**Weed Emergence Winter Meeting**

**January 7th, 2020, 12:15p, Philadelphia PA**

**Attending**

Toni DiTommaso, Caroline Marschner, and Lynn Sosnoskie of Cornell University, Jacob Barney and Vijay Singh of Virginia Tech, Thierry Besacon of Rutgers University, John Wallace and Tosh of Pennsylvania State University, Richard Smith and Nicholas Warren of the University of New Hampshire, Theresa Pisckacova of North Carolina State University, Peyton Ginakes of University of Maine.

**Announcements**

Lynn Sosnoski is joining the project from Geneva, NY. It'll be the standard setup, but add waterhemp (not Palmer).

Vijay Singh is joining the project from Virginia Tech; he is on the other end of the state from Jacob, and will be focused on Palmer Amaranth and waterhemp.

We will arrange another meeting towards the end of the month/early Feb, ensuring we have Art, Mohsen, and Mark V-G on the call. We'll work with Mohsen, Art, and Meter Group on the questions below so we have as many answers as possible before that next meeting. Doodle poll here.

We are looking at purchasing equipment for 2020 from Meter Group; many questions arose, which are below. Carri will work on getting some answers.

**Questions:**

Why not build the model with real soil moisture data, and then adjust it for the modeled data?

John would prefer to use his Decagon – are the probes from Meter compatible?

How similar do we need to be the readings of the different sensors? Are they more consistent midrange vs wet and dry extremes?

What about the cheaper loggers Mohsen uses? Who builds them, how do we get them?

What about gravimetric measurements to validate the sensors? At least Lynn, Jacob, and Rich are game to do this – is it something we should do?

Ask Art/Mohsen how quality the soil moisture data need to be.

NH has old Meter sensors (Decagon and Meter both) and some data loggers – they also use and like HOBOs. What about HOBOs – are they an option?

**Season report**

Virginia: Jacob seeded, things were going fine, he even got the weather station to work, and hten it got sprayed and had to start over. After that too little emergence. Started early April. Next year let's not have it sprayed! Yes for 3 wks after end. Sprayed after counts.

Pennsylvania: Tosh is a technician working with John Wallace in PA. They did the four species using an artificial seedbank seeded in December into a fall-tilled field. Things went fine, although the pigweed came up weirdly early. Maybe the superficial disturbance in late March to break the crust did something to it, but maybe not since we saw the same thing in NY. Tosh conducted the collection once he joined in spring. Data logger took on water and crapped out; John switched to EM50 Decagon probes instead. John replicated the same plot setup for next year in an additional field with higher weed pressure, where he hopes to collect ambient seed emergence rather than seeded emergence. The second setup has ambient seeds, 5 reps, 1m^2 per species. For the original plot array, he spiked the whole meter squared and subsampled if necessary. Hand-pulled after counts.

New Jersey: Thierry. 2 locations, one N one S. Northern was soy previously so tilled. Seeded both sites with 1m^2 divided in four section, one for each species, replicated four times. Monitored crabgrass (both species), lambsquarter, ragweed, smooth pigweed overseeded, also added galinsoga – all at both locations (over 5k seedlings/week!). N NJ was similar, but no initial tillage but some light cultivation the previous fall. More weed pressure, overseeded a month before emergence. Some things came up pretty early – we should start earlier. Probably zone 7. Collected from mid-April through Sept – no water in August, and nothing emerged after mid-August. In one location the probes worked, the other one didn't. Thierry has an undergrad student back-engineering the USDA board to develop a better system. None of the Rutgers weather stations provides soil information. Hand-pulled after counts.

New Hampshire: Rich and Nick Warren. New Hampshire had one set of plots embedded in an existing experiment that had both till and no-till treatments in a corn/soy rotation. They used ambient seeds rather than seeding, and four reps. They started in mid-May and finished in mid-October. No luck with the sensors. They do have older Meter and Decagon sensors and data loggers, and also use and like HOBO products; Nick will check with the student who has used the Meter/Decagon products and see if she likes them. Hand-pulled after counts.

Maine: The experiment was set up on a student farm, which was super weedy and didn't need additional seeding, in early April using rototilling for tillage. They had an abundance of lambsquarters, crabgrass, and redroot pigweed. Emergence continued through the summer, so monitoring continued through mid-October. There was a late season spike in lambsquarters at the end of September. Their sensor was no good despite heroic efforts on Peyton's part. The farm is organic, so they managed their post-count weed removal with flaming.

North Carolina: Theresa Pisckacova added our experiment's species to data she was collecting anyway, using ambient populations rather than seeding. She didn't get much lambsquarters and no redroot pigweed, but good crabgrass and morning glory. She does have moisture and temperature data, and had no trouble with the sensors. She started in April; emergence began in May, and was done by August.

New York: We collected data on common weeds including the four northern species from early May through mid-September at two sites, one a gravelly loam and the other a silty loam site. We collected no useful temperature or moisture data, but do have weather stations at each experimental farm.

