Science Societies

New frontiers in seed research

Discussing the "-Omics" with Rodomiro Ortiz

By DJ McCauley

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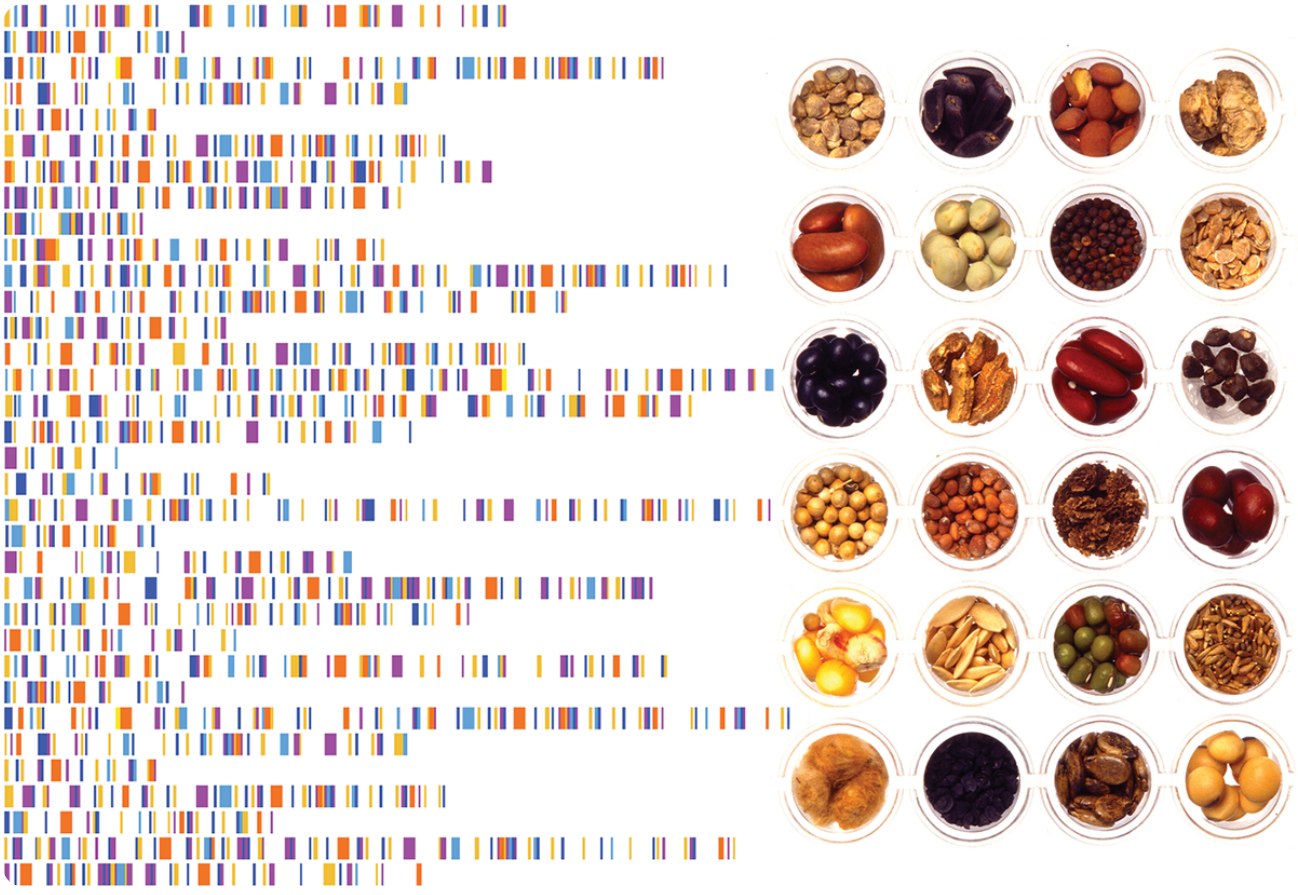

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- 22–28 Mar. 2021 is CSSA's inaugural "Seed Week," a promotional effort to bring news and information to the public about seeds.
- In celebration of Seed Week, CSA News magazine sat down to talk with Rodomiro Ortiz, corresponding author of a new review of genomic seed research, published in Crop Science.
- Ortiz describes how advances in genomic seed research can help us modify seed traits by harnessing their genetics and biological pathways, inspire researchers, and improve food security worldwide.

