MERCOLA
Take Control of Your Health

Some Plants Use an Internal Thermometer to Trigger Growing Season

Analysis by Dr. Joseph Mercola | October 19, 2024

STORY AT-A-GLANCE

- Plants have a complex relationship with their environment, able to communicate with each other, take the outdoor temperature and ward off insect attacks
- Gardeners and farmers have been using plant growth to predict weather patterns and harvest times for decades; researchers have now discovered the phytochemical responsible for this behavior
- Some plants use outdoor temperature and others use the number of sunlight hours to determine when to start growth in the spring

Editor's Note: This article is a reprint. It was originally published November 12, 2016.

Although they look like bystanders in your garden, plants are actually active communicators and engage in a complex relationship with their environment. They don't just soak up the sun each day.

More than just providing food, plants have played an important part in human history. Before modern-day medicine, there were plants that provided for medicinal needs. Ancient Egyptian scrolls detail 700 herbs and how they were used to treat patients.[1]

The World Health Organization (WHO) estimates that 80% of the world's population primarily uses traditional remedies, a major part of which is derived from plants.[2] They also play a significant role in the development of the majority of new medications, as manufacturers are using plants to model their synthetic drugs.[3]

Plants have a unique interconnectedness between each other, soil, microbes, pests and human health. Some of the newest research has now detected how plants know exactly when to increase their growth patterns in preparation for spring and summer.

Phytochromes Have Dual Function

This short 1.5-minute video explains the process researchers from the University of Cambridge have discovered and how they anticipate it may be used in the future. An international team of scientists has found previously discovered plant molecules, phytochromes, serve two functions.[4]

Initially, scientists believed that plants only used phytochromes to detect light during the daylight hours. Phytochromes are a photoreceptor pigment used mainly to detect the red and far-red visible light spectrum.[5] In the plant, it was mainly believed to be responsible for germination, shade avoidance and light detection.

Exposure to red light produces a chemical reaction that moves chromoprotein to a functional active form, while darkness makes it inactive.[6] The plant will grow toward the sun as the red light converts the chromoprotein to an active form that triggers an increased growth in the plant cells.

Although farmers and gardeners have known for centuries that as the weather warms, plants begin to grow faster and flower, researchers are now discovering the mechanism behind this phenomenon.

As the sun goes down, phytochromes found in every plant cell take on another role in the health of some plants and gauge the temperature of the night air.[7] The scientists found that the pace at which they change function is directly proportional to the temperature of their surroundings.

In colder temperatures this switch from active to inactive is slower, and so is the growth of the plant. In warmer weather the phytochromes inactivate faster, triggering a growth spurt in the plant. This is the function that is responsible for earlier flowering of spring plants during a warmer winter.

Active Phytochromes Mean Slower Growth

Phytochromes are activated during the sunlight hours. In this state they are bound to the plant DNA, purposefully slowing growth. At night the phytochromes gradually become inactivated, separating from the DNA and allowing the plant to resume growth.

The deactivation of phytochromes in the plant is called "dark reversion." Lead research author, Philip Wigge, Ph.D., from Cambridge's Sainsbury Laboratory at the University of Cambridge, explains their discovery:[8]

> *"Just as mercury rises in a thermometer, the rate at which phytochromes revert to their inactive state during the night is a direct measure of temperature. The lower the temperature, the slower phytochromes revert to inactivity, so the molecules spend more time in their active, growth-suppressing state.*
>
> *This is why plants are slower to grow in winter. Warm temperatures accelerate dark reversion, so that phytochromes rapidly reach an inactive state and detach themselves from DNA — allowing genes to be expressed and plant growth to resume."*

This same process helps plants to avoid the shade of other plants and get more sun. Once in the shade, phytochromes are quickly inactivated, which increases the rate of growth. This growth helps the plant to find sunlight.[9] Interestingly, these light-driven changes to phytochromic activity occur in less than a second.[10]

Plants Use Either Day Length or Temperature to Gauge Growth

Not all plants use this method of determining when to increase growth. Some plants use the length of the day instead. During a warm winter you may see daffodils flowering much earlier than expected, as they are temperature sensitive.

A well-known garden rhyme inadvertently relies on the science discovered. This rhyme was used to predict rainfall in the coming season: "Ash before oak, we're in for a soak; oak before ash, we're in for a splash."

The oak tree relies on temperature to determine the start of growing season, where the ash relies on day length. Between 1751 and 1788, Robert Marsham recorded plant activity during spring on his estate in the U.K.[11] He noted it was more common for ash trees to leaf out before oak trees.[12]

However, over the past years, this has not been the case. Only two years in the past have ash trees come into leaf earlier than oak, in 2010 and 2013.[13] Wigge explains it this way:

> *"Oak trees rely much more on temperature, likely using phytochromes as thermometers to dictate development, whereas ash trees rely on measuring day length to determine their seasonal timing.*
>
> *A warmer spring, and consequently a higher likelihood of a hot summer, will result in oak leafing before ash. A cold spring will see the opposite. As the British know only too well, a colder summer is likely to be a rain-soaked one."*

Farmers and Gardeners Use Plant Behavior to Predict Weather and Harvest

The impact of warming temperatures is being felt around the globe. While this research was performed in the U.K., other researchers are documenting similar changes in budding and leafing patterns in the U.S.

