Agricultural chemicals

For better or worse

Spraying herbicides changes the flavour and nutritional value of crops

GARDENERS know only too well how hard it is to keep on top of weeds, because hoeing and pulling them out is back-breaking work. With big fields to look after, most farmers turn to herbicides. Over the years these chemicals have become better at knocking out weeds but leaving commercial crops alone. Organic farmers do not use artificial herbicides, and can suffer lower yields as a result. Which system produces the "better" crop is open to debate, although it is known that crops sprayed with herbicides are biochemically transformed in subtle ways. New work shows those changes in treated crops are substantial enough to change both their nutritional value and flavour.

The investigation was led by Matthew Cutulle, a horticulturalist at Clemson University in South Carolina, in collaboration with Greg Armel at the University of Tennessee, Knoxville, and their colleagues. They ran an extensive series of trials on large fields growing sweetcorn, a widely eaten vegetable.

The team worked with the four commonly used herbicides: mesotrione, topramezone, nicosulfuron and atrazine. These are often used in combination with safeners, which are chemicals that selectively help protect crops from herbicide damage. Hence a safener called isoxadifen-ethyl was also included in the experiment, sometimes pairing it with the herbicides and sometimes allowing the herbicides to work on their own.

The researchers planted sweetcorn in several plots split between two different locations. When the plants were between five and ten centimetres in height, they exposed each plot to one of seven different herbicide/safener combinations. As a control, one field was treated with atrazine before the corn was planted (a full control using no herbicides at all would have been destroyed by weeds without an overwhelming amount of hand weeding). After 45 days the sweetcorn was gathered. The mature kernels were analysed for levels of antioxidants, sugars, amino acids, proteins, fatty acids, minerals and fibre.

Sugary outcome

The results, just published in the *Journal of Agricultural and Food Chemistry*, revealed that applying herbicides increased the amount of protein that the plants stored in their kernels by as little as 4% and as much as 12% when nicosulfuron was combined with the safener. The amounts of mineral taken up by the plants increased as well, with levels of phosphorous, magnesium and manganese going up by between 14% and 51% and iron content rising by 67% in plants exposed to the nicosulfuron/safener combination. The balance of sugars found in the tissues of the sweetcorn changed as well. Fructose concentrations shot up by 48% upon exposure to nicosulfuron; 63% to topramezone and 68% to the nicosulfuron/safener combination. Glucose concentrations increased by 19% with