How sunflowers track the sun

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Credit: Pexels

Plants tell time. Not the way we do – for example, it's 3.40pm, time to pick up the kids. But like animals, plants can sense that winter is coming and it's time to drop leaves.

A sunflower anticipates daybreak, much like a rooster does before starting to crow. At sunrise, sunflowers face east to greet the first rays and continue to move with the sun until it sets in the west. Overnight, the sunflower head swings back around so it faces east at dawn.

Dr Mike Haydon, a University of Melbourne plant scientist, says sunflowers only move until the flower bud opens. At that point they stop their daily dance and permanently face east. "This is where the controversy arises," says Dr Haydon, from the School of BioSciences. "People say 'my sunflowers don't track the sun'. Well if they're open sunflowers, then they don't do that because that's when they've stopped."

Before scientists studied a plant's internal clock, the Greek myth of Clytie and Helios was used to explain their movements.

Clytie was a water nymph who fell madly in love with Helios, the sun god. But Helios had eyes for another woman and ignored Clytie. Full of unrequited love, Clytie would watch Helios race his chariot across the sky. She didn't eat or drink and after nine days of watching him cross the sky, she became rooted to the ground and transformed into a sunflower.

Since helio refers to the sun and tropism refers to movement, heliotropism describes the movement that plants like sunflowers make in relation to the sun. "There is certainly a clock driven component, an internal or circadian rhythm to this," says Dr Haydon.

Experiments have shown that if sunflowers in a field are turned 180 degrees, they continue to move during the day, but now in a west-to-east direction, opposite to the sun. After several days, the sunflower corrects itself to move east-to-west again. During this time, the sunflower retunes its internal clock, using one of the most powerful entrainment cues – sunlight.

Tick, tock, the internal clock

"The external cues remind the plant what time of day it is. It slightly readjusts itself so that its internal clock is matched to the environment," says Dr Haydon. This is essential when dawn changes by three minutes or more everyday depending on your latitude.

"This experiment shows very clearly that there's an internal clock that is driving this plant behavior."

On parade. A field of sunflowers. Credit: Pixabay

But the big question is whether sunflowers actually track the sun or would they do it anyway because of its internal clock that is triggered by sunlight. "The missing experiment that would answer this is the one that moves sunflowers growing in the sunshine into a dark room for a day or so," he says.

At its core an internal clock is made up of a set of genes that regulate each other's expression. Each gene is expressed at a different time of the day to generate rhythms in the plant's internal cycle. This internal rhythm controls a wide range of processes in the plant including metabolism, movement and growth.

So heliotropism is regulated by an internal rhythm of gene expression. But the actual mechanics of the movement remains "very much a black box … but we suspect that the mature leaves have something to do with it since the rhythmic movement stops when mature leaves are cut off," says Dr Haydon.

He also suggests two possible mechanisms seen in other plants to explain this.

The first theory involves cell elongation, which is how most stems grow. If cell growth on the east and west sides are cyclical and matches the sun's movement, sunflower stems would appear to 'follow' the sun.

Water movement

The other is that of water movement within the plant, known as turgor pressure. Water can be distributed differently within the stem and these differences in water pressure cause it to curve. This distribution of water pressures can be synchronised so that it would cause sunflowers to curve and mimic the sun's movements.

"The support for this is that the water status of the soil can impact on whether sunflowers move or not. If it's dry they don't do it. If the soil is waterlogged, they don't do it either, so it suggests water balance is important," says Dr Haydon.

As it stands, sunflowers do follow the sun but only until they bloom. Dr Haydon says it's not fully understood why the moving stops after blooming, but there are two hypotheses.

"It could simply be mechanical: as the sunflower head grows, it simply becomes too heavy for the stem to move, " he says. "The other possibility is that it is related to diminishing robustness of the internal clock. There is evidence that circadian rhythms weaken with age, not only in plants but also in animals."

After it blooms most people recognise the plant as a sunflower. And then it remains steadfast watching the eastern sky, like Clytie waiting for Helios to rise.

Provided by University of Melbourne