United States Department of Agriculture

**Progress Report**

| Title: | Development of a Weed Emergence Model for the Northeastern United States |
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| **Sponsoring Agency** | NIFA | **Project Status** | ACTIVE |
| **Funding Source** | Hatch/Multi State | **Reporting Frequency** | Annual |
| **Accession No.** | 1018540 | **Project No.** | NYC-125838 |
| | | **Multistate No.** | NE1838 |
| **Project Start Date** | 12/12/2018 | **Project End Date** | 09/30/2021 |
| **Reporting Period Start Date** | 12/12/2018 | **Reporting Period End Date** | 09/30/2019 |
| **Submitted By** | Crystal Clark | **Date Submitted to NIFA** | 01/15/2020 |

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**Performing Department**

Crop & Soil Sciences

**Non-Technical Summary**

Unlike crops, which have been selected for uniform emergence, weed species have evolved variability in timing of their emergence; even seeds maturing on the same plant may germinate at different times. This "bet-hedging" strategy, with which a weed avoids putting all its "seed in one basket" of emergence timing, enables weeds to escape control measures that are applied at the "wrong" time. Post-emergence management carried out too early, i.e. before most problem weeds have emerged, will yield low returns for the effort, investment, and ecological cost of the management (herbicide off-target effects, soil compaction, etc.), as weed seeds that have yet to germinate are often unaffected. Providing seedling emergence information so that farmers can effectively time their weed management operations can increase efficacy of control, reduce labor costs, and minimize any negative environmental impacts (e.g. reduce the likelihood that repeat applications of an herbicide or cultivation may be required for late germinating/emerging weeds). There is, therefore, an urgent need for the development of time-specific weed management tools to help address the frequently asked, yet to be answered, question of when is the "right" time to control weeds?

Weed seedling emergence is a complex process regulated by a multitude of internal (e.g. species-specific parameters such as base temperature, base water potential) and environmental (e.g. soil temperature and moisture) factors. A range of modeling approaches, varying from simple empirical to advanced mechanistic models, have therefore been adopted to quantify the extent and time of emergence for a significant number of weeds. These can be used to produce weed management decision support tools, which enable farmers to determine the percent emergence of a specific weed species by a given date, taking into account the weather, management actions, and field conditions to that point. Populations of weeds respond differently in different regions to climate and habitat, requiring that emergence models be modified for a particular region. No weed management decision support tool exists for the Northeastern region of the United States, despite recent advances in our understanding of regional weed emergence patterns and developments in fine-scale weather prediction and soil moisture modeling. Data exist to create a weed forecasting product similar to those available for insect and disease threats to Northeastern agriculture, which would enable farmers to approach weed management with more precision and planning. In the past decade, decision support tools have been developed to help farmers manage weeds effectively in the Midwestern United States and Europe; these would serve as a road map for the Northeastern decision support tool. Recent advancements in climate and weather models and computational power have generated detailed weather data that are available to the general public free of charge. In the Northeast, daily weather data are now available on a 4 × 4 km grid across the region using the Applied Climate Information System (ACIS) Web Services (DeGaetano et al. 2014). These databases provide an unprecedented opportunity to estimate parameters directly relevant to seedling emergence such as growing degree day and hydrothermal time, from soil temperature and moisture data at very fine spatial resolution.

The **overarching goal of this project** is to work collaboratively across the northeast region to optimize farmers' ability to manage weeds in agricultural systems, in the face of challenges posed from a changing climate and increased prevalence of herbicide resistant weeds.

In this proposal, our goal is to develop and validate a user-friendly, online decision support tool for the real time prediction of weed emergence in the northeastern US. The decision support tool takes GPS location, soil type, tillage, crop data, and accesses weather history to provide percent emergence of the farmer's problem weeds at that location.

**Accomplishments**

**Major goals of the project**

(1)
Link Northeastern weed emergence timing data to existing weed emergence models and modern weather prediction models to create an online tool for farmers that will help them plan their weed management for optimal weed control. This tool will include three weeds that are problematic across the region: common lambsquarters (Chenopodium album), redroot pigweed (Amaranthus retroflexus) and large crabgrass (Digitaria sanguinalis). Common ragweed (Ambrosia artemisiifolia) will also be included in the northern portion of the Northeast and morningglory species (Ipomoea spp.) in the southern portion of the region. Individual participating states may also include one additional species of particular interest to their state.

(2)
Collect weed emergence data across the region to validate and refine the existing weed emergence models to fit Northeastern data, and refine the decision support tool through testing by select farmers and extension staff.

