develop suppressiveness and increase in volumes of suppressive soils. We will test the effects of factors, including soil mix ratio, moisture, temperature, incubation timing and organic matter amendments, on scale-up of RKN suppressive soils. Obj. 3.2: We aim to learn from organic vegetable growers who have successfully built suppressive soils against RKN and translate their knowledge to optimized protocols, which will help more transitioning and organic growers to manage RKN. We will learn from farmers and apply results generated from Obj. 1 to develop 2-3 protocols representing typical organic vegetable farming scenarios (open-field vegetable production, monoculture high tunnel tomato production and four-season high tunnel production, etc.). We will follow the protocols and test the effectiveness of converting conductive soils to suppressive soils. The experiment will be conducted at Purdue SWPAC organic field, organic or transitional vegetable farms with RKN-conductive soils in Indiana. The two procedures, scaling-up and de no creation, will provide transitioning and organic vegetable growers ways to develop suppressive soils to manage RKN and potentially other plant-parasitic nematodes on their farms. Objective 4: We propose to develop and validate a new method for managing RKN in organic vegetable production by transplanting with suppressive soils. The vertical distributions of RKN in soil were mainly found in the top 30-cm soils in fields during growing seasons. Our hypothesis is that providing a protective zone to vegetable plant roots in this depth by transplanting with suppressive soils can reduce RKN infection of roots and therefore yield losses. In addition, plant roots grown laterally out of the protective zones may be protected by the beneficial rhizomicrobes originally in the suppressive soils which can propagate along developing roots to the outside of the suppressive soil zone. We will test the hypotheses by conducting experiments in greenhouse at Purdue University to optimize the transplanting method and further conducting on-farm trials in Kentucky to validate the efficacies of the methods on reducing RKN infection and alleviating yield losses. We expect that the optimized vegetable seedling transplanting with suppressive soil can provide effective protection of vegetable plants from RKN infections. Objective 5: Creating a knowledge-generating and sharing platform among organic vegetable growers and the scientific community. This project aims to enhance the understanding and utilization of natural suppressive soils in the management of RKN. Organic vegetable growers play pivotal roles in advancing this knowledge and will be encouraged to join the Extension members of the team to facilitate the dissemination of project findings to a broader audience. The project outcomes will be communicated to the broader farming community through various Extension platforms, including field days, presentations at farmers\' conferences, articles in Extension newsletters and popular media. Additionally, we will produce videos and audio content and contribute to both existing and newly developed farmers\' webinars and podcasts. The Purdue Nematology Lab website (https://ag.purdue.edu/department/btny/labs/zhang/index.html) will serve as the central information hub for this project, providing timely updates on project activities and disseminating new findings.Evaluation Plan: Research performance of the project will be evaluated by publishing research findings as peer-reviewed journal articles, extension publications and informative articles on websites. The number of times that the information is accessed or downloaded, and citations of journal articles will be monitored. For Obj.1, we will monitor the number of growers interacted and soil samples collected, and suppressive soils against RKN identified during the project. Obj. 2, we will monitor the number of suppressive soils included in the soil microbiome analysis, and the diversity and core microbes identified in representative suppressive soils. Obj. 3, the success rates of creating suppressive soils by scale-up and de novo methods will be closely monitored, and optimizations will be made when necessary. Obj. 4, efficacies of RKN management by vegetable transplanting with suppressive soils will be monitored. We will actively involve growers and stakeholders in the four research objectives to build connections which are important for the extension activities

we will conduct. -- --

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Tapping the Potential of Double Cropping for Profitable Organic Grain and Forage Production in the Southeast Us

Contract / Grant No.	2024-51106-43053
Grant Year	2024
Investigator(s)	Sindhu Jagadamma
Performing Institution	University of Tennessee

NON-TECHNICAL SUMMARY

Increasing organic grain and forage production is crucial to meet the escalating demand for these products for human and animal consumption. However, organic systems typically experience multiple production challenges that lower yields compared to non-organic counterparts, with a larger yield gap for field grain crops. Although acreage under organic field grain crops is increasing, domestic production remains insufficient to meet consumer demand. Sustainable intensification of existing organic production systems is thus needed. Double cropping, harvesting two crops from the same land in one year, can help decrease the gap between market demand and domestic production. The long growing season of the southeastern U.S. provides favorable conditions for double cropping, which is already practiced by conventional producers and many transitioning producers in this region. Stakeholders have expressed interest in implementing this yield-boosting strategy in organic systems. Using a system approach, we will evaluate multi-tactic organic double-crop strategies (growing a winter grain/forage crop before soybean) relative to full-season soybeans in Tennessee and Florida, which have distinct climate and soil types. We will test several rotational options as well as residue and weed management techniques to optimize production (grain and forage yield and quality), weed pressure, nematode occurrence (specifically in Florida), profitability, nutrient cycling, soil carbon accumulation, and soil health. The research outcomes will be shared with stakeholders through comprehensive extension and education programs at both locations.

