Report and Recommendations
NORTHEAST MULTISTATE ACTIVITIES COMMITTEE MEETING
August 09, 2023
12:00 PM - 1:00 PM ET Zoom Teleconference

Members: Matt Wilson (WVU-Chair), Puneet Srivastava (Maryland), Jason White (CT-New Haven), Blair Siegfried (Penn State), Cindy Fitch (WVU/NEED), Ali Mitchell (NEED) [Non-voting, ex officio: Rick Rhodes (NERA), David Leibovitz (NERA)]

Request to Approve Peer Reviewed Multistate Activities (MAC recommendations to NERA)

- NE_TEMP2338: *Weed Emergence in a Changing Climate*, 10/2023 – 09/2028 [Renewal of NE1838, AA: Margaret Smith – Cornell]
    - Crop species have uniform emergence, weed species have evolved variability – important in the face of changing climate
    - Northeast focused; activities ongoing in NH, PA, NY, DE, NJ
    - Accomplishments of the previous project were not initially listed, and the previous project did not submit annual reports over its 5-year cycle.
    - **A motion to approve the NE_TEMP2338 proposal was introduced by Jason and seconded by Ali. Prior to approval, the motion was amended so that approval is conditional upon the submission of annual reports for the previous project cycle. The full committee approved this motion with the conditional amendment.**
- NECC_TEMP2312: *Northeast Coordinating Committee on Soil Testing*, 10/2023 – 09/2028 [Renewal of NE1834, AA: Rick Rhodes – NERA]
    - Demand for soil testing units has increased, and staffing has decreased.
    - This coordinating committee has a successful history and is dedicated to the maintenance of the northeast regional soil testing reference manual, which provides guidance to ensure consistency in testing across laboratories.
    - The committee assisted NERA in drafting a recommendation to the National Research Support Project Review committee on the development of the new NRSP11 proposal.
    - **A motion to approve NECC_TEMP2312 was introduced by Rick on behalf of the Chair and seconded by Cindy. The motion as presented, was approved by acclamation.**

Other business

- Outreach plans should be more implementation strategy focused. Ali and Cindy offered to engage NEED Directors about how to refine outreach plans for multistate research project proposals. There could be an "evergreen" template developed for teams to use as guidance for drafting an outreach plan.

Informational Items

- Draft proposals undergoing peer review:
    - NECC_TEMP29: *Northeastern Corn Improvement Conference*, 10/2023 – 09/2028 [Renewal of NECC29, AA: Margaret Smith – Cornell]
    - NE_TEMP2332: *Biological control of Arthropod Pests and Weeds*, 10/2023 – 09/2028 [Renewal of NE1832, AA: Jason White – Connecticut-New Haven]
- The MAC anticipates meeting in September, prior to the NERA business meeting in Grand Rapids. The meeting will be scheduled following receipt of peer reviews.
- Expiring multistate activities not seeking renewal:
    - NE1944: Management of the Brown Marmorated Stink Bug, 10/2018-9/2023 – **project ending 9/2023**
    - NEERA1603: Northeast Pasture Consortium (AA Margaret Smith) – **ended 9/2021**

NE_TEMP2338: Weed Emergence in a Changing Climate

Status: Under Review

Duration	10/01/2023 to 09/30/2028
Admin Advisors:	[Margaret E. Smith]
NIFA Reps:	

Statement of Issues and Justification

Background

Unlike crops, which have been selected for uniform emergence, weed species have evolved variability in their emergence timing. 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. Post-emergence management carried out too early 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. On the other hand, most weed management tactics such as post-emergent herbicides and cultivation are most effective when weeds are small, at or near the seedling stage (Norsworthy et al. 2012). Therefore, delayed management operations may result in reduced weed control efficacy and greater yield loss (Davis 2006). Thus, weed management should be timed to occur soon after the emergence of most problem weeds.

The timing of weed emergence is not easy to predict because it reflects a multitude of speciesspecific parameters (e.g., base temperature, base water potential) and environmental factors (e.g., soil temperature and moisture). While many weedy species can germinate under a broad range of environmental conditions (Baker 1974), weeds in most agricultural systems have evolved to germinate when the appropriate microenvironmental cues are detected (Long et al 2016) to maximize fitness during favorable environmental conditions (Grime 1977). Weed growth, competitiveness, and fecundity are strongly influenced by emergence timing relative to the crop (Hartzler et al 2004, Wu et al 2014). Temperature is a particularly dominant influence on emergence timing in many annual weed species (Werle et al 214a; Werle et al 2014b). Understanding how changes in winter temperatures affect weed germination and emergence is crucial to designing weed management systems that are resilient to climate change.

Changing winters in northern climates.

In northern latitudes, winters are warming faster than any other season (Hayhoe et al 2007, Karmalkar et al 2017, Brown et al 2010, USGCRP 2017). Winters are also shortening as spring advances earlier in the year and autumn senescence is delayed, resulting in a longer growing season (Piao et al 2015, Monahan et al 2016, Contosta et al 2020). Against this backdrop of milder winters and longer, warmer growing seasons, climate change is driving greater winter weather variability (Chen et al 2018) related to changes in the Arctic jet stream (Francis et al 2015, Cohen 2016, Overland et al 2016). This variability may result in extreme cold temperatures (Cohen et al 2013, Kug et al 2015, Overland 25 al 2011, Cohen et al 2018). One extreme occurred in 2018–2019, when the incursion of the polar vortex plunged temperatures below –20°C across the Northeast. While swings between extremely cold and warm temperatures are somewhat rare, freeze-thaw cycles in which temperatures fluctuate around 0°C may become increasingly common as the climate warms (Henry 2008) with significant implications for agricultural productivity (Rotz et al 2016) and concomitant weed management.

Weed seed bank dynamics and their responses to temperature.