More than 100 years later, an international team of researchers hailing from India, Ireland, Canada, and Sweden just published a review article in *Crop Science* (**https://doi.org/10.1002/csc2.20402**) that not only sums up the state of genomic seed science research, but also suggests future areas of discovery—from high-throughput analyses to assess seed dormancy, germination, and vigor, to altering the nutrients within seeds for specific nutrition needs, to discovering the specific pathways that contribute to all the traits of the seed we can modify.

Here, *CSA News* magazine talked with Rodomiro Ortiz, the corresponding author, about the review and its focus; namely, the "-omics" of seed science. Ortiz is currently the Chair Professor of genetics and plant breeding at the Swedish University of Agricultural Sciences. The following conversation was edited for length and clarity.

CSA News: Where did you get the idea for this review in *Crop Science*?

Ortiz: My colleague in India, Sangam Dwivedi, retired and decided to put his knowledge into these review articles, going through the literature and providing a state of the knowledge. We realized in 2018 that we're really missing up-to-date information on the genomic side of seed research. So we gathered a team, with specialists in everything—[Dr.] Spillane in Ireland, and his student, Francesca [Lopez], and our colleague in Canada, Dr. Ayele. Everyone contributed to all the sections.

CSA News: Why, in 2018, did it seem like the right time for a review of genomic seed science research?

Ortiz: This was not on our initial list of ideas, but as we were researching for these reviews, it was clear to us that we needed to study more about the seed. It was not well appreciated. If you look for in-depth research on seeds, you need to go to the 1990s! There's information, especially for crop production, seed-propagated crops, seed quality, and certified seed. But the different biological aspects of seed development and seed production? That was missing.

CSA News: Your review is pretty thorough—out of all the topics you covered, what do you see as the most exciting?

Ortiz: I will say, it's how we gain insights into processes related to seed development using all these new "-omics" methods: Genomics, proteomics, and phenomics. They allow us to monitor the relationship between the gene and the final seed. Those are the things that are exciting, no? We've gained a lot of insights. We know much better the pathways that lead to a seed with high quality, with viability, a seed that may increase in size. Or, when we go into the composition of the seeds, especially when we look at seed-propagated crops that are feeding the world, namely the cereals. Now you can

start changing the compositions of protein, of fatty acids—that's what's exciting to me.

Along with that, you have all these advances in high-throughput phenotyping with image analysis, and that's helped a lot, because you have much more precise phenotyping of characteristics of seeds. Coupling that with genomics, you can even identify markers you can use for selection when you want to develop characteristics.

CSA News: Was there anything that surprised you?

Ortiz: What was surprising was how much knowledge we've gathered in the last 10 to 15 years because of these new insights from the "-omics" as well as advances in the last five years with high-throughput phenotyping using image analysis. I thought we already knew these things, with all this plant research, but it's amazing that we have all these areas to advance for studying seeds! I find that very positive.

CSA News: One of the areas of focus in the article is food security. Can you tell me about that?

Ortiz: Well, we say seed, and when you say seed, it's related to producing crops, and if you produce crops, you'll get food. But the seeds not used for planting are for eating, and that's grain! The grains of legumes, cereals, oil crops like canola. That's about 50% of our calorie intake, for the world. The review, in that sense, is not only about the seed for planting material, but about the seed as a source of food. There's a section on improving [seed] composition because we know that protein and fatty acids are very important components of the seed.