OBJECTIVES

Objective 11a: Compare the effect of different double-crop systems relative to single-crop systems on grain and forage yield and nutrient uptake, forage nutritive value, and weed pressure.1b: Within each system, compare the effect of different residue and weed management methods on grain and forage yield and nutrient uptake, forage nutritive value, and weed pressure.Objective 22a: Quantify the impact of different double-crop systems relative to single-crop systems on soil physical, chemical, and biological health metrics with a special emphasis on nutrient cycling, soil organic carbon dynamics, and nematode communities.2b: Within each system, quantify the impact of different residue and weed management methods on soil physical, chemical, and biological health metrics with a special emphasis on nutrient cycling, soil organic carbon dynamics, and nematode communities.Objective 33a: Conduct a comparative economic analysis to compare profitability among full-season and DC systems and between grain and forage-based DC systems3b: Assess the production, marketing, and financial risk management tools available to organic crop producers.Objective 4Integrate the knowledge and experience generated from intensified row crop systems into Extension and education programs that aim to improve producers\' awareness and adoption of organic double-cropping in row crop systems.

APPROACH

We will conduct a 3-year field experiment on certified organic lands at two locations: Knoxville, TN and Citra, FL. We will test slightly different crop rotation treatments in each location to align with the differences in biophysical conditions (climate and soils), growing period, stakeholder preference, and marketing opportunities. There will be five rotation treatments in each location, which will include two full-season soybean and three DC soybean systems. Each treatment will have a summer crop rotation of single/DC soybean-corn-single/DC soybean. The winter crop choice preceding single/DC soybean includes rye and wheat, and barley as cover crops, wheat and barley for grain, and wheat and barley for forage, depending on the study location and rotational treatments. Each rotational treatment plot will be split into two subplot treatments to test two different residue and weed management goals: Subplot 1 for maximizing production by managing weeds with aggressive tillage and Subplot 2 for enhancing SOC accrual and soil health by reducing physical soil disturbance. Cover crops before corn was also varied to provide more N in Subplot 1 and more C inputs in Subplot 2. We will evaluate changes in grain yield and nutrient uptake between full-season and double crop soybean systems as well as between two residue and weed management strategies within each system. We will also quantify the forage yield and nutritive value, and weed pressure from treatments in which forage production was incorporated. Soil samples will be collected from both sites on a biannual basis for three years from 0-10 and 10-30 cm depths. The samples will be analyzed for nutrient availability, soil organic carbon accumulation, nematode population, and overall soil health. We will collect all the necessary data to conduct an economic evaluation of the tested practices in years 3 and 4. A comprehensive Extension and education program will be implemented to disseminate the research experiences and knowledge to a wide range of audiences.

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Developing Guidelines for Organic Grain Growers to Manage Soil Health and Mitigate Climate Change Impacts

Contract / Grant No.	2024-51106-43044
Grant Year	2024
Investigator(s)	Xia Zhu-Barker
Performing Institution	University of Wisconsin

NON-TECHNICAL SUMMARY

Facilitating the transition to organic farming and its sustainability in Wisconsin requires developing tailored soil health management practices (SHMPs) guidelines that can help organic farmers to improve nutrient use efficiency, increase crop yield potential, and mitigate climate change impacts like drought. In this project, we aim to leverage a comprehensive statewide soil health dataset, enhanced by new field observations, remote sensing data, and advanced machine learning models, to create a web tool offering region- and field-specific SHMPs guidelines for direct use by organic grain farmers in managing soil health and ensuring climate-resilient farming. Our specific objectives include (i) conducting state-wide sampling campaigns to assess soil health parameters, soil nitrogen mineralization rate, nitrogen use efficiency, crop climate-stress resilience, and yield under SHMPs, (ii) developing and validating farm-scale machine learning models to estimate crop yield dynamics under SHMPs, (iii) developing and validating farm-scale machine learning models to estimate changes in soil health parameters under SHMPs, and (iv) delivering SHMPs guidelines and corresponding nutrient management recommendations to organic farmers through a web tool that visualizes model outcomes and integrates existing resources. The results of this project will be disseminated to stakeholders and scientific professionals through extension activities and publications.Our interdisciplinary team, in partnership with extension specialists, soil conservation groups, and the organic farming community, is committed to providing region- and field-specific soil management guidance. This project is directly aligned with the program priorities, aiming to improve the productivity, ecosystem services, and profitability of Wisconsin\'s organic farms while preparing them for a changing climate.