Weeds are a persistent challenge for crop production. They reduce crop yield and quality, sometimes even causing stand failure (Grekul and Bork 2004, Baker and Mohler 2014, Hatzler 2004, Rosenbaum et al 2011). Weed seed banks are the primary source of weed recruitment in most agroecosystems. Weed issues are likely to be exacerbated by a warming climate (Hatfield et al 2011, 2014), which will impact weed seedbanks as well as emerged weeds. Weed seed persistence within the soil seedbank is strongly regulated by soil temperature (Smith et al 2018, Kreyling et al 2010, Walck et al 2011). For this reason and others, changes in temperature are likely to drive shifts in weed community composition and abundance that could pose new challenges for cropping systems in the region.

Warmer temperatures affect weed seed dormancy.

Most weed species exhibit seed dormancy (Cavers et al 1989). Seed dormancy, which prevents germination at times that would result in low survival, is controlled by species-specific physiological, physical, and/or chemical mechanisms that may confer both dormancy and defense (Baskin and Baskin 2014, Davis et al 2016). Dormancy mechanisms are strongly influenced by temperature (Benech-Arnold 2000). Maternal plants exposed to warmer air temperatures during seed set can produce seeds with lower dormancy levels (Gutterman 2000). Warmer temperatures following seed dispersal can increase the rate of afterripening and thus the fraction of germinable weed seeds within the soil (Dwyer 2016).

Increased soil freeze-thaw cycles and warmer temperatures affect seed longevity.

Soil freeze-thaw cycles directly affect weed seed persistence by breaking down hard seed coats (Baskin and Baskin 2014). In species with physical dormancy, fractures to the weed seed coat release dormancy and thereby increase germination, emergence, and recruitment (e.g., velvetleaf (Abutilon theophrasti)). Fracturing of the seed coat also increases vulnerability to soil pathogens and decay (Connolly and Orrock 2015). Indirect effects of increased soil temperatures and freeze-thaw cycles on seed longevity may be mediated by increased activity of pathogenic fungi and other microorganisms (Classen et al 2015). Another indirect effect is that soil heaving associated with freeze-thaw cycles moves weed seeds in the soil profile (Chambers and Macmahon 1994). Some seeds are moved into deeper layers where they are more protected from seed predators (Omani et al 1999, Korres et al 2018).

Importance of the Work

Weed management is a priority issue for Northeastern farmers, particularly given the increasing prevalence of organic production, the rise of herbicide-resistant weeds, and the recent increase in small farms and urban farming. Interest in local food is also increasing, so specific, regionally focused data and tools for the Northeast could provide great benefits to growers and consumers while reducing negative impacts on the environment. Weeds are the major cause of yield losses in organic production (Baker and Mohler 2014; Jerkins and Ory 2016). Yield losses to weed competition are an increasing problem for conventional farmers as well, as the incidence of herbicide-resistant weeds continues to increase (Heap 2023). Preventing yield losses requires weed management operations such as cultivation or herbicide applications conducted at the proper time. The failure to account for the temporal variability of emergence can result in mistimed application of these control measures, leading to poor efficacy. Poor efficacy may necessitate repeated operations that are not only costly to the farmers, but also detrimental to our environment. Thus, better timed, and more effective use of herbicides and/or cultivation will protect yield and minimize unintended consequences like the spread of herbicide resistance in weed populations.

As the climate warms, changes to weed emergence patterns or weed community composition are likely to impact crop yield and farm profitability. Accurate predictions about near-term effects of increased temperatures on weed communities will allow farmers throughout the Northeast region to proactively respond to these changes.

Technical Feasibility

We need effective and affordable methods to simulate increasing temperatures and increasing weather variability in the field to better understand the impacts climate change may have on weed emergence. Our current research has shown that hexagonal open top chambers (“OTCs”, shown in Figure 1 (Marion et al 1997)) meet this need and passively increase air and soil temperature, while having a minimal effect on soil moisture. OTCs have been used to simulate warming throughout a wide range of climates and environments (Bjorkman et al 2017; Seipel et al 2019). We found that our OTC design was relatively easy to implement and effective at modifying temperatures. The OTCs had substantial effects on air and soil temperature (Figures 2 and 3) and are built of plastic that allows 95% light transmission (Carolyn Lowry, pers. comm.). On average we obtained an increase in air temperature within the OTC of approximately 0.5°C, and soil temperatures by approximately 0.4°C. If funded, we will test light transmission and the frequency of transmitted light, to test whether collected data are impacted by a shift in light ratio.

For example, fall maximum air temperature within the OTC was up to 5°C warmer compared with the control plots, while the OTC increased maximum air temperature by as much as 10°C in spring. The change in autumn air temperature within the OTC decreased cold hardiness accumulation by 20 chilling degree day units (base 5°C). Interestingly, the magnitude by which our OTCs decreased chilling degree days is consistent with the predicted decline in chilling degree days for future climate change scenarios in northeastern North America (Bélanger 2002). In the spring, the OTC increased the number of days that maximum air temperature was above 15°C (the temperature at which alfalfa breaks dormancy) by 40% compared with the control. While the OTC did not impact winter maximum air temperature as much as in autumn and spring, we did observe up to an 8°C increase in the minimum daily temperature in winter. Throughout the spring, the OTC doubled the number of days that air temperature was greater than 30°C compared with the control plots without an OTC.

This OTC design is already being implemented by two multistate collaborators in an AFRI-funded grant focused on alfalfa management in Pennsylvania and New Hampshire. Importantly, the proposed work will provide complementary information to the existing project focused on weed responses in a wider range of Northeastern US states and climate conditions.

Figure 1, found in Attachments section. Picture of OTCs at Rock Springs, PA (photo credit A. Isaacson).

Figures 2 and 3, found in Attachments section. Figure 2. Average monthly difference in temperature (ºC) for year one (A. 2020-2021) and year two (B. 2021-2022) in State College, PA. Data are monthly averages of the daily average temperatures of temperature sensors at a 10 cm height in an alfalfa-orchardgrass mixture. Figure 3. Daily maximum (top) and minimum (bottom) soil temperature at 5 cm depth in Pennsylvania (PA, left) and New Hampshire NH, right) buried in a plot with an OTC (“constant warming ’’) and without (“control”).