CSA News: Another thing that you talk about is seed storage and conservation—how do you see new research helping?

Ortiz: There have been some advances to genomics to study seed viability and storage, seed dormancy, and seed vigor. All of these are better understood with the use of "-omics." We can map genes that correspond to different pathways to increase storability and longevity of the seeds, their viability and vigor. These are things we can improve with breeding, but now we can start in on this side with genetic pathways and apply this knowledge. We need a much more reliable seed conservation system to ensure we have enough food in the 21st century, especially with our changing climate.

CSA News: What do you hope the biggest takeaway is for other researchers reading your paper?

Ortiz: First, it will help them be up to date in new developments in seed research, especially in the "-omics." Now they finally have a reference to go to. The other thing is, by reading the state-of-the-art [research], they come up with new ideas. For me, as a scientist, that is the most important thing. Finally, anyone who reads the article who is not working on seeds gains knowledge of the importance of seeds. We need renewed interest in seeds by the scientific community!

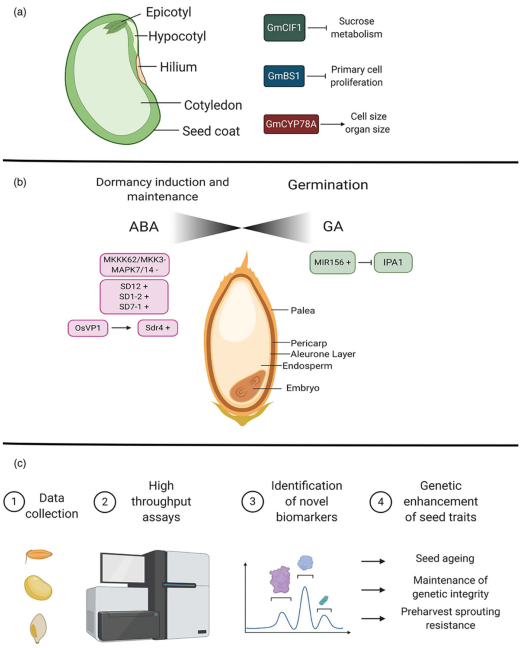

Illustration from the review article discussed here showing regulation of seed development for improved agronomic traits in dicot and monocot models and crops. (A) Seed weight in soybean is modulated by metabolism, cell wall proliferation, and cell size. Disruption of inhibitors, such as GmCIF1 (a cell wall invertase) and GmBS1 (negative regulator of cell proliferation), results in increased seed weight and seed size. Conversely, the KLU Arabidopsis ortholog (GmCYP78A) positively regulates organ size in soybean, including seed size. (B) Dormancy and germination are key agronomic traits regulated by environmental factors and phytohormones. The balance between abscisic acid (ABA) and gibberellic acid (GA) controls both dormancy and germination. In Oryza sativa, several genes have been implicated in these processes, either as positive or negative regulators of seed dormancy and germination. (C) Data generation from different crop species using high-throughput assays is ideal to identify novel biomarkers for genetic enhancement of seed morphometric and germination traits. Figure created with Biorender.

CSSA to Celebrate Seed Week 22–28 March

By Susan V. Fisk, ACSESS Public and Science Communications Director

In 2017, CSSA's **C522 Communications Committee**[1] in conjunction with the science communications staff, completed a public communications plan aimed at increasing awareness of crop science topics within the general public. Several messages and tactics were developed, and the biggest program was a joint blog with ASA, called the ***Sustainable, Secure Food Blog***[2] which features two new blog posts each month. The blog first launched in January of 2018 and currently has between 8,000 and 10,000 views per month (which is considered excellent in the blogging world!).

As part of the same plan, CSSA launched **Crop Wild Relative Week**[3] in 2018 and continues to expand and re-promote materials each 22–28 September. Every year, the communications team recruits new bloggers to add to the popular list and promotes them along with the **crop wild relative web page**[4] a series of blogs, a

video, and collected journal papers. Creating public promotions and keeping them fresh and alive is an important part of the plan.