OBJECTIVES

In this project, we aim to leverage a comprehensive statewide soil health dataset, enhanced by new field observations, remote sensing data, and advanced machine learning models, to create a web tool offering region- and field-specific SHMPs guidelines for direct use by organic grain farmers in managing soil health and ensuring climate-resilient farming. Our specific objectives include (i) conducting state-wide sampling campaigns to assess soil health parameters, soil nitrogen mineralization rate, nitrogen use efficiency, crop climate-stress resilience, and yield under SHMPs, (ii) developing and validating farm-scale machine learning models to estimate crop yield dynamics under SHMPs, (iii) developing and validating farm-scale machine learning models to estimate changes in soil health parameters under SHMPs, and (iv) delivering SHMPs guidelines and corresponding nutrient management recommendations to organic farmers through a web tool that visualizes model outcomes and integrates existing resources. The results of this project will be disseminated to stakeholders and scientific professionals through extension activities and publications.

APPROACH

We will leverage an extensive statewide soil health dataset, incorporating new field observations, remote sensing data, and data-driven machine learning (ML) models to develop targeted soil health management practices and corresponding nutrient management guidelines, aiming to enhance soil health, crop nutrient use efficiency (NUE), and mitigate the impacts of climate change on organic grain crops.Our project\'s long-term goal is to support and enhance organic farming in Wisconsin by providing region- and field- specific soil health promoting strategies and corresponding nutrient management recommendations for organic farmers to build sustainable and climate-resilient agroecosystems. The results generated from this project will enable growers to better understand the impact of SHMPs on soil health, soil seasonal N mineralization rate,crop yield, and climate-resilience, thereby formulating optimal management strategies to enhance the productivity, ecosystem services, and profitability of Wisconsin\'s organic farms, as well as to prepare them for the changing climate such as drought, floods, and other extremes.

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Enhanced Weathering for Carbon Sequestration in High Disturbance Organic Systems - an Evaluation on Climate Change Potential, Soil Fertility and Agronomic Implications

Contract / Grant No.	2024-51106-43042
Grant Year	2024
Investigator(s)	Alex Woodley
Performing Institution	North Carolina State University

NON-TECHNICAL SUMMARY

Organic agriculture, long associated with sustainability, faces uncertainty aligning with theemerging demand for climate-smart food. While organic farming promotes many sustainabilitypractices, its contribution to CO2 drawdown into soil carbon for climate change mitigation is stilldebated. Building soil carbon is challenging for organic systems in the southeast U.S. due to themild, humid climate, weathered soils, and heavy reliance on tillage. In this context, enhanced rockweathering (ERW) emerges as a promising scale-neutral strategy for carbon sequestration. Whenadded to soils, crushed silicate minerals react with atmospheric CO2 to form stable carbonates,removing CO2 from the atmosphere, regardless of soil disturbance. ERW also acts a limealternative raising soil pH and releases plant nutrients. Global estimates show ERW sequestrationpotentials at the same magnitude as more well-known climate-smart strategies. North Carolina hasactive quarries producing ERW as a by-product and organic growers are already applying it to theirfields. However, this is a nascent climate-smart practice and there is currently no information onERW in organic systems in the U.S.This proposal is a collaboration with North Carolina State University and North CarolinaAgricultural and Technical State University. The objectives of this project are: 1) Evaluate theagronomic and soil fertility impacts of substituting lime for ERW in both organic row crop (12 siteyears) and small-scale organic vegetable (6 site years); 2) Estimate carbon dioxide removal rates forSoutheast soils; 3) Measure GHG mitigation potential and 4) Empower organic stakeholdersseeking to adopt ERW through Extension activities.

