MINUTES OF ANNUAL MEETING
W3168 Multi-state Research Project
Oregon State University, Corvallis, OR
June 28-30, 2018

Meeting information and agenda: https://www.nimss.org/meetings/51304

Friday, 29 June 2018

Present (by state/agency)
AZ, Ramin Yadegari (U. Arizona)
CA, Kent Bradford (UC Davis)
FL, Hector Perez (Univ. FL)
KY, Robert Geneve (Univ. KY)
NY, Alan Taylor (Cornell U.)
OR, Sabry Elias & Thomas Chastain (OR State U.)
SD, Xingyou Gu (SD State U.)
TX, Daniel Leskovar (Texas A&M)
VA, Greg Welbaum (VA Tech)
USDA-NIFA, Liang-Shiou Lin

Welcome and introductory remarks by Elias Sabry and Jay Noller (Dept Head, Crop & Soil Science, OSU). A discussion about hemp/cannabis as new areas of research and extension work. Taylor asked about incorporating hemp into W3168 project goals. Bradford asked about legal status of working on hemp/cannabis. Noller responded on the experiences at OSU, and offered to provide advice and guidance to others.

Chairperson Geneve called meeting to order.

Lin described current NIFA competitive funding programs and the available web resources for USDA grants. The slide show is made available to the participants.

New Project Proposal

Geneve initiated discussion on the new project proposal, content, goals, and logistics.

Perez described the results of the recent survey of the members, with 5 questions focusing on topics including: whether the members plan to participate in a new 5-year project (11 yes, 2 no), which of the existing goals to pursue, what additional activities to pursue, and which other scientists to recruit into the working group (results of the survey attached).

Discussion (by all members) of how to proceed with the new project and how many participants are necessary to make the project impactful:

Geneve: there is a general attrition in seed science areas in universities; necessary to change focus to bring in additional people; most institutions can only afford (or required to) send only one member, this reduces ability to recruit young scientists into the program.

Perez commented on the need to maintain or reinforce seed system as a broad concept.

Taylor suggested hemp as a potential focus commodity for the group.

Rewrite should be based on exiting members with potential of recruiting additional faculty members based on the current and future hires in the participating institutions.

Need to use new, updated terminology in the project rewrite and for recruitment of new members, and having a message or vision to help increase participation in this group.

Define our objectives, and clarify or remove old language: for example, “eliminating seed dormancy” should be reconsidered in favor of “manipulating seed dormancy” (Gu).

Consider incorporating ideas such as high-throughput phenotyping.
Geneve suggested consensus for the project to focus on "seed systems biology"

Bradford led discussion on an outline for the new project goals around a set of core concepts including: (a) Reproductive biology including genetics, seed development, flowering, etc.; (b) Seed quality, manipulation, dormancy, seed as products, vigor, native seeds; and (c) Seed delivery: technology, microbes, stand establishment, post-germination.
Other concepts and considerations discussed included seed banks, weed scientists, and apomixis.
Recruitment of female members and general recruitment of workers in the field including some inactive participants form previous years. The Secretary (Yadegari) will maintain official mailing list. Bradford will send Yadegari the existing working-group's mailing list for the record.

Outline of Project Proposal

After a brief break, restarted the meeting with continuation of discussion of the new objectives, and developed an outline accepted by consensus as indicated below:

Overall concept/title: Seed Systems Biology
Individual components:

1) Reproductive Biology
    a. Flowering
    b. Apomixes
    c. Embryogenesis & endosperm development
    d. Shattering
    e. Dormancy and germination (supports goal 2)
2) Seed trait assessment and manipulation (quality)
    a. Assessing and manipulating seed quality through knowledge of seed dormancy and germination
    b. Digital assessment approaches and tools
    c. Agtech, phenotyping (supports goal 3) under normal and stress conditions
    d. Post-harvest technologies
    e. Seed testing
3) Seed "delivery" systems (considering that G×E×M×M)
    a. Microbe enhancement
    b. Weeds (problem in delivery of seeds)
    c. Seed traits: seedling inoculation enhancing root growth, etc.
    d. Food safety
    e. Restoration/ecology of ag fields
    f. Stand establishment and automation
    g. Cover crops
    h. "new crops"

