AGRICULTURAL RESEARCH FOUNDATION
SECOND INTERIM REPORT
FUNDING CYCLE 2019 – 2021

TITLE: Introduced earthworms in Oregon: an investigation into the impacts on soil organic matter in agroecosystems

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COOPERATORS: None

EXECUTIVE SUMMARY:
The Willamette Valley hosts vast stretches of agricultural land and is the site for growing nationally important crops, such as grass seed. Soil organic matter (SOM) is vital for maintaining high quality soils for the production of these plants. Earthworms have been suggested as a way to promote the increase of SOM in agroecosystems, given that they move plant material from the surface into deeper parts of the soil. However, most earthworms in the Willamette Valley are non-native species. In the summer of 2016, two species of Asian jumping worms were discovered in Oregon and have since been found in numerous locations throughout the western part of the state, including Oregon State University's Corvallis campus. These worms will likely continue to spread and will eventually interact with existing populations of European earthworms. Research on the impacts of these new Asian earthworms is limited, and earthworm research in general focuses on forest soils rather than agricultural systems. In this project, we study the effects of two individual earthworm species, the Asian jumping worm (*Amynthas agrestis*) and the Canadian nightcrawler (*Lumbricus terrestris)*, along with a two species community, on SOM in several agricultural systems of the Willamette Valley including Perennial Ryegrass (*Lolium perenne*), Red Clover (*Trifolium pratense*), and Oregon Ash (*Fraxinus latifolia*) forest (an ecosystem which commonly flanks agricultural land in the Willamette Valley). In addition, we are testing these effects in experimental containers that are both planted and unplanted, which will allow us the opportunity to compare our results to previous container-based research as well as determine the relative contributions of plants and earthworms to SOM. These findings will help us better understand the role which both species of earthworms play in agricultural settings, as well as help local growers determine if there is a need to invest in preventive measures to keep Asian jumping worms from spreading into their fields.

OBJECTIVES:
This project has three main objectives:

1. Assess the effects of non-native earthworms (Asian jumping worm, Canadian nightcrawler) on soil organic matter in agroecosystems of the Willamette Valley
2. Compare individual-level effects on soil organic matter to the effects of a multispecies earthworm community

3. Compare the effects of earthworms and plants on soil organic matter

PROCEDURES:
Research was conducted at the Lewis-Brown Horticulture Farm in Corvallis, Oregon. Because it would be environmentally unacceptable to introduce a non-native species into Oregon farmland without knowledge of how it might impact the agroecosystem or surrounding systems, this study utilized large containers (called mesocosms) to test its hypotheses. Mesocosms were 70-liter round nursery containers filled with a locally sourced loam and manure mixture to a height of 40 cm. Mesocosms were placed inside of two portable greenhouses with an overhead sprinkler system (Figure 1).

Figure 1. Greenhouses at the Lewis-Brown horticultural farm.

For planted mesocosms, two different agricultural crops, Perennial Ryegrass and Red Clover, were seeded as monocultures in April 2019. Plants were periodically cut and clippings were stored for the creation of leaf litter. In addition, mesocosms representing typical riparian forests of the Willamette Valley were created by planting an Oregon Ash seedling and Piggyback plants. Dormant seedlings were planted in March 2019, but failed to survive and were replaced with new seedlings in July 2019. Ten grams of appropriate dried leaf litter was added to mesocosms prior to the addition of earthworms.

For earthworm treatments, there were two individual species treatments, one mixed treatment, and one worm-free control. Due to the different natural densities of each species, worms were added to mesocosms by mass rather than by number of individuals, at a live mass of 15 (±0.75) g per mesocosm. For the mixed-species treatment, this was equally divided between the two species. Each worm treatment was matched with a plant treatment, resulting

in 12 worm-plant combinations (including worm-free controls). Each worm-plant combination had three replicates, resulting in a total of 36 mesocosms. There were also a second set of mesocosms identical to these but with no plants (and instead only supplemented with leaf litter from the appropriate plant species), bringing the total number of mesocosms to 72. Juvenile worms were added in mid-October 2019.

Prior to the addition of earthworms in October, soil samples were collected from each mesocosm to determine initial soil conditions. Soil was collected using a coring device which collects a column of soil from the top to bottom of the mesocosm. The soil core was divided into 3 sections (0 – 10 cm, 10 – 20 cm, and 20 cm to the bottom) for analysis. A mid-experiment sampling event was intended to occur in April 2020; however, COVID restrictions, quarantine, and an injury prevented sampling. Thus, there will only be an initial and final soil analysis for the project.

SIGNIFICANT ACCOMPLISHMENTS:
Worms have been active in their mesocosms since their addition in October 2019. Nightcrawlers have formed middens in their mesocosms (Figure 2) and jumping worms have rapidly depleted leaf litter, in particular clover. From visual observations, jumping worms have also consumed more litter than nightcrawlers.

Figure 2. Nightcrawler middens in an unplanted Ash mesocosm.

After a heat wave in late summer, extra mesocosms (not used in the experiment but to which worms were added) were checked to ensure earthworm survival. Since the pots are above ground and are black in color, there was a risk of earthworm mortality from excessive heat. No living worms were found, so additional earthworms were ordered and added to the mesocosms at the same mass as the initial introductions in September 2020.

Because of closures and restrictions due to COVID, the Soil Health Lab (formerly Central Analytical Laboratory) has been operating at reduced capacity with longer turnaround times. Due to this, we have requested and received approval for a no-cost extension on this project to allow for the extra time needed to process the soil samples. Final results should be available to report in March 2021.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM:
None

FUTURE FUNDING POSSIBILITIES:
We have generated a lot of interest in Asian jumping worms and this research through outreach in the form of a nationally-viewed webinar through Extension (recording available for viewing at https://www.youtube.com/watch?v=tflbNuegJH0). We also presented information on the Asian jumping worm at the International Conference on Aquatic Invasive Species and have recently been invited to present at the British Columbia Invasives Forum. We believe that these connections will generate new partnerships that could lead to additional funding and resources.