Friends keep enemies at bay

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Foliage that repels pests can be a useful companion of food plants

Large scale cultivation of food plants, especially of single varieties, leads to rapid increase of pest population. The farmer is forced to use pesticides, which has a cost, and has its downside. Apart from being a pollutant, chemical pesticides harm useful organisms in the soil and on plants, including the plants' natural protection against pests. And even against the pests, they become progressively less effective.

A group of environment scientists in the UK takes note of an old gardeners' practice, of letting French marigolds flower along with tomato bushes, to protect the food plant from the Glasshouse Whitefly, an important pest that affects tomatoes. In a paper in the journal, *PLOS ONE*, Niall JA Conboy, Thomas McDaniel, Adam Ormerod, David George, Angharad MR Gatehouse, Ellie Wharton, Paul Donohoe, Rhiannon Curtis, Colin R Tosh, from the Newcastle and Northumbria Universities and Stockbridge Technology Centre, North Yorkshire, describe their studies to track down how this device, of planting marigold, works and to see if it could be harnessed to help tomato production, and crop protection in general.

The Glasshouse Whitefly is a small, moth-like insect that lays eggs on the underside of the leaves of many vegetable and other crop plants. When the eggs hatch, the Whitefly larvae — and even later stages of insect development — consume the plant fluids and material by penetrating leaf veins to reach the sap. This apart, the sugary "honeydew" that they excrete sustains fungal growths and blocks photosynthesis. And then, the adult insects transmit viral infections.

The study by the scientists, which was to establish the protective effect of the marigold and other plants, was carried out with different timing and mix of protection. One was to introduce marigold, and then to add other Whitefly-repelling species along with tomato plants right from the start. And the protective effect was compared against a control group.

Another trial was to introduce the marigold plants later in the season, after a viable Whitefly population had collected, to see if the farmer could take recourse to marigold not as a preventive but when she finds that Whitefly started getting active.

The third trial was to see if the opposite approach, of planting Whitefly attracting hosts in the periphery of the tomato patch, to draw the Whitefly away, brought about an improvement.

The studies showed that the presence of marigold plants had a definite effect of keeping the Whitefly away, most effectively when used from the start, with lesser improvements when combined with other pest-repellent species, and scarcely any when pests were drawn away by competing hosts in the periphery. And the agent that brought about the effect was isolated as limonene, a volatile substance that is found in the skin of citrus fruits and was a large part of the substances exuded by the marigold plant.

Trials were then conducted by placing, not marigolds, but limonene dispensers in the tomato beds. As limonene was the operative agent in marigolds, the dispensers did prove effective in keeping the Whitefly away. And in the case of "emergency", use, which is pressed into use only after Whitefly have multiplied to good numbers, the dispensers were found to be more effective than planting marigolds. The paper notes that optimum strategies for deploying marigold plants as well as limonene dispensers need to be developed.

Along with marigold, there are other plants that repel, both the Whitefly as well as other pests that farmers need to control. A viable bouquet of plants and dispensers of the plant volatiles could hence take the place of chemical pesticides.

This would save the cost of energy used in production of pesticides and the pollution that pesticides cause in soil, in run-off water and in the vegetable product. The next is the advantage that comes from biodiversity. And finally pests would not develop resistance, which they do with insecticides.

The mechanism of resistance is that when an organism is killed by the intervention, the occasional mutant individuals in the population that are immune get a survival advantage. These numbers then proliferate, and in a few generations the whole population consists of resistant insects. When the method of pest control is to repel, rather than eliminate the pest species, individuals that are not repelled do have the advantage in foraging and breeding, but others only move away, they do not die out. Resistant individuals hence do not dominate and cannot overwhelm the others to the extent that we speak of a resistant strain having arisen.

In 2015, researchers based in Sweden and Mexico City had described in the journal, Trends in Plant Science, a method of interspersing crop plants with other plants that react to pests by releasing volatile substances that attract the predators of the pest species. Wild plants, they said, often generated volatile organic compounds, which produce odours, to announce that leaf-eating organisms, which endanger plants, have appeared on the scene. An example is the smell, that all of us would be familiar with, which comes from the damage to grass when a lawn is being mown.

Many kinds of volatiles are released and can indicate the nature of damage. In the case of attack by herbivores, the VOCs could alert the specific predators of the herbivore involved.