Other considerations in writing and incorporation of non-scientific components to be considered for the new project:

(a) Cross-cutting approach to stating goals, perhaps using a matrix to indicate how (1) could help obtain (2) to get to (3) as an outcome.
(b) Industry participation

(c) Impacts and future directions would include (a) Meetings (graduate student and industry participation, (b) a major meeting that has international impact, (c) publications, and (d) education outcomes.
(d) Public relations
(e) Broad educational impact

Writing of the New Proposed Goals

Discussion of who will do what to draft the new project goals"

Group agreed to form a coordinating committee of three individuals to help draft the new project proposal, two of whom were identified immediately (Yadegari and Perez), one to be identified later. The committee will (a) put together a timeline for writing the proposal (current project will terminate on 20-Sept-2019), (b) develop a set of focused objectives by refining the above-mentioned goals, (c) communicate the draft outline to the participants, (d) poll the group for interest in involvement and identify individual contributors, (e) delegate responsibilities of writing sections of the proposal to the individual participants, and (f) identify individuals from the group who would review and rewrite the proposal as necessary.

The format of the proposal is not clear to the group at this point. Will send an inquiry to Paul Johnson (see below).

With regard to the annual report, the Secretary (Yadegari) will put together the annual report based on previous formats and is based on activities since the Monterey ISSS meeting (see below).

<u>Saturday, 30 June 2018</u>

Call to order.

Geneve announced that the next meeting would take place in KY, sometimes during summer.

Sabry and Bradford suggested a need to outreach to new members, identify new members by working group and send out invitation emails.

Perez will email Paul Johnson to ask about the renewal proposal format.

Yadegari will put together the annual report from the individual submissions.

Election of a new Secretary was deferred to a future time as no one volunteered at the time.

Reports of Research Activities

Perez

Funded research is carried out in four major areas: (a) Examining latitudinal influence on Sea Oats germination ecology and temperature stress tolerance (US Dept of Commerce Sea Grant), (b) Preparing plant production leaders through multi-disciplinary training in controlled environment agriculture (USDA-NIFA NNF), (c) Meeting *in* and *ex situ* federal recovery plan objectives of Harperocallis flava via seed biology and micropropagation (FLDACS-Endangered Plant Conservation Program), and (d) Enhancing seed production of regionally adapted crops in the southeastern farmer seed system (USDA-Southern SARE). Described ongoing instruction, training and outreach efforts including teaching the course "Evolution, Eco-Physiology and Global Importance of Seeds" at Univ. FL, and enhancing non-technical workplace competencies of early-career seed scientists e.g., graduate, undergraduate and postdoctoral training). The latter efforts in the past year focused on outreach activities before and during the 2017 ISSS meeting in Monterey with 52% of invited orals presentations, 35% of poster presentations and 8 session co-chairs drawn from these groups. There was multiple opportunities for networking during the meeting. Including a speed networking events in

Salinas with representatives of 13 seed companies interacting with 65 undergraduate students, 20 graduate students and 3 postdoc. These efforts were summarized for the community in a recent paper (Pérez, H.E. 2018. Seed Science Research 1-4).

Taylor

Focused on Objective 3: Seed Treatment and Coating Technologies. He briefly discussed his group's efforts in the areas of pest management using seed treatments for eradication of seed-borne bacteria in tomato, and organic seed treatments for control of seed-borne fungi in table beets. Taylor described in detail the more recent work from his group on (a) the use of seed coating agents in mitigating abiotic stress (drought stress) using hydrophilic polymers, and (b) for development of systemic seed treatment uptake by studying seed coat permeability in relation to lipophilicity of active compounds. For (a), the goal is to develop appropriate seed coating protocols that can help with germination and survival of cover crops such as red clover. Presented data on the optimization of the amount of hydrophilic polymers to hold water around seeds and uniformity of application. He also reported on the efforts to determine the relative rate of uptake of systemic compounds that can be used for coating as means of countering early season pest damage. For the latter, he presented data on uptake of fluorescent tracers including piperonyl amides and coumarin in treated seeds of soybean, corn, and tomato.