A pilot project begun in 2007 called Project Budburst allows people living anywhere in the U.S. to make a contribution to the data being collected.[14]

Measurements are made of tree buds as they emerge and are then uploaded into a national database. Scientists around the world are studying these records to determine how a changing climate affects the timing of spring plant growth.

Scientists have noted that some plants are extending their growing season in response to climate change.

However, while the plants have methods to accommodate some of the changes, insects often breed and disperse based on sunlight rather than temperature. This may result in a mismatch between plant growth and the activities of pollinating insects.[15]

Researchers have also looked at the relationship between heat and how long it takes to achieve harvest.

In one study using cucumbers, researchers found plants cultivated earlier in the season required more days to flower and produce fruit than those planted later.[16] It appears the plants exposed to warmer temperatures grew faster and produced fruit sooner, despite not having been planted earlier.

Montana State University Extension developed a plan of Growing Degree Days, or those days when the average temperature was ideal for plant growth, to help famers and gardeners better predict the best time to harvest.[17] As the number of warmer days begins to grow throughout the world, scientists at Cambridge University hope to use their research to breed wheat and rice plants more resistant to warmer temperatures.

Plants Talk to Each Other and Protect Themselves from Predators

Plants do more than grow. They also communicate with each other and with predators. For instance, when an insect begins munching on a leaf, the plant "hears" or senses the vibrations from the insect and immediately begins to mount a defense.[18]

Researchers have found the plant then produces a phytochemical the insect finds inedible, which deters the bug. In this experiment the researchers recorded the plants' responses to the vibrational sounds of a caterpillar chewing. They found when plants were exposed to these feeding sounds later, they released higher amounts of the phytochemicals to repel the insect.

This research suggests that minor pest attacks on plants play an important role in promoting plant growth that have higher levels of important nutrients to humans. One of the researchers remarked on the curious ability of the plant to distinguish between vibrations made by a gentle wind and those of a chewing insect.[19]

Another application to this finding is to help boost the natural chemical defense of the plants by using vibrations to increase chemical production. One of the researchers commented:[20]

> *"This research also opens the window of plant behavior a little wider, showing that plants have many of the same responses to outside influences that animals do, even though the responses look different."*

Scientists have also found plants use an underground connection of mycorrhizal fungi, which form a symbiotic relationship with plants. The fungi colonize the roots and send many extremely fine filaments out into the soil, acting as root extensions. Researchers discovered these filaments conducted signals between plants, acting as an early warning system.[21] This is part of the reason why tilling the soil is so harmful, as it disrupts and destroys these important filaments.

Sources and References

- [1] Natural News, September 2012, Ancient Egyptian scrolls document natural herbs and holistic medicine that saved lives and cured disease
- [2] Herb Day, Herbal FAQs (Archived)
- [3] Journal of Natural Products, March 2007; 70(3): 461-477
- [4, 8] University of Cambridge, October 27, 2016, Plant ‘thermometer’ triggers springtime budding by measuring night-time heat
- [5] Swarthmore College, Plant Pigment: Phytochromes and Photoreceptors
- [6] Boundless, Plants use a phytochrome system to sense the level, intensity, duration, and color of environmental light to adjust their [...] (Archived)
- [7] Science Daily, Plant 'thermometer' discovered that triggers springtime budding by measuring night-time heat
- [9] Annals of Botany, February 2005; 96(2): 169-175

- [10] EurekAlert! October 2016, Plant 'thermometer' discovered that triggers springtime budding by measuring night-time heat
- [11] Robert Marsham
- [12, 13] Field Studies Council Ash before Oak - we’re in for a soak, Oak before Ash - we’re in for a splash (Archived)
- [14, 15] NCAR UCAR "Ten Most Wanted" Plants Inspected for Cues to Climate Change
- [16] North Carolina State University, Growth Stage, Flowering Pattern, Yield, and Harvest Date Prediction of Four Types of Cucumber Tested at 10 [...]
- [17] Montana State University, Using Growing Degree Days to Predict Plant Stages
- [18] Oecologia, July 2014, Plants respond to leaf vibrations caused by insect herbivore chewing
- [19, 20] University of Missouri News Bureau, July 2014, Plants Respond to Leaf Vibrations Caused by Insects' Chewing, MU Study Finds
- [21] Ecology Letters, May 2013, Underground signals carried through common mycelial networks warn neighbouring plants of aphid attack