

Sunflower

Helianthus annuus

Sunflowers, *Helianthus annuus*, (Daisy family) are annual plants originally from the Americas, extending from southern Canada right across North America to Central Mexico. They are now cultivated worldwide and sunflower seeds are one of the world's most important edible oils. There is an ancient record of sunflower cultivation, about 4000 to 5000 years ago in Tennessee in east central North America, and also evidence of domestication in Tabasco, Mexico, 3,600 years B.C.E. One characteristic of domestication is the unbranched stem that supports a single large flower head, seeds much larger than those of the wild types and that are retained *in the flower head* well after the flower matures. These days they are becoming increasingly popular as garden plants and as potted annuals.



The Spanish introduced sunflowers to Europe where they were initially grown as ornamental crops and later for stock feed. Surprisingly, it was in Russia where varieties with high oil content were developed. These became the basis for commercial

production in North America, the sunflower's place of origin. The sunflower is the national flower of Ukraine. Sunflowers are a major component of the Ukrainian economy, with Ukraine and Russia between them exporting 70-80% of the world's exports of sunflower oil.



Ukraine's sunflowers are known as *hyperaccumulators*, plants with the potential to accumulate metals from soil at levels sometimes hundreds or even thousands of times greater than normal. In 1986, following the explosion at the Chernobyl Nuclear Power Plant in Ukraine, scientists planted sunflowers to extract radioactive material from the soil of the surrounding lands.

It is almost impossible to Google 'Sunflower' and not come up with a reference to Fibonacci and Fibonacci numbers. Leonardo Fibonacci (~1170 - ~1250) was an Italian mathematician who brought a Hindu-Arabic number sequence to the attention of European scientists². In the Fibonacci sequence, starting with 0 and 1, each number is the sum of the previous two numbers, thus:
0, 1, 1, 2, 3, 5, 8, 13, etc

Fibonacci numbers occur in many biological systems, including tree branching,



flower petal number, spirals on pine cones and pineapples and facets of insect eyes. In sunflowers, florets are arranged in interconnecting spirals, where the number of left-hand spirals and the number of right-hand spirals are *nearly always* successive Fibonacci numbers, e.g., 55 spirals in one direction, 34 in the other. But there's more! Each floret is set at an angle of $\sim 137.51^\circ$ (known as the *golden angle*) to the next, so no floret is exactly the same angle from the centre of the 'flower'.

This means that the greatest number of florets, and ultimately seeds, can be efficiently packed into the available space.

Sunflowers have the reputation of being able to *track the sun* – this is known as **heliotropism**. That's true to a certain extent at least: only the young plants have the ability to orient their flowers towards the sun, in the morning, flowers face east then track the sun to face westwards by the afternoon. As the plants age, eventually their

stems stop growing, and the flowers mature facing east, no longer tracking the sun. The advantage of eastern orientation is that the flowers warm more rapidly in the morning, increasing visits by pollinators.

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Photograph of sunflower with spirals: Mathematica, <http://mathematica.stackexchange.com/questions/20924/spiral-pattern-and-fibonacci-numbers>

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