Multistate Advantages

Weather patterns, soil types, and weed communities are highly variable across the Northeast, making the collection of data from across the region critical for understanding the response of agricultural weed emergence to climate change. Additionally, Cordeau et al. (2017) found that populations of weed species had different emergence patterns in different Northeastern states. It is not yet clear whether that difference is due to genetic variability within the species or plasticity in emergence patterns depending on climatic conditions. A multistate project will allow us to replicate the same weed emergence experiment at multiple sites across the region. Participating researchers will include Richard Smith (New Hampshire), Carolyn Lowry (Pennsylvania), Mark VanGessel (Delaware), Antonio DiTommaso (New York), and Thierry Besancon (New Jersey). Our thorough coverage of the region will ensure that results capture regional variability in weed emergence and climate.

Likely Impact

Current research on Northeastern weed emergence does not account for warming temperatures which are occurring at a much more rapid rate than predicted (Karmalkar and Horton 2021). The findings from this research will allow weed scientists to model changing patterns of weed emergence under warming conditions and will provide more accurate information for our growers and other stakeholders in the region.

The findings of this research will empower farmers to better predict the emergence patterns of common weeds, thereby improving weed management efficacy and efficiency. While weed emergence timing is one of many factors that determine treatment windows for farmers, application outside of the optimal window of emergence and early growth is drastically less effective. Better information on emergence timing will be especially helpful for newer farmers; with many of our experienced farmers aging out of farm management, new farmers are likely to become more common in the next decade. Improving farmers’ ability to manage weeds effectively in a rapidly changing climate will be an important aspect of cropping system adaptation and resiliency to deteriorating stressors of climate change. Optimized weed management programs will simultaneously enhance farm profitability and reduce negative environmental impacts.

Related, Current and Previous Work

This proposal builds on past work conducted through the multistate Federal Capacity Funds, extending the research we have conducted on ecological management of weeds and on weed emergence to application in a changing climate. Weed emergence is variable by species; while it is likely that warming temperatures will trigger earlier emergence, it is also possible that the responses of individual species will alter weed abundance and community composition in the Northeast (Westbrook et al 2022). Climate change may also increase variability in weed emergence, rendering existing models less accurate.

Cornell University weed ecologists are at the forefront of weed emergence research (Brown et al. 2022, Cordeau et al. 2017) and on the effects of climate change on weed performance and weedcrop interactions (e.g., Averill et all 2022 A & B, DiTommaso et al 2021, Westbrook et al. 2021, Young et al. 2017). Dr. DiTommaso and coauthors have included 200 additional species into the recently released second edition of Weeds of the Northeast relative to the first edition released in 1997, largely due to the expansion of more southern species into the Northeastern region (Neal et al 2022). He has also co-authored a chapter on modeling invasive species and climate change (Westbrook et al 2022). The DiTommaso lab has led multistate weed ecology studies since 2011 through Multistate projects NE-1047 “Ecological Bases for Weed Management in Sustainable Cropping Systems” and NE-1838 “Development of a Weed Emergence Model for the Northeastern US” which is in its final months. In NE-1838, we collected three years of weekly weed emergence data across five to eight Northeastern states, correlated emergence with temperature and soil moisture, and are using resulting emergence models to build a decision support tool for farmers to help predict emergence for several problematic summer annual weed species. These projects brought together networks of weed scientists from the region to identify effective non-chemical weed management strategies, and to develop a weed emergence decision support tool for farmers. While the decision support tool under development applies to the current climate conditions of the Northeast, it may not apply under the warmer conditions expected in the near future. The proposed research will assist in extending the value of previous work by incorporating future climate conditions.

Penn State collaborator Carolyn Lowry’s recent work has examined how extreme precipitation events affect weed management efficacy (Lowry, in progress), how abiotic factors influence the composition of weed communities (Lowry et al., in review), and how management factors influence crop-weed competition (Lowry et al. 2019). Dr. Lowry is a co-PI on an AFRI project (PENW-202109936) focused on the implications of warmer climate conditions on perennial forage and weed communities; this proposed work will directly support that work by adding more locations and more weed-focused research to the existing project.

University of New Hampshire collaborator Richard Smith’s recent work has investigated how soil weed seedbank communities are structured by climate and edaphic factors (Smith et al. 2018) and agricultural management practices (Smith et al. 2016). Dr. Smith Dr. is a co-PI on an AFRI project (PENW-2021-09936) focused on the implications of warmer climate conditions on perennial forage and weed communities; this proposed work will directly support that work by adding more locations and more weed-focused research to the existing project.

University of Delaware collaborator Mark van Gessel has participated in a wide range of weed emergence research projects, including the previous two multistate programs mentioned above. These projects have modelled weed emergence in a variety of Northeastern weed species (Myers et al. 2004; Myers et al. 2005) including winter annuals (VanGessel et al. 2015) and horseweed (Conyza canadensis; Dauer et al. 2007).

Rutgers University collaborator Thierry Besancon is researching environmental parameters that govern germination and emergence of volunteer cranberry (Vaccinium macrocarpon) and Carolina redroot (Lachnanthes caroliana). These weeds are challenging for New Jersey cranberry growers because of genetic pollution of the cranberry beds or direct competition with the cranberry vines.

Objectives

1. Evaluate how weed emergence timing and weed communities vary under ambient (control) and increased temperature conditions across multiple sites with different environmental conditions (NH, PA, NY, DE, NJ).
   Comments: To achieve this objective, we will deploy open-top chambers (OTCs) for in situ manipulation of air and soil temperatures at each site to determine how increasing temperature affects emergence of winter and summer annual weeds.

Methods

Experimental Design:

The study will consist of two treatments: 1) “Warmed”: a warmer-climate treatment with an OTC, recording OTC-modified temperature, soil moisture, and weed emergence, 2) “Control”: a control treatment with no OTC, recording ambient temperature, soil moisture and weed emergence. These will be arranged in a randomized complete block design with four replications. Plots will have no crops planted and will be 1 m2, which is the maximum area that can be consistently warmed within the OTC structures. Data will be collected from the center 0.25m2, but the data collection area will be adjusted to 0.5 m2 if weed emergence is low or subsampled if emergence is very high. Plots will be at least 6 m apart to limit any effect of OTCs on snow fall in neighboring plots, which might affect the conditions overwintering seeds experience. The experiment will be moved each year so that plots are on novel locations, to avoid exhaustion of the seed bank, but researchers will attempt to keep them in the same general area to reduce variability introduced by changing soil types.