Geneve

Described recent work in two areas related to Objective 2: (a) Temperature effects on seed germination in industrial hemp (*Cannabis sativa* L.), and (b) Near-infrared spectroscopy (NIRS) used to predict soybean seed germination and vigour. Geneve presented experiments measuring the germination frequency of two varieties of Cannabis (Georgina and Victoria) under a range of temperatures and determined sub and supra optimal temperatures using linear regression models. He also showed experiments where a solid matrix and osmotic priming protocols were used to enhance germination rates under various temperature conditions. He also describe the use of NIRS to predict seed quality of 81 seed lots of soybean with a known range of germination rates displaying an associated accelerated aging and electrolyte leakage phenotypes. The seed lots were divided to high, medium and low-vigour seed lots based on the above characteristics. NIRS was able to produce clustered data indicating distinct separation between of the low vigor from the other two lots, and a relatively well clustering of the medium from the high vigor lots.

Welbaum

Described work on four areas: (a) Bacterial Fruit Blotch (BFB) of Cucurbits (BARD funded), (b) Hemp seed germination (funded by State of VA), and (c) seed transmission of Tobacco Mosaic Virus (TMV, funded by tobacco industry), and (d) effects of low phytate Soybean lines on seed vigor. Welbaum described the ongoing research on BFB using a Central American squash (*Cucurbita okeechobeenis*) where detached fruits are detached, cut in half and inoculated with the bacteria. They have identified a cultivar with putative resistance to the M6 strain of BFB, and are making crosses with other *Cucumis melo* L. plants this summer to learn more about inheritance of the resistance gene(s) For (b) currently determining the minimum, maximum, and optimum germination temperatures for hemp seeds of diverse genotypes produced in the same field using the thermogradient table. Work on (c) is focused on reducing TMV transmission through seeds, as dissection assays and PCR analysis suggest that TMV is coat transmitted rather than embryo transmitted. Seedlings are likely infected as they emerge from the seed coat. A population of seeds infected with TMV during seed development was germinated on different types of media in two different years. The percentage of infected seeds was determined by ELISA. The percent TMV infection was highest on blotter paper. Substrates containing

clay show a reduction in TMV infection. Welbaum also reported that the Thermogradient Systems LLC is now a company and selling the tables to companies and institutions for measurements of seed germination rates under controlled conditions.

Bradford

Described the ongoing activities associated with his responsibility as the Interim Faculty Director of World Food Center and his research efforts at Seed Biotechnology Center, UC Davis. For the latter, provided an update on a number of technologies utilized or developed at the Center including the Videometer used for analysis of physical characteristics of seed lots, and their health, vigor and germination speed. As an example, provided data on the use of the instrument for separation and collection of individual seed features such as area, length and width of corn and tomato seed lots. He also provided a progress report on current efforts in development and testing of protocols and instrumentation for establishing and maintaining the dry chain to reduce postharvest losses and improving food safety in humid climates. These included development of DryCard as a quick means of determining relative humidity of seed lots, and the related awareness campaign (www.drychain.org). Bradford also provided a summary of his recent research on the relationship between seed germination speeds and seed respiration rates, and provided data on the variation detected in seed lots for these parameters—that is, detection of subpopulations of seeds with distinct physiological characteristics. He provided a general model of how to interpret such variations in the context of sensitivity thresholds associated with detection of each set of the contributing biological processes.

Gu

Provided a brief overview of the ongoing activities in his lab to understand the molecular-genetic basis of seed dormancy (SD) using weedy rice. SD influences seed bank longevity as the more dormancy-enhancing alleles that are present in a given genotype, the higher the extent of seed viability after 7 months of soil burial. He reported on cloning efforts of four SD QTLs qSD1-2, 7-1, 7-2 and 12. qSD12 consists of 3 loci, each with an additive effect on regulating seed dormancy in weedy rice. Two loci, SD12a and SD12c encode bHLH transcription-factor proteins, while the third locus SD12b encodes a protein of unknown function. SD12a and c arose as a result of a local gene duplication event. Further work on characterization of the network of the genes regulated by these proteins is ongoing.

