Genetic snooze button governs timing of spring flowers

August 9 2006

In the long, dark days of winter, gardeners are known to count the days until spring. Now, scientists have learned, some plants do exactly the same thing.

Addressing scientists today (Aug. 9) at a meeting of the American Society of Plant Biologists, University of Wisconsin-Madison researcher Richard Amasino described studies that have begun to peel back some of the mystery of how plants pace the seasons to bloom at the optimal time of year.

"Flowering at the right time is all about competition," says Amasino, Howard Hughes Medical Institute Professor and UW-Madison professor of biochemistry.

Amasino and his colleagues have studied, in particular, the behaviors of biennial plants, which require long periods of exposure to the cold to initiate flowering in the spring. What they have found reveals some of the complex interplay of genes and environment and provides hints that, one day, it may be possible to exert precise control over flowering, a process essential for plant reproduction and fruiting and that has enormous implications for agriculture.

Flowers are the reproductive organs of plants and are responsible for forming seeds and fruit. As their name implies, biennials complete their life cycles in two years, germinating, growing and overwintering the first year. The second year, the plants flower in the spring and die back in the fall.

That biennial strategy, Amasino explains, arose as flowering plants, which first evolved some 100 million years ago during the age of the dinosaurs, spread to fill the niches of nature. Spring blooming confers numerous advantages, not the least of which is leafing out and flowering before the competition.

But how do the plants know when to flower?

"If you carve out that niche, you need to get established in the fall, but you need to make darn sure you don't flower in the fall," Amasino says. In the case of biennials, "the plants can somehow measure how much cold they've been exposed to, and then they can flower rapidly in the spring niche."

Exposure to the cold triggers a process in plants known as vernalization, where the meristem — a region on the growing point of a plant where rapidly dividing cells differentiate into shoots, roots and flowers — is rendered competent to flower.

In a series of studies of Arabidopsis, a small mustard plant commonly used to study plant genetics, Amasino and his colleagues have found there are certain critical genes that repress flowering.

"The plants we've studied, primarily Arabidopsis, don't flower in the fall season because they possess a gene that blocks flowering," Amasino explains. "The meristem is where the repressor (gene) is expressed and is where it is shut off."

The key to initiating flowering, according to the Wisconsin group's studies, is the ability of plants to switch those flower-blocking genes off, so that they can bloom and complete their pre-ordained life cycles.

But how that gene was turned off was a mystery until Amasino and his group found that exposure to prolonged cold triggered a molecular process that effectively silenced the genes that repress flowering.

Another processes known as bud dormancy, which is similar to vernalization, occurs in many plants that grow in temperate climates. "Bud dormancy is not broken until the plant has 'counted' a sufficient number of days of cold to ensure that any subsequent warm weather actually indicates that spring has arrived," Amasino says.

The Wisconsin team led by Amasino has worked out much of the process of vernalization, and their hope is to add to knowledge of other cold-regulated processes such as the regulation of bud dormancy in trees. Bud dormancy may be similar to vernalization or, the Wisconsin scientists adds, it may be controlled by a completely different mechanism.

"But our study of vernalization may help us get our foot in the door," Amasino says. "It gives us a basis to test whether there are similarities."

Knowing the genes that control flowering and how they work provides a much more detailed working knowledge of plants, many that are useful to humans and some of great economic importance, Amasino explains.

"This is important agriculturally," he notes. "There are many crops — cabbage, beets — that we don't want to flower. Many of the cultivated varieties we use are never exposed to cold in a typical farmer's field growing season."

When that is the case, a cold snap can fool sugar beets, for example, into flowering, a process that can ruin the crop by redirecting nutrients from the valuable root to the production of seeds and flowers.

And although Amasino and his group have demystified some of the molecular underpinning of the familiar process of flowering, the biochemist emphasizes that much of the fine biochemical detail remains to be worked out.

Source: University of Wisconsin-Madison, by Terry Devitt