OBJECTIVES

The use of ERW for carbon capture is a nascent climate-smart practice with much of the information on its use still at the research stage. Despite this, the carbon markets are expanding rapidly and this form of agricultural carbon sequestration offers the highest payback to farmers and one of lowest barriers to entry being scale-neutral and simply used as a liming agent. While publications are beginning to emerge on efficacy on carbon dioxide removal potential there is extremely limited information on agronomic and soil fertility implication of its use. To our knowledge there is no information on ERW in organic systems in the U.S in any crop type. This is despite the fact the land application has begun at scale throughout the U.S. and in particular in North Carolina with such a large deposit of available material and an active carbon market. The goal of this research is to conduct foundational research on the both applied and basic understanding of integrating this climate smart practice into U.S. organic systems in the south east. Objectives:1. Evaluate the agronomic and soil fertility impact of substituting agricultural lime for ERW materials in organic row crop systemsGenerate liming equivalence estimates for improved target pH changes from field and lab incubationsQuantify plant available soil nutrients over 3 years after applicationMeasure yield, plant nutrient uptake and grain quality compared to conventional lime products2. Evaluate the agronomic and soil fertility impact of substituting agricultural lime for basalt materials in organic small acreage vegetable crops with the same sub-objectives as in Obj. 1. Led by NC&AT Co-PI Binswanath3. Evaluate the potential co-benefit of ERW application on greenhouse gas emissions (CO2 and N2O) mitigation in the field and lab4. Fully characterize basalt ERW, calculate weathering rates and estimate Carbon Dioxide Removal rates for the ERW product across varying soil types and the impact of biological weathering, using experimental data from the field, greenhouse and lab column trials5. Use a suite of extension strategies to build an information platform for this new climate-smart practice for organic growers

APPROACH

EWR Basalt Characterization: At field delivery a subsample of ERW will be collected and characterized. The following will be characterized:Specific Surface Area: Brunauer Emmet Tell (BET) surface area analyzerParticle Size Distribution: Laser DiffractionMineralogy: X-ray diffraction (XRD), including screening for presence of existing carbonate materials.Carbon Dioxide Removal Potential: Calculated using Steinour formulation (Equation from Reershemius et al. 2023) which is the maximum amount of CO2 removed if all basalt were to react with carbonic acid and is ultimately captured as bicarbonateNorth Carolina Department of Agriculture Waste Analysis ReportCarbon Dioxide Removal Estimate Approach: In the greenhouse and columns we are able to use a mass balance approach, where we sample from specific chemical pools including the soil exchangeable fraction, plant material and leachate to represent the speed of weathering (Reershemius et al. 2024). In addition, a solid phase elemental analysis using a lithium borate fusion at the start and end of the experiment will provide an estimate of weathering. Using all of these chemical pools a presumed carbon dioxide reduction (CDR) in t CO2 ha-1 yr-1 estimate will be calculated (Almaraz et al. 2022). In the field trials we are using change over time of the solid phase of the soil+basalt mixture compared to the unamended control and time 0, as an estimate of weathering over three time periods. Including samples of the basalt rock, ERW+Soil at time 0, end of year 1 and end of year 3. The two sampling times will allow some inference on potential weathering rate changes over time.Leachate/Pore Water: Water samples will be measured for pH, Dissolved Inorganic Carbon, Cations and Metals and total alkalinityPlant Tissue: Digestion and Analysis on ICP-OES for Mg, Ca, K, NaSoil Weather Analysis: Soil samples will be taken from the Greenhouse Mesocosms, the row crop on-farm trials and the GHG field trials. For the field trials two depths will be used 0-30 cm and 30-90 cm. Surface samples (0-30cm) will be homogenized from 8-10 samples per plot using a push probe and 30-90 cm samples will be taken from two samples from plot using AMS UTV mounted hammer probe. All samples will be processed through a 2mm sieve. For solid phase analysis samples will be submitted to ALS laboratories for a lithium borate fusion and analysis on a ICP-OES. In addition an ammonium acetate extraction will be performed to remove elements bonded to exchangeable sites and some carbonates. Subtracting the ammonium acetate leach from the solid phase prevents underestimating weathering that has occurred.Soil Inorganic Carbon: Lastly, soils will be analyzed for total carbon on the LECO, a subsample will be treated with an acid pre-treatment to remove organic carbon and then analyzed on the LECO for total inorganic C. Soils in the coastal plain of NC do not have inherent soil inorganic carbon, if weathering has occurred and carbonate formation is detected this quantity will be attributed to the weathering of the material.Soil Nutrient Properties: Samples submitted to the North Carolina Department of Agriculture will return the following parameters: \"Mehlich-3 extractable phosphorus, potassium, calcium, magnesium, sulfur, sodium, zinc, manganese, and copper, humic matter, pH and Mehlich buffer pH, weight per volume, cation exchange capacity (CEC), and base saturation\" (NCDA 2024)Plant Tissue Analysis: Samples submitted to the North Carolina Department of Agriculture will return the following parameters:Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, sodium, iron, zinc, manganese, copper, boron and aluminum. -- -- -- --

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