Yadegari

Described recent work on elucidating gene-regulatory networks involved in differentiation of maize endosperm compartments with an emphasis on networks associated with the development of basal endosperm transfer layer (BETL) and starchy endosperm (funded by NSF-PGRP). He summarized the previous analysis of gene co-expression networks in maize endosperm cell types and presented new data on the connection between starchy endosperm gene networks regulated by the Opaque-2 transcription factor protein and networks that are associated with aleurone cell type differentiation.

Chastain

Described his ongoing research in understanding the effect of various agents in increasing yield perennial ryegrass in Oregon as a result of individual changes seed number and seed weight. He described the effects of inhibitors of gibberellic acid synthesis such as acylcyclohexanedione agents on floret numbers, seed set, stem length, etc. in perennial ryegrass. Current projects include high-throughput phenotyping of reproductive characteristics in perennial ryegrass by topometry, and identification of traits associated with seed shattering in ~160 accessions. In addition, he is studying seed development

in orchardgrass by measuring seed growth rate, length of seed filling period, seed set, progress toward seed maturity (GDD), and formation of the most important seed yield components (seed number and seed weight) in different positions in the inflorescence. Finally, his group is using a hand-held near-infrared reflectance spectroscopy (NIR) device to measure seed moisture as mean if determining the best time for harvesting of grass seed crops.

Elias

Described recent work on plant growth regulator and irrigation effects on physiological and harvest maturity of red clover in relation to seed quality. Plant growth regulators (PGRs) and irrigation affect seed yield of red clover (Trifolium pratense L.). However, the effects of these factors on physiological maturity (PM), harvest maturity (HM), and seed quality are unknown. The objectives of the Elias research is to determine the effects of trinexapac-ethyl (TE) PGR and irrigation on PM, HM, and seed viability and vigor on the most common red clover variety in Oregon over two years. He showed that the application of TE increased seed yield in the second year by up to 16.2%, when applied in the stem elongation stage. Irrigation increased it by 10% in both years. Irrigation resulted in a four-day delay in PM compared to the non-irrigated treatment, but TE applications did not affect timing of seed maturation. At PM, flower heads contained light brown petals and brownish-green sepals, while seeds were pale green to pale yellow. At HM, heads contained dark brown petals and sepals, whereas seeds ranged from yellow to yellow-dark grayish purple. Seed dry weight did not change from PM to HM. Seed moisture content at PM ranged from 340 to 540 g kg-1 and decreased to below 140 g kg-1 at HM. At HM, seeds reached maximum quality as viability ranged from 92 to 98% by TZ and SG, and vigor ranged from 90 to 94% by CT.

Leskovar

Described work in areas related to Objective 3.3. Seed/seedling treatments to enhance germination and vigor under abiotic stresses. He first discussed the importance of low N rates on enhancing root growth and reducing transplant shock in artichoke transplants. He also reported that exogenous application of ethylene to imbibed onion seeds, promoted fine root development and overall root surface area in onion seedlings. Another tomato transplant study presented promoting root and shoot growth responses to a soil bio-stimulant based on a combination of humic substances. Conversely, he showed that the application of 1-MCP to pepper and tomato transplants exposed to heat stress had inconsistent transplant responses, which varied with genotypes. He then discussed data on the benefits of grafting (high root vigor) in enhancing growth and yield of tomato under protected cultivation, and presented evidence of using a ground-penetrating radar to detect fine roots. Finally, he presented activities associated with his responsibility as Chair of the Working Group titled Seed, Transplant and Stand Establishment, (SEST), International Society of Horticultural Sciences, and the upcoming SEST Symposium he is organizing in Turkey.

Meeting adjourned at noon.