Winter temperatures play complex role in triggering spring budburst

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The seedlings on the left were exposed to typical current winter conditions. The seedlings on the right were exposed to much warmer conditions, resulting in delayed bud burst. Credit: Brad St. Clair, US Forest Service

The opening of buds on Douglas-fir trees each spring is the result of a complex interplay between cold and warm temperatures during the winter, scientists with the U.S. Forest Service's Pacific Northwest Research Station have found.

Their research—which is featured in the December issue of *Science Findings*, a monthly publication of the station—led to the development of a novel model to help managers predict budburst under different scenarios of future climate.

"We take it for granted that buds will open each spring, but, in spite of a

lot of research on winter dormancy in plants, we don't really understand how the plants are sensing and remembering temperatures," said Connie Harrington, research forester and the study's lead. "The timing of budburst is crucial because, if it occurs prematurely, the new growth may be killed by subsequent frosts, and if it occurs too late, growth will be reduced by summer drought."

Although scientists have long recognized that some plants require a certain amount of exposure to cold temperatures in the winter and warm temperatures in the spring to initiate the opening of buds, the precise interaction between these chilling and forcing requirements has, until now, been largely unexplored. Harrington and her station colleagues Peter Gould and Brad St Clair addressed this knowledge gap, which has implications for forecasting the effects of climate change on plants, by conducting greenhouse experiments in Washington and Oregon using Douglas-fir, an ecologically and economically important species.

Winter temperatures and length of exposure influence the timing of spring bud burst for Douglas-fir. Here, US Forest Service researchers check Douglas-fir seedlings for bud burst. Credit: Connie Harrington, US Forest Service

For their experiments, the researchers exposed Douglas-fir seedlings from 59 areas in western Oregon, western Washington, and northern California to a range of winter conditions. After the seedlings finished their first year of growth, they were divided into groups and placed in different locations where their exposure to temperatures varied according to predetermined scenarios. In the spring, the scientists monitored the seedlings and documented the length of time it took for their buds to open.

"We found that, beyond a minimum required level of chilling, many different combinations of temperatures resulted in spring budburst," Harrington said. "Plants exposed to fewer hours of optimal chilling temperatures needed more hours of warmth to burst bud, whereas those exposed to many hours of chilling required fewer hours of warm temperatures for bud burst."

The plants were responding, the researchers found, to both warm and cold temperatures they experienced during the winter and spring. And, they noted that the same temperatures can have different effects depending on how often they occur—a fact that may seem counterintuitive at first. While some winter warming may hasten spring budburst, substantial periods of mid-winter warming, such as is projected under several future climate scenarios, may actually delay, not promote, normal budburst.

Harrington and her colleagues used their findings and research results from other species to develop a novel model that depicts this gradual tradeoff between chilling and forcing temperatures and have verified its accuracy using historical records. They found that the model was fairly accurate in predicting past budburst in Douglas-fir plantations, which indicates it works well with real-world conditions.

Because the model is based on biological relationships between plants

and temperature, the researchers expect it will be fairly straightforward to modify for use with other species and for other areas. Managers, for example, could use the model to predict changes in budburst for a wide range of climatic projections and then evaluate the information to determine if selecting a different species to plant or stock from a different seed zone would be a useful management strategy.

More information: To read the December issue of Science Findings online, visit www.treesearch.fs.fed.us/pubs/36960

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