Warmed Plots: To simulate increasing temperatures associated with climate change we will use hexagonal open-top chambers (OTCs). OTCs will be constructed from 1 mm thick Sun-Lite HP (Solar Components Corporation) attached to a metal frame, with a 2.65 m basal diameter, a top opening diameter of 1.75 m, and a height of 0.8 m. OTCs will be anchored into randomly fixed points in the ground. The OTCs will remain on the plots across all seasons for the entire duration of the experiment, and only be removed temporarily for emergence counts and plot maintenance (seeding out new species). The OTCs described above have been deployed in central PA for over two years. We will test light transmission through the OTCs in year 1 of the experiment.

For this experiment, researchers will record weed emergence for the most common 10 summer annual weeds at their site, and will also include if present these species of interest:

- Smooth pigweed or redroot pigweed (*Amaranthus hybridus* or *retroflexus*)
- Velvetleaf (*Abutilon theophrasti*)
- Lambsquarters (*Chenopodium album*)
- Large crabgrass (*Digitaria sanguinalis*)
- Foxtail (*Setaria*)
- Palmer amaranth (*Amaranthus palmeri*)
- bur-cucumber (*Sicyos angulatus*)
- ivyleaf morningglory (*Ipomoea hederacea*)

Control Plots: No OTC present, ambient temperatures.

- Initial fall tillage will occur prior to establishing the experiment and after that soil will remain for the most part untilled, but in sites where soil cursting occurs we will use a scuffle hoe to break up soil crusting as needed.
- Researchers will locate plots in weedier fields.
- Plots will be monitored weekly. Emerging seedlings of the 10 most common species, and any of the priority species listed above, will be counted and removed; at the end of the sampling, all seeds will be either clipped and removed or sprayed with herbicide. Sampling will begin before weed emergence in the spring, and will continue until none of the target species have emerged for three sampling periods or until the end of October.
- We will use soil temperature and soil moisture sensors attached to data loggers, to quantify the relationship between weed seedling emergence and both soil GDD accumulation and soil moisture.

Data analysis: To examine the effect that warming has on relative timing of weed emergence, we will first convert emergence to cumulative emergence (%) based on the total seedling emergence per experimental unit per year (each species will be analyzed separately). Cumulative emergence of each weed species will be modeled using a Weibull function (Weibull 1951): $Y=M*\{1-\exp[-\exp(lrc)*(GDD-z)c]\}$ where Y is cumulative percent emergence, M is the upper horizontal asymptote, lrc is the natural log of the rate of increase, GDD is growing degree days and is the predictor variable, z is the time of first emergence, and c is the curve shape parameter [Werle et al 2014b, Goplen et al 2018). We will use the model to extract time to 25%, 50%, and 75% emergence, and then examine whether the fixed effects of climate manipulation treatments affect the relative timing of emergence with block nested in year and site as random factors.

Measurement of Progress and Results

Outputs

- field data Comments: Our field research will provide three years of emergence data from five Northeastern states on annual weed species under ambient and elevated temperature conditions.
- Peer-reviewed research articles Comments: The synthesized results of our research will be published in peer-reviewed literature, probably in Weed Science or Weed Research.
- Extension materials Comments: The synthesized results of our research will be extended to Northeastern farmers through extension articles, website information, field days, and presentations.

Outcomes or Projected Impacts

- Improve weed management efficacy in the face of climage change This project will help maintain weed control efficacy in the face of climate change. We anticipate that researchers will be able to build on our findings to determine how different crops influence emergence timing. If this method is successful, future research can apply this technique to other problem weed species, and as we accrue a larger data set, we may be able to predict responses in similar weed species. Extension educators will use information derived from our research to communicate scientifically sound weed management practices to farmers across the Northeast. Farmers will use the weed emergence information to optimize their weed management programs and proactively address changes in weed emergence patterns. We hope that the results of this work will be used to launch a common garden experiment to determine how phenotypic variations affect differences in emergence timing across the Northeast.

Milestones

(**1**):Finalize field research plans

(**1**):Season 1 data collection

(**2**):Season 1 data management

(**2**):Season 2 data collection

(**3**):Season 2 data management

(**2**):initial extension talks

(**3**):Season 3 data collection

(**3**):Outreach to extend research outcomes

(**3**):Write and publish related papers

(**3**):Final report

Outreach Plan

The project will produce useful weed management information for farmers, extension personnel, crop consultants, and the general public. The results will be shared in research papers, on the Cornell University Weed Science website, and in talks by extension professionals in New York, Delaware, and New Jersey where our collaborators have extension positions. Some likely venues include:

Weed Science Society of America annual meeting

Northeastern Plant, Pest and Soils annual conference

Tri-Society of America annual meeting

New York Cooperative Extension Agricultural In-Service

Delaware Cooperative Extension In-Service

Cornell University Musgrave Research Farm Field Day

Delaware University's Weed Science Field Day

What's Cropping Up

Extension Insider (a weekly internal New York extension publication)

Field day / twilight tours / field walks

County extension meetings

The results of our research will also be incorporated into our respective undergraduate and graduate weed science and integrated pest management teaching programs.

Organization/Governance

The multistate research group will have an elected Chair, Chair-elect, and Secretary; we will elect them for the duration of our funded cycle. Administrative guidance will be provided by an assigned Administrative Advisor and a NIFA Representative.

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Land Grant Participating States/Institutions

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**0**	**0**	**0**

Program/KA	Total FTE
Grand FTE Total:	**0**

College of Agriculture and Life Sciences
School of Integrative Plant Science
Soil and Crop Sciences Section

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July 31, 2023

Dear Multistate Action Committee,

We thank the three reviewers and the MAC for this helpful feedback on our Multistate NE_TMP2338 proposal. Please find below our responses to reviewer and MAC comments.