Many such traits, which confer direct resistance to pests, the Mexico City paper says, have been counter-selected during domestication, because they depend on undesirable properties such as bitterness, hairiness, toughness, or toxicity, and thus reduce the quality of the consumed parts. Another reason for breeding them out could be that expression of the resistance, in the form of VOC, for instance, consumes resources and reduces the yield of the crop. This may be the same with vegetable plants and means of repelling pests like the Whitefly and the tomato plant.

The paper in *PLOS ONE* also says that if the plants that help crop plants, like the tomato, could be bred to have economic value, like being edible or ornamental, this would make them attractive to growers, with overall benefit to society and the environment.

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PLUS POINTS

Vanishing savannah

Up to a third of the plant life occupying the African savannah could be driven to extinction as CO_2 is pumped into the atmosphere, scientists have warned. A new study suggests that besides warming the climate, rising levels of the greenhouse gas will also trigger profound changes in the planet's vegetation.

The research team analysed "chemical fossils" to track plant growth over the years in south-eastern Africa, and found shifts in CO_2 levels had sparked dramatic changes in the region's greenery. Faster growing species including certain grasses are able to capitalise better on surges in the gas, edging out more specialised plants. Given this, the new analysis suggests almost 8,000 of the 23,000 sub-tropical plant species found across the continent's plains could be wiped out if current CO_2 trends continue. They estimate the rate of loss for savannah plant communities over the next century will likely be the highest it has been for over 15,000 years.

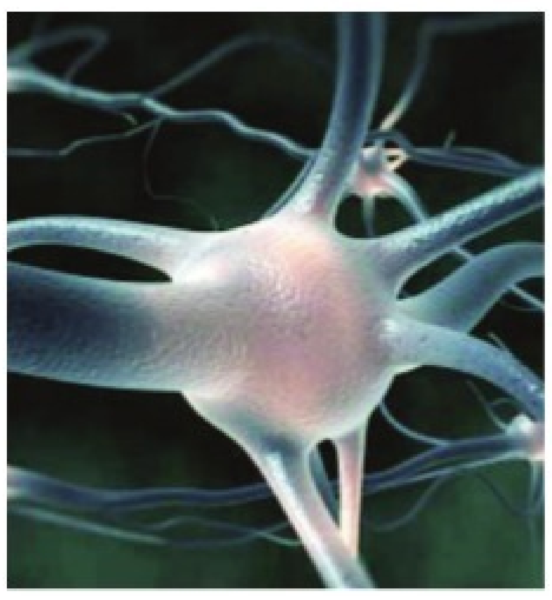
The scientists studied chemical traces left by vegetable oils in the earth that revealed changes in plant communities over the course of millennia. They found that these changes in composition mirrored CO_2 levels fluctuating over the last 25,000 years, and said this trend was likely to continue in the coming decades.

Carbon pollution resulting from fossil fuel consumption reached unprecedented levels last year, and CO_2 levels are expected to continue rising in 2019. Human emissions of greenhouse gases have already been implicated in an on-going mass extinction event, primarily due to their role in global warming.

The new results were published in the journal *PLOS ONE.*

The Independent

Genetic cause



Scientists have discovered a new gene variation that causes motor neurone disease in a novel biological pathway that until now hasn't been linked with neuro-degeneration. The findings for the study, conducted by a team of researchers from the Sheffield Institute for Translational Neuroscience and the NIHR Sheffield Biomedical Research Centre in the UK, could potentially help to identify completely new ways of treating MND.

MND, also known as Amyotrophic Lateral Sclerosis, is a devastating neurodegenerative disorder that affects the nerves — motor neurones — that form the connection between the brain and the muscles. The messages from these nerves gradually stop reaching the muscles, causing them to weaken, stiffen and eventually waste. The progressive disease affects a person's ability to walk, talk, eat and breathe. Approximately 10 per cent of MND cases are inherited but the remaining 90 per cent are caused by complex genetic and environmental interactions, which are not well understood — this is known as sporadic MND. There is currently no curative therapy.

Johnathan Cooper-Knock, NIHR clinical lecturer at the University of Sheffield's Institute for Translational Neuroscience, explained the impact of the ground breaking research, which is helping scientists to understand the fundamental genetic basis of MND. "The mutations found in patients were shown to be toxic to neurons and, when expressed in zebrafish they produced muscle weakness consistent with MND. This work strongly suggests that the mutations are the cause of MND in the patients where they were identified," he said.