**What was accomplished under these goals?**

1) We worked with scientists from Spain, California, and New York to improve the models for emergence in our region. We worked with six site-years of preliminary data collected in New York and Delaware, and explored model variables such as the kind of equation used, the start of growing degree day accumulation, the lower threshholds for growing degree day accumulation, moisture threshholds for emergence of each species, and lag periods before emergence initiation. Working with Carlos Sousa from the University of Seville, Spain, Dr. Mohsen Mesgaren of the University of California at Davis, and Art DiGaetano of Cornell University's Department of Atmospheric Sciences, we compared model methods and explored resources for geospatial data the online model could use for soil texture information and temperature, precipitation, and soil mosture data. We also experimented with soil moisture probes for our field sites. We developed a set of equations that include hydrothermal time and soil type, and validated them on several states of the first year of data collection from across the region. Model fit needs improvement; we look forward to a second year of data collection and further model refinements around soil moisture and regional differences in weed phenology.
We also initiated a scoping review of weed emergence literature; this project will continue into years two and three.
2) We collected our first of three years of emergence data in eight states: Maine, New Hampshire, New York, New Jersey, Pennsylvania, Delaware, Virginia, and North Carolina. These data included the target weeds listed above, as well as additional species collected in various states. Delaware collected data on fifteen species, and New York collected data on at least twenty species.

**What opportunities for training and professional development has the project provided?**

Most states used undergraduate summer helpers to collect data, which is an excellent training opportunity for advanced weed identification skills. As this experiment checks weekly emergence, students develop skills identifying weeds at the cotyledon and first-leaf stage, which is critical for effective weed management in agriculture. These students receive one-on-one field instruction from weed science technical staff and scientists.
Carlos Sousa was a visiting graduate student from the University of Seville, Spain. He brought modeling expertise to the project, and received close assistance and instruction from Dr. Mesgaren on how to fine-tune emergence models.
Theresa Pisckacova is a graduate student at North Carolina State University, who singelhandedly added North Carolina to our data set. She is developing expertise in project management and interstate project collaboration.
Caroline Marschner is developing project management skills while leading this project. She attended Cornell Cooperative Extension's Program Management Leadership Cohort course, which has supported both this project and Smith-Lever Project # 2018-19-268: Development of a Weed Identification Network for New York State.

**How have the results been disseminated to communities of interest?**

{Nothing to report}

**What do you plan to do during the next reporting period to accomplish the goals?**

In year 2, we will present our current models to the Northeast Plant, Pest, and Soils Conference in Philadelphia, PA in January of 2020. We will hold our annual meeting at that conference, discuss changes to field plans for the next year, and

recruit new researchers if possible. We will purchase and deploy soil moisture sensors during the 2020 field season. We will continue to work on model refinement, including testing of equation component values from existing literature, experimentation with biphasic equations, and modeling sub-regions of our trial separately to account for regional phenotypic variability. We will continue to work on the scoping review of weed emergence literature, and present our findings to undergraduate students and growers.

**Participants**

**Actual FTE's for this Reporting Period**

| Role | Non-Students or faculty | Students with Staffing Roles | | | Computed Total by Role |
|---|---|---|---|---|---|
| | | Undergraduate | Graduate | Post-Doctorate | |
| Scientist | 0.3 | 0 | 0 | 0 | 0.3 |
| Professional | 0.2 | 0 | 0 | 0 | 0.2 |
| Technical | 0.8 | 0.1 | 0.2 | 0.1 | 1.2000000000000002 |
| Administrative | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Computed Total | 1.3 | 0.1 | 0.2 | 0.1 | 1.7000000000000002 |

**Student Count by Classification of Instructional Programs (CIP) Code**

| Undergraduate | Graduate | Post-Doctorate | CIP Code |
|---|---|---|---|
| 1 | 2 | 1 | 01.11 Plant Sciences. |

**Target Audience**

Information from the project was presented to weed and plant scientists at the 2019 Northeast Plant, Pests, and Soils conference in Hunt Valley, Maryland from January 8-10. ~20 scientists attending.
The project was presented to ~30 Cornell University undergraduate students as part of the Weed Ecology and Management course August 28 & 29, 2019.
The project was presented to ~8 Cornell University graduate students as part of the graduate level Weed Management seminar on March 28, 2019.
Information from the project was presented to growers on May 8, 2019, at the North Jersey Commercial Fruit Grower Twilight Meeting II (Rutgers University Snyder Research and Extension Farm, Pittstown, NJ)
Information from the project was presented to growers on August 7, 2019, at the RAREC Vegetable Twilight Meeting and Research Tour (Rutgers Agricultural Research & Extension Center, Bridgeton, NJ)
Preliminary results from the project were shared as part of a talk on weed identification resources in New York to extension educators and related personnel on November 14th at the Cornell Cooperative Extension 2018 Agricultural In-Service. Results were shared in talks in both the horticulture and agriculture tracks.

**Products**

{Nothing to report}

**Other Products**

{Nothing to report}

**Changes/Problems**

Bill Phillips, our collaborator in Maryland, had to remove himself from the project for health reasons. Happily, Theresa Pisckacova joined the project, adding a state and maintaining our state count at 8 while expanding our geographic range. Our project requires soil moisture sensors and data loggers, which we did not anticipate when writing the grant. We will be

taking funds from travel and other pieces of the budget and reallocating them to the purchase of these sensors and data loggers.