Sincerely,

Caroline Marschner, Project Manager
Antonio DiTommaso, Principal Investigator

Reviewer and Comment Responses

Reviewer 1

Understanding how weed seed germination and weed seedling emergence might respond to our changing climate may help to anticipate future challenges and problems associated with timely weed management. However, I often doubt that farmers will use this sort of information because they are contending with a complex set of moving pieces when making decisions about when to apply control measures. That said, the goals of this proposed regional project are interesting from a weed science perspective.

We agree that weed emergence timing is one of many factors that determine treatment windows for farmers. However, application outside of the optimal window of emergence and early growth is drastically less effective. Better information on emergence timing will be especially helpful for newer farmers. With many of our experienced farmers aging out of farm management, new farmers are likely to become more common in the next decade.

How will the OTCs alter other important environmental signals besides soil and air temperature? The enclosures will surely also impact light quantity and quality, which are key signals governing dormancy status for many weed species. It's an age-old problem: how do we impose experimental treatments without also imposing other changes that may affect our results?

Many experiments have evaluated impacts of temperature on weed emergence, but they have mostly been conducted in growth chambers. The benefit of OTCs is their ability to elevate soil and air temperatures under real field conditions, thereby providing a more realistic model of weed

responses to climate change. We feel that OTCs are the best available tool for increasing temperature in the field.

OTC enclosures are built out of plastic designed to allow 95% light transmission. Light measurements taken under similar OTCs in Pennsylvania in the late afternoon recorded 6–10% light interception by the OTCs in the center of the plot (Carolyn Lowry, personal communication). It is possible that reduced light transmission will alter plant growth, although many species already receive saturating levels of light on sunny days.

Germination is often more strongly impacted by light quality (wavelength). We do not have data on how OTCs affect light quality. The plastic from which the OTCs are constructed is translucent white, which is unlikely to alter the R/FR ratio of light. We can test for any effects once we have funding and OTCs.

Why omit crops from the experimental plots? The absence of a crop canopy creates an artificial environment that does not resemble real agroecosystems subjected to weed management. Removing the weeds as they emerge may also create similar unrealistic environments that weed species may respond to, especially later-emerging weeds that are becoming more of a management problem. Crop and weed canopies alter the magnitude of soil temperature fluctuations as well as light quantity and light quality reaching seeds at shallow soil depths. All these factors can exert a profound influence on germination and emergence behavior. Each weed species also may respond differently to thte same set of signals. Because you are imposing experimental treatments that do not resemble realistic crop-weed canopies, your results may not be relevant to these environments.

Our collaborators across the multistate project work in several different commodity groups — field crops, vegetables, forage, berries, and more. We chose a no-crop condition to produce general information that would apply to many different commodities. Data from this project can provide a baseline for crop-specific research.

Finally, do you intend to consider base temperatures for germination and emergence when summing GDDs for each weed species? If the species of interest have very different base temperatures, ignoring this component could be a source of error in your models.

We will incorporate base temperatures, as they are a critical component of weed emergence modeling. Base temperatures have been reported in the literature for our species of interest.

Reviewer 2

I think the participants should consider a 'common garden' component, where the same species and/or seedlot of one or two key species are included at all sites. Given all the work involved in constructing the OTCs and monitoring emergence, this would be a relatively low effort type of

control that would might provide additional insights. The team is highly qualified and I expect will tweak the protocols as needed and collect and publish results that will be beneficial to both the weed science community and farmers.

We wholeheartedly agree that common garden experimentation would be an excellent addition to this project. There is an ongoing research project at the Pennsylvania State University that involves common garden experiments related to our previous multistate project (NE 1838). This work will address seed dormancy variability.

The funds provided through the multistate funding mechanism do not cover the costs of experimentation for most of our collaborators. The funds available to the lead institution would not be sufficient to cover the currently proposed field work, project management, and high-quality execution of a common garden experiment. Among other things, a common garden experiment would require careful prevention of cross-pollination during a single-location generation to remove any maternal effects, prior to the actual research season. We feel that a common garden project would be an excellent avenue to pursue under another funding mechanism, perhaps building on results of the multistate project proposed here.

Reviewer 3

I think this approach has sound merit and will provide a good tool for growers and extension, but I agree with some of the previous reviews that genetic variability and seed dormancy will play a significant role in robustness and utility of the platform. While those species represent significant challenges, I would also like to see some mention of how this work can be translated for other species and other cropping systems.

We agree that weed emergence patterns and the effects of climate change vary within and between weed species. Our previous project was limited to four common species and four additional species of regional interest. To collect more general data for this next project, we chose to focus on the ten most common species in the fields selected by multistate partners. This approach will help provide a broader dataset while also ensuring that each species counted in a field occurs at a high enough frequency for reliable modeling in that field. The downside to this approach is that the data will by necessity be more shallow for most species. For each species, our data set will capture genetic variability and seed dormancy polymorphisms that occur within fields. It is likely that many species will be tracked at multiple fields, and therefore our research will also provide some insight into geographic variability. These data will create a preliminary picture of how temperature affects weed emergence trajectories under field conditions. This work could later be expanded with experimental research and simulation on the effects of intraspecific, interspecific, and cropping system factors.

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MAC questions

The Multistate Activities Committee (MAC) has also requested that the proposal clearly indicate what was accomplished during the lifetime of NE1838. The MAC appreciates the citations provided by institution in the "Related, Current and Previous Work". Of the work listed in this section, what was accomplished as components of NE1838? The MAC also requests that the editing team include in the response to the reviews, an explanation of why the project team did not hold any authorized meetings during the term of NE1838 and did not file annual reports. The annual reports are required elements of a multistate research project and highlight the milestone accomplishments, collective outputs, outcomes, and impacts.

