EXECUTIVE SUMMARY
Understanding how plants use dormancy to survive a harsh winter so they can reemerge in the spring is vital to controlling weeds and to improving yields of economically important crops. Dr David Horvath at the USDA has been using Elsevier's Pathway Studio as an essential tool in his research to expand our understanding of plant responses to stress and the dormancy process.
Genetic research has benefited tremendously from advanced tools in recent decades. David Horvath, PhD, agrees that it would be fair to say his career has, too.

Dr. Horvath is a plant physiologist with the USDA’s Agricultural Research Service in Fargo, ND, whose studies are focused on leafy spurge (Euphorbia esula), an invasive weed related to cassava, poinsettia and castor bean and native to Central and Eastern Europe.

Dr. Horvath and his unit pioneered the use of heterozygous microarrays to aid their investigation into the growth and development of the perennial plant, but they needed a way to use the gene expression data to help understand the underlying physiology and signaling pathways. In 2003, a demonstration at the annual Plant and Animal Genome conference convinced Dr. Horvath that Pathway Studio could further elevate his research. “We've been using Pathway Studio to study leafy spurge transcriptomics ever since,” he says.

His unit’s focus has been on transcription factor interactions that play a role in the bud dormancy and growth processes. Leafy spurge can regrow from underground adventitious buds, he explains. “If you don’t want the plant to put out flowers, you have to do something to keep the buds from growing in the spring. If you kill the top of the plant in the summer and don’t control the regrowth of the buds, you end up with a denser stand than you started with.”

In the fall, the above-ground portion of the leafy spurge dies, but the buds become endodormant to survive the winter and re-grow in the spring.

By understanding the pathways that control the plant’s reproductive lifecycle and its response to external signals that trigger growth, Dr. Horvath says the research is contributing to understanding dormancy in perennial plants in general.

As one of the first groups to research weed transcriptomics, Dr. Horvath’s unit has not only furthered knowledge about weed control, but it has contributed to the study of dormancy and other responses of crop plants including cassava, corn, wheat, tea, soybean and potato, he says. Dr. Horvath’s characterization of a dormancy-controlling transcription factor in leafy spurge that is also present in raspberry and peach could be useful to the cultivation of those crops as well.

Lately, Dr. Horvath says his unit has been using Pathway Studio to look beyond dormancy processes into how crop plants interact with weeds. “We’re learning that corn seems to be different from soybeans in its response to weeds,” he says. “Pathway Studio gene expression data pointed out to us that when weeds are present, soybean has what looks like classic shade-avoidance response—a process previously shown in Arabidopsis by which plants sense the presence of weeds by detecting change in the far-red to red light ratio. Surprisingly, Pathway Studio did not highlight this signaling system in corn, but rather implicated other stress responses.”
Dr. Horvath explains the impact that the availability of transcriptomics data has had on the field: “Fifteen years ago, you would focus on the expression of one or two genes to try to make sense of difference in gene expression. If you were looking at cold stress, you would try to do knockout genetics to figure out how genes allowed the plant to respond to cold. Now with Pathway Studio, you can throw 30,000 genes at it with various expression levels and it will tell you, for instance, that targets of specific transcription factors or hormones are overrepresented in your data set. You can quickly get a nice overview in a broad sense of what the plant is doing in response to whatever treatment you’re looking at.”

That approach helped Dr. Horvath and others in his unit to identify interactions between flowering and dormancy: “A lot of ontologies associated with flowering kept coming up in my Pathway Studio analyses, and that helped us solidify the connection between dormancy and flowering.” It might also eventually be what enables his work to contribute to agricultural advances such as controlling when fruit trees break dormancy in the spring so that they can remain dormant longer in warmer climates, or refrain from flowering before a late frost in colder climates.

“Pathway Studio has added a whole lot of variety of my work,” Dr. Horvath says. “I talk to colleagues about their transcriptomics projects, and run analyses for them. It has enabled me to contribute to a lot more publications than I would have otherwise, and it has helped me to establish partnerships that I otherwise might not have. And that improves the quality of my life.”

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