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Turning off the night

A WAY HAS BEEN FOUND FOR THE TOMATO PLANT TO STAY UP FOR 24 HOURS, SAYS **S ANANTHANARAYANAN**

As the earth had formed with a pattern of day and night long before the appearance of life on the planet, most living things have evolved to survive best with a break of darkness between spells of light. Unlike animals, which grow and repair tissue during sleep in the night hours, the growth of plants takes place during the day, in sunlight. What repair takes place during the night hours is not clear, but it appears that extending the time of exposure to light could increase the growing hours of plants, including food plants.

Aaron I Velez-Ramirez, Wim van Ieperen, Dick Vreugdenhil, Pieter MJA van Poppel, Ep Heuvelink and Frank F Millenaar, a group of scientists working in the Netherlands, report in the journal *Nature Communications* that they have discovered a single genetic factor that enables some strains of the tomato plant to avoid adverse effects of being exposed to artificial light after sunset so that the growing hours extend through the night. Increased production of tomatoes to the extent of 20 per cent, in some cases, has been reported.

It is well known that during the summer months, when the length of the day is longer, vegetation flourishes more than during the winter, when the day is short. This is, of course, due to the fact that vegetation grows with the help of photosynthesis, a process that needs sunlight. Farmers, at various stages, have tried to boost production, particularly in winter, by artificial lighting. The process is clearly expensive and not practical at a larger scale, but the trials have been extended to the stage of keeping plants exposed to light for the whole 24 hours.

A peculiar result of such continuous exposure to light, noticed in the 1920s with the domesticated varieties of the tomato plant, is that the plants develop leaf injury that can kill them. Many other plants, including pepper, lettuce and rose, and even thale cress, regarded as a model plant organism for research, are not adversely affected by long hours of exposure to light. In fact, even wild varieties of tomato are resistant; it is the domesticated varieties that cannot tolerate continuous lighting. As the most important vegetable crop worldwide, as stated in the paper published by the Netherlands group, there has been an interest in finding why this is so, but with little success after eight decades.

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The Netherlands group report that they went into the genetic internals of the known wild tomato strains that were tolerant of Continuous Lighting and discovered that a particular gene, CAB-13, which gives rise to a protein that binds to light harvesting chlorophyll, was the major fact that brought about the tolerance. The study included a survey of tolerant types, their breeding, to show that tolerance was a dominant, as opposed to recessive, trait and a trial where CAB-13 was suppressed, leading to revival of adverse symptoms of CL. The tests "unequivocally indicate" that "CAB-13 plays a key role in the CL tolerance in tomato", the authors of the paper state.

Further testing showed that tolerance to CL and exposure to CL conditions affected how the plant took in carbohydrates and also the pathway of photosynthesis – ie, the manner of production of food from sunlight. As higher levels of carbohydrates were found in CL-tolerant plants, too, this could not be the reason for injury to domesticated tomato plants. Tests also showed that the course of development or interaction with the environment of the plants was not affected by CL. In fact, it was found that even the daily rhythm of the plants, the *circadian*, or 24-hour clock, was not affected — flowers opened and closed in the morning or night — despite CL, which shows that the clock is running, adjusted perhaps by timing of temperature variation. As for pollination, bees were admitted to the plants only in the daytime and the cycle was unaffected. The level of photosynthesis, or fixing of carbon dioxide, with the release of oxygen, was also found to stay nearly unaffected in CL-tolerant plants. Overall, the yield of CL-tolerant tomato varieties was as good or better, rising to 20 per cent in some cases.

It was also found that the gene for CL tolerance could easily be introduced in domestic varieties by crossbreeding with wild strains. And the trials have shown that tomatoes can be cultivated under CL, for the first time. The mechanism of the increased yield in CL-resistant strains is still not clear, as many factors are involved, but the identification of the gene responsible for CL tolerance is significant. This has now opened the way to more research into the nature of photosynthesis, the mechanism of formation of carbohydrates, light signaling and the circadian clock.

Velez-Ramirez at work.

The authors of the paper observe that the increase in yield up to 20 per cent shows that "the limitations for crop productivity, caused by the adaptation of plants to the terrestrial 24-hour day/night cycle, can be overcome". In this context, it is worth observing that for all the progress made, varieties of tomato that grow round the clock may not actually be created and used. A basic reason is that the extra production cannot be more than the energy input during the longer hours of exposure to light. The actual light used for illumination would always be much more than what is used by the plant.

Artificial light, during the night, moreover, is not free, as in the case of sunlight, but would come from electricity generated by burning fossil fuels, a process that is hardly efficient. Even with greater food demands as a result of a growing population, CL cultivation for increased yield, and at the cost of further environmental damage, may not be an answer.

On the other hand, if an eco-friendly power supply, like stored solar energy, hydel or wind power is available, then CL cultivation could be viable. But the day that eco-friendly power, for our existing needs and more, will be available is not visible to the ordinarily sighted. The discovery of CAB-13, a breakthrough in photosynthesis research, may, hence, not directly benefit the tomato farmer.

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