Based on readership of the *Sustainable, Secure Food Blog* by topic, **seeds** are something the public wants to know more about—and who better than CSSA members to provide that information? Two popular blogs, one about **seed germination5** and another about **seed banks**,**6** have accumulated more than 12,000 and 11,000 views, respectively! Thus, members of the C522 committee decided that the next promotional week would be about seeds.

The first **Seed Week** will be celebrated 22–28 Mar. 2021. Like Crop Wild Relative Week, it will be ongoing each year. For its launch, the team recruited seven bloggers and is developing a web page.

Marilyn Warburton, president-elect of CSSA, was part of the team that created Crop Wild Relative Week in 2018 and has also helped with Seed Week planning. "I was glad to participate in the development of Crop Wild Relative Week in 2018, and I'm very excited to see how Seed Week has come together. I like how our communications team keeps metrics to help us know what types of communications work best for public relations."

"I was happy to join the C522 Communications Committee," says Christine Bradish, who is now serving as chairperson. "I've enjoyed the science communications workshops offered by CSSA staff, and this is a great opportunity to serve. Seeds are indeed fascinating, and it was interesting to learn that they are the most read topic on our blog. I was glad to help recruit blog writers, write a blog myself, and help with the

web content for this topic—and I look forward to the week and how the progress will be measured."

Mark Westgate, past president of CSSA, was integral in creating the initial communications plan in 2017, which the C522 committee continues to build upon. "I'm very happy to see CSSA continuing to expand the communication of crop-related topics among our members and with the public. The plant science blogs and promotional weeks focused on special topics have been particularly effective. I hope we see the public engagement continue to grow."

Watch your *News Flash* in mid-March to learn more about Seed Week and to get the links—and help the team spread the word by following our social media channels and liking and sharing posts during Seed Week!

The year is 1918, and Dr. O.A. Stevens just published an article in the *Journal of the American Society of Agronomy* (now *Agronomy Journal*), describing the ways sampling errors lead to variations in seed test results.

In 1914 and 1915, "when routine duties were not pressing," Stevens sent samples off to various seed-testing laboratories from a common batch of seeds, which he kept and used to conduct his own control tests.

He found "variations in the results of seed testing are fundamentally of two kinds and are to a great extent impossible to avoid." In short, Stevens lays out a treatise on the "human element" of seed-testing errors—imperfect sample mixing, errors in hand-counting seeds, and errors in weighing them out.

But Stevens, an active and prolific professor of botany from 1909–1956 at North Dakota State University, would likely be astonished and delighted by the level of complexity possible in today's seed testing. I imagine he'd be thrilled to learn that

high-throughput phenotyping could combat many of the issues that arise with hand-phenotyping seeds.

Thanks to Our Seed Week Team Members

- Christine Bradish, C522 committee chair
- Marilyn Warburton, Crop Science editor (2020) and CSSA president-elect (2021)
- Paul Scott, Crop Science editor (2021)
- Nicole Anderson, Seed Physiology, Production, & Technology (C04) Division chair
- Claire Heinitz, Plant Genetic Resources (C08) Division chair
- Susan Fisk, public and science communications director
- DJ McCauley, CSA News science editor/writer
- Rebecca Polk, membership manager
- Rachel Schutte, science communications manager

Dig Deeper

View the ***Crop Science*** review article, "First the Seed: Genomic Advances in Seed Science for Improved Crop Productivity and Food Security," at https://doi.org/10.1002/csc2.20402. And for more Seed Week content, check out two new episodes of the ***Field, Lab, Earth*** podcast: In the first episode, Dr. Helen Anne Curry will join us to discuss the history of seed banks. In the second episode, Dr. Joel Cohen will discuss the life and legacy of Dr. Nikolai Vavilov, creator of one of the world's first seed banks. Find us at **https://fieldlabearth.libsyn.com** or

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