During the study, published recently in the journal *Cell Reports*, researchers genetically sequenced tissue from two related patients with an unknown familial form of MND and found a mutation in the substrate binding region of a glycosyltransferase enzyme called GLT8D1. They went on to screen a larger sample of 103 patients, five of whom had this mutation.

The study revealed a new genetic subtype of MND.

Life-bearing sequences

A final property of the genetic code worth noting is its near universality

The Genetic Code

nonpolar | polar | basic | acidic | (stop codon)

Standard genetic code

1st base	2nd base: U		2nd base: C		2nd base: A		2nd base: G		3rd base
U	UUU	(Phe/F) Phenylalanine	UCU	(Ser/S) Serine	UAU	(Tyr/Y) Tyrosine	UGU	(Cys/C) Cysteine	U
	UUC		UCC		UAC		UGC		C
	UUA	(Leu/L) Leucine	UCA		UAA	Stop (*Ochre*)	UGA	Stop (*Opal*)	A
	UUG		UCG		UAG	Stop (*Amber*)	UGG	(Trp/W) Tryptophan	G
C	CUU		CCU	(Pro/P) Proline	CAU	(His/H) Histidine	CGU	(Arg/R) Arginine	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	(Gln/Q) Glutamine	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	(Ile/I) Isoleucine	ACU	(Thr/T) Threonine	AAU	(Asn/N) Asparagine	AGU	(Ser/S) Serine	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	(Lys/K) Lysine	AGA	(Arg/R) Arginine	A
	AUG[A]	(Met/M) Methionine	ACG		AAG		AGG		G
G	GUU	(Val/V) Valine	GCU	(Ala/A) Alanine	GAU	(Asp/D) Aspartic acid	GGU	(Gly/G) Glycine	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	(Glu/E) Glutamic acid	GGA		A
	GUG		GCG		GAG		GGG		G

TAPAN KUMAR MAITRA

By 1966, just five years after the first codon was identified, the entire genetic code had been worked out. The elucidation of the code confirmed several properties that had been deduced earlier from indirect evidence. All 64 codons are in fact used in the translation of mRNA; 61 of the codons specify the addition of specific amino acids to the growing polypeptide, and one of these (AUG) also plays a prominent role as an initiation codon that starts the process of protein synthesis. The remaining three codons (UAA, UAG, and UGA) are stop codons that instruct the cell to terminate synthesis of the polypeptide chain. The genetic code is unambiguous — every codon has only one meaning. The figure also shows the degenerate nature of the code — that is, many of the amino acids are specified by more than one codon. There are, for example, two codons for histidine, four for threonine and six for leucine. Although degeneracy may sound wasteful, it serves a useful function in enhancing the adaptability of the coding system.

If there were only one codon for each of the 20 amino acids incorporated into proteins, then any mutation in DNA that led to the formation of one of the remaining codons would stop the synthesis of the growing polypeptide chain at that point. But with a degenerate code, most mutations simply cause codon changes that alter the specified amino acid. The change in a protein's behaviour that results from a single amino acid alteration is often quite small, and in some cases may even be advantageous.

Moreover, mutations in the third base of a codon frequently do not change the specified amino acid at all. For example, a mutation that changes the codon ACU to ACC, ACA, or ACG does not alter the corresponding amino acid, which is threonine in all four cases. It has been confirmed by analysing the amino acid sequences of mutant proteins.

For example, sickle-cell haemoglobin differs from normal haemoglobin at a single amino add position, where valine is substituted for glutamic acid. The genetic code table reveals that glutamic acid may be encoded by either GAA or GAG. Whichever triplet employed, a single base change could create a codon for valine. For example, GAA might have been changed to GUA, or GAG might have been changed to GUG. In either case, a glutamic acid codon would be converted into a valine codon. Many other mutant proteins have been examined in a similar way. In nearly all cases, the amino acid substitutions are consistent with a single base change in a triplet codon.

The genetic code is, nearly, universal or in other words, a final property of the genetic code worth noting is its near universality. Except for a few cases, all organisms studied so far — prokaryotes as well as eukaryotes — use the same basic genetic code. Even viruses, though they are non-living entities, employ this same code. In other words, the 64 codons almost always stand for the same amino acids or stop signals specified; suggesting that this coding system was established early in the history of life on earth and has remained largely unchanged over billions of years of evolution.

However, exceptions to the standard genetic code have been observed in a few situations, most notably in mitochondria and in a few bacteria and unicellular organisms.

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