The multistate group has met annually during the funded portion of the grant cycle, although due to the pandemic we have met remotely since 2020. We did not realize we needed to authorize the meetings to trigger a NIMSS report. The Cornell University collaborators on this project were funded through an AES project for NE1838 and provided project management for the multistate effort. Cornell staff reported all activities conducted by all partners in the project annually for the Cornell AES project, not realizing that there was a separate report needed for the umbrella project. We will enter past years' reports into the NIMSS system if there is a way to do that retroactively. Moving forward, we will follow the correct procedure to authorize our annual meeting and submit the annual report into NIMSS. We will also shift back to in-person meetings for the next funding cycle if that is the preferred meeting format. With the return of the in-person Northeastern Weed Science Society conference, we will have a convenient venue to meet in person.

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Appendix G: Peer Review (Submitted)

Status: Complete
Project ID/Title: NE_TEMP2338: Weed Emergence in a Changing Climate

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project with revision
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Good
5. Overall technical merit:
Good
Comments
Understanding how weed seed germination and weed seedling emergence might respond to our changing climate may help to anticipate future challenges and problems associated with timely weed management. However, I often doubt that farmers will use this sort of information because they are contending with a complex set of moving pieces when making decisions about when to apply control measures. That said, the goals of this proposed regional project are interesting from a weed science perspective.

I have several concerns about the proposed experimental methodologies.

How will the OTCs alter other important environmental signals besides soil and air temperature? The enclosures will surely also impact light quantity and quality, which are key signals governing dormancy status for many weed species. It's an age-old problem: how do we impose experimental treatments without also imposing other changes that may affect our results?

Why omit crops from the experimental plots? The absence of a crop canopy creates an artificial environment that does not resemble real agroecosystems subjected to weed management. Removing the weeds as they emerge may also create similar unrealistic environments that weed species may respond to, especially later-emerging weeds that are becoming more of a management problem. Crop and weed canopies alter the magnitude of soil temperature fluctuations as well as light quantity and light quality reaching seeds at shallow soil depths. All these factors can exert a profound influence on germination and emergence behavior. Each weed species also may respond differently to thte same set of signals. Because you are imposing experimental treatments that do not resemble realistic crop-weed canopies, your results may not be relevant to these environments.

Finally, do you intend to consider base temperatures for germination and emergence when summing GDDs for each weed species? If the species of interest have very different base temperatures, ignoring this component could be a source of error in your models.

This proposal should be revised to address the above potential pitfalls and limitations.
Your Recommendation:
Approve/continue project with revision

Appendix G: Peer Review (Submitted)

Status: Complete
Project ID/Title: NE_TEMP2338: Weed Emergence in a Changing Climate

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Good
Comments
The project has a realistic set of achievable goals and takes advantage of existing projects and expertise of participants to address important questions. The outlined protocol is reasonably straightforward (critical for such coordinated efforts) and should provide useful information for modelling and gaining perspective on likely changes associated with warmer winters. I think the participants should consider a 'common garden' component, where the same species and/or seedlot of one or two key species are included at all sites. Given all the work involved in constructing the OTCs and monitoring emergence, this would be a relatively low effort type of control that would might provide additional insights. The team is highly qualified and I expect will tweak the protocols as needed and collect and publish results that will be beneficial to both the weed science community and farmers.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete
Project ID/Title: NE_TEMP2338: Weed Emergence in a Changing Climate

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Good
5. Overall technical merit:
Good
Comments
I think this approach has sound merit and will provide a good tool for growers and extension, but I agree with some of the previous reviews that genetic variability and seed dormancy will play a significant role in robustness and utility of the platform. While those species represent significant challenges, I would also like to see some mention of how this work can be translated for other species and other cropping systems.
Your Recommendation:
Approve/continue project

NECC_TEMP2312: Northeast Coordinating Committee on Soil Testing

Status: Under Review

Duration	10/01/2023 to 09/30/2028
Admin Advisors:	[Richard C. Rhodes III]
NIFA Reps:	

Statement of Issues and Justification

The Northeast Coordinating Committee on Soil Testing (NECC-1812) works to ensure that soil testing, plant analysis and waste/residual analysis are properly used and interpreted within our region to support sustainable, economic, and environmental resource management for all who live in the region. The diversity of our region in terms of soils, climate, land use and demographics requires an approach that is appropriate for our needs rather than just adopting an approach “as-is” from elsewhere. Traditional agriculture continues to be practiced throughout the region. Alternative agricultural systems, such as high tunnel production, organic production, and new niche crops (e.g., malting barley, hemp), continue to expand.

Increased urbanization has also led to an increase in home gardening, urban landscapes, and urban farms. Soil “health” as opposed to soil “fertility” – and the questions on how to evaluate it and what those evaluations mean – continue to receive an increased level of interest in the Northeast and elsewhere.

All these changes, combined with the increased recognition of the role of proper nutrient management in environmental and economic sustainability, require that this committee remain actively engaged in efforts to support our clientele. Those efforts will include research to evaluate and update nutrient recommendations for old crops, new crops or new production systems, the development and/or modification of testing protocols for new uses, or the interpretation of test results and development of recommendations for alternative land uses.

While demand for our efforts continues to grow, staffing at the land grant universities in our region continues to shrink. This situation, therefore, requires a collaborative approach to make the best use of the expertise available. No one institution has all the resources necessary to address emergent and on-going concerns; however, using a team approach across institutions, we can leverage expertise in our region to meet our clients’ needs. Our committee has a history of successful multi-state regional research and outreach efforts based on ideas and discussion that originated from the committee. For example, collaborative research on nitrogen and potassium response of high tunnel tomatoes in New England was instrumental in producing a New England High Tunnel Production fact sheet, with yield-dependent recommendation tables. Similarly, cooperators from Maryland have led field research designed to guide production of hemp in the Mid-Atlantic US. Committee members have also collaborated to share information for a homeowner audience on topics such as soil testing, management of raised beds, and soil lead contamination. We plan to continue with collaborative initiatives as we move forward to address emergent problems, especially those being observed in multiple states. This type of “team effort” helps to improve credibility, as regional recommendations developed by the committee do not change at “state lines” but rather at the natural boundaries where they should (e.g., where soil changes dictate). Exploring relations with others at our host institutions in the areas of horticulture and extension will enable the committee to better address soil testing and fertility issues in agronomic systems, as well as in areas that need our expertise, but which have fallen outside the traditional “agronomic” emphasis. These areas include (but are not limited to) urban food production, ornamental production, and lawn and landscape management – which increasingly fall under nutrient management regulation.

Meeting the needs of our stakeholders – the growers, the landscapers, the homeowners, the regulators we advise – first requires the sharing of information among ourselves at our annual meetings where evaluations and discussions may focus on methods, instrumentation, field research, local, regional and nations issues, and much more. Contributions to the field include evaluation and vetting of new methods being proposed for adoption in our national proficiency testing programs (e.g., NAPT and ALP) and by commercial laboratories serving our region to ensure they are appropriate for use in the Northeast region. Stakeholder outreach included the maintenance of our regional soil testing methods reference manual, development of regional fact sheets on topics of importance in all or parts of the northeast, and designing, implementing, and disseminating results of regional research. Collaborative work with other regional research committees contribute to activities and publications such as the national manure testing manual. Committee members also continue to provide talks at local, regional, and national meetings and training programs on a variety of these topics. At a time when there is much conflicting information available to our stakeholders, it is critical that unbiased, science-based information is researched and made available by committees such as NECC-1812.

Objectives

1. To improve, standardize, and validate soil, plant, and waste analysis methods used within the Northeastern region of the US.
2. To improve crop nutrient recommendations based on soil, plant, and waste analysis results, crop management factors, and environmental sustainability.
3. To provide a forum for discussing and responding to challenges facing soil testing and nutrient management efforts.
4. To support Extension efforts in soil testing, nutrient management, and related environmental issues.
5. To serve as an educational resource on the appropriate use and interpretation of soil, plant and waste analysis for the general public, environmental and nutrient management regulators, and the commercial testing industry.

Procedures and Activities

The Committee will include members from the regional land-grant universities with expertise in soil testing, plant and waste analysis, and soil fertility and nutrient management. The Committee will strive to achieve its objectives by:

1. Meeting annually to discuss advances in soil, plant and waste analysis methods, laboratory instrumentation and data management, nutrient management techniques, issues and policies, and the relevant research and Extension efforts occurring in each state within the region.

2. Pursuing cooperative research efforts among the participants in the areas of soil testing methodology, soil fertility and field calibration, and nutrient management.

3. Sharing all soil test correlation and calibration data among all members on an ongoing basis.

4. Holding discussions by conference call or e-mail at other times during the year, on issues of immediate importance within the region and serving as a collective resource for all members.

5. Providing and updating a Committee website as the primary means of improving access to regional soil testing and nutrient management information by others outside the committee.

6. Interacting with other soil testing and nutrient management communities to promote cooperative efforts on a national scale by meeting jointly every four years with the other regional workgroups, including NCERA-13, SERA-IEG-6, and WC-103. Members also participate in other groups such as MASTPAWG, SERA-17, FRST, NECC-2103, SPAC, SSSA, ASA and CSA.

7. The workgroup holds a voting seat on the Oversight Committee of the North American Proficiency Testing Program for Agricultural Laboratories (NAPT). One member is elected to a 3-year term.

Expected Outcomes and Impacts

- Collaboration and regional participation on Fertilizer Recommendation Support Tool (FRST) projects to update and enhance nutrient and liming recommendations. Over the next five years the Northeast region will contribute data for least 50 site-years from soil test correlation field trials.
- Evaluation of the Moore/Sikora Buffer, Mehlich Buffer and Direct Titration methods as replacements for the Adams/Evans buffer. Replacement of the Adams/Evans will reduce the hazardous waste and improve laboratory safety. This work also has the potential to improve the precision and accuracy of lime recommendations throughout much of the region.
- Continued updating of Cooperative Bulletin No. 493 Recommended Soil Testing Methods for the Northeastern United States as new methods are developed and validated, and existing methods are revised or improved. The committee will specifically look to revise the soil pH and liming methods based on results of regional research to evaluate alternative lime requirement methods. A delineation of recommended test methods for high tunnel soils will also encourage more widespread adoption by commercial and University testing programs. Exchange of information on soil sulfur testing and sulfur recommendations.
- Exchange of information on compost testing and develop regional guidelines for interpretation of results and use of compost with an emphasis on avoiding the accumulation of excess phosphorus from application of compost to increase soil organic matter.
- Discussion of the philosophy, science, and regulation behind nutrient recommendations for turf in the region.
- Review of non-chemical fertilizer recommendations for certified organic farmers and gardeners and develop regional guidelines. This work should lead to more efficient use of non-chemical fertilizers to reduce the potential risk for build-up of nutrients and nutrient losses in organically-managed soils.
- Review of existing soil test methods and recommendations for high tunnel production systems, with continued development and refinement of regional guidelines. The goal is to encourage more widespread adoption of methods that address soil fertility and soil health concerns specific to high tunnel production.
- Discussion, review, and evaluation of new and existing nitrogen management tools to move regional production systems toward better nitrogen management, thereby reducing nitrogen losses (atmospheric and to water) and improving the economics of nitrogen fertilizer use.
- Evaluate, validate, and develop interpretations for soil health/soil quality tests that are appropriate for and relevant to the soils and climate in our region with the goal of offering tests with meaningful interpretations to regional growers at the lowest cost possible.
- Discussion of approaches for testing and nutrient recommendations for potting mixes/raised beds, with possible development of uniform regional approach and fact sheets for home gardeners and urban farms.
- Evaluation of salinity test methods and interpretations for use on Northeast Region soils where saltwater intrusion is increasing with the goal of implementing low cost tests with meaningful interpretations that can be used to determine if land can be remediated or should be transitioned to other uses.
- Review of EC methodology, interpretation, and cross correlation with SME methods, as it applies to soil testing for high tunnel production with the goal of improving nutrient use efficiency, soil quality, and productivity of these systems.
- Development of a Committee website to include approved articles and relevant regional fact sheets and resources on soil metals analysis, plant tissue analysis, compost evaluation and use, and other topics not included in routine soil fertility testing.

Educational Plan

The committee will update and maintain Cooperative Bulletin No. 493 to serve as primary reference and an educational guideline for laboratories serving the region.

Committee members will provide educational presentations at national, regional, and local meetings to communicate new and existing test methods, as well as nutrient management philosophies and tools to all stakeholders in the region.

Regional factsheets will be prepared as a means of disseminating information to various groups including Extension educators, regional laboratories (public and private), commercial growers, commercial landscapers, and/or homeowners.

Organization/Governance

The committee is governed by a Committee Chair and a Secretary selected on a rotational basis from the participating states. A new secretary is selected at the end of the annual meeting at which point the current Secretary becomes Committee Chair for the next 12 months. The Committee Chair is responsible for organizing the annual meeting and planning the agenda. The Secretary records the minutes at the meeting for which he/she is Secretary.

Administrative guidance is provided by an assigned Administrative Advisor and a NIFA Representative.

Literature Cited

NECC-1012, 2011. Recommended Soil Testing Procedures for the Northeastern United States. 3rd Edition. Northeastern Reg. Bull. No 493. Univ. of Del., Newark, DE. http://extension.udel.edu/lawngarden/1864-2/lawn-garden/soil-health-composting/recommended-soil-testing-procedures-for-the-northeastern-united-states/.

Land Grant Participating States/Institutions

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**0**	**0**	**0**

Program/KA	Total FTE
Grand FTE Total:	**0**

Response to Reviewer Comments

Appendix J1: CC Evaluation (Submitted)

Status: Complete
Project ID / Title:
NECC_TEMP2312: Northeast Coordinating Committee on Soil Testing

Questions

1. Goals and objectives clearly stated and appropriate to committee activity(s) **Excellent**

2. There is a good potential to attain the objectives and plan identified in the activity. **Excellent**

3. Activity addresses priority research and is not duplicative with existing activities. **Excellent**

4. Activity has moved beyond individual activity(s) and ideas to a collective, interdependent activity. **Needs Improvement**

For renewal projects only:
5a. Attendance of the preceding project has been adequate and reflects broad participation by designated project participants. **Excellent**

5b. The project has developed and demonstrated technology transfer to clientele. **Fair**

Recommendation
Approve/continue with normal revision.

Comments:
Regional soil testing groups are important for faculty in NE Region's land grant universities and their stakeholders. These regional groups mentor young faculty, address agricultural sample analyses in the laboratory, and collaborate on applied nutrient management research and educational issues. The regional methods manual, last updated in 2011, is an important output of this regional project. The project should continue, but would benefit from some revision and renewed effort. My comments and recommendations are listed below.

1. The issues and justification should be updated more extensively. The document for the renewal is very similar to the current project. I understand that the issues and justification may be similar as in the past, but it would be good to communicate what if any progress has been made on the issues. For example, high tunnel production systems, malting barley, and soil health continue to be mentioned as justification for the project. I would like some mention of what has been done to address these issues to reinforce that the regional group is making progress on finding answers and solutions for the stakeholders.

We have expanded the issues and justification section to include some of the progress we have made in the past renewal period toward finding answers and solutions for stakeholders.

2. The objectives cover research and extension missions with practical and achievable tasks. Are there activities that involve the traditional teaching mission - e.g., student training? If so, teaching-related objectives should be included.

At this time, the focus of the committee on stakeholder engagement. Some members may participate in traditional student training, but these efforts are tangential to the NECC group activity. Individual group members may provide opportunities through outreach activities and assistance with material preparation for graduate and / or undergraduate students to gain experience as they prepare for future careers in outreach and extension.

3. Procedure #3 should include the term "correlation" in addition to calibration.

This term was included.

4. The "Expected Outcomes and Impacts" Section provides a list of activities (discuss, review, collaborate, etc.) but is short on tangible, measurable outcomes and impacts (publish, present, etc). Some of these outcomes and Impacts should change as the project continues and matures. Many of these are identical to the current project suggesting progress in addressing the issues is slow. None of the activities have an impact listed.

Additional information has been provided to include tangible impacts.

5. I could not find a website for the activity but the document mentions the website several times including in Procedure #5. The methods manual was found on the Univ Delaware website. The website is also mentioned in the last bullet in the Outcomes and Impact Section. Developing the website (or making it findable in a Google search) is low-hanging fruit and would be a vehicle to show progress on objective #5.

This was updated to list that we would develop this website.

6. Outcomes and Impacts that show group collaboration are needed to improve the rating to question number 4 above.

Appendix J1: CC Evaluation (Submitted)

Status: Complete
Project ID / Title:
NECC_TEMP2312: Northeast Coordinating Committee on Soil Testing

Questions

1. Goals and objectives clearly stated and appropriate to committee activity(s) **Excellent** 2. There is a good potential to attain the objectives and plan identified in the activity. **Excellent** 3. Activity addresses priority research and is not duplicative with existing activities. **Excellent** 4. Activity has moved beyond individual activity(s) and ideas to a collective, interdependent activity. **Excellent** For renewal projects only:

5a. Attendance of the preceding project has been adequate and reflects broad participation by designated project participants. **Excellent** 5b. The project has developed and demonstrated technology transfer to clientele. **Excellent** Recommendation
Approve/continue with normal revision.
Comments:
The proposal is well-written and addresses critical soil testing and nutrient management research, education, outreach, and extension needs in the northeast U.S. region.

Appendix J1: CC Evaluation (Submitted)

Status: Complete
Project ID / Title:
NECC_TEMP2312: Northeast Coordinating Committee on Soil Testing

Questions

1. Goals and objectives clearly stated and appropriate to committee activity(s) **Excellent** 2. There is a good potential to attain the objectives and plan identified in the activity. **Excellent** 3. Activity addresses priority research and is not duplicative with existing activities. **Good** 4. Activity has moved beyond individual activity(s) and ideas to a collective, interdependent activity. **Excellent** For renewal projects only:

5a. Attendance of the preceding project has been adequate and reflects broad participation by designated project participants. **Excellent** 5b. The project has developed and demonstrated technology transfer to clientele. **Good** Recommendation
Approve/continue with normal revision.
Comments:
Very important committee for LGU to lead nutrient management effort. Objectives, methods and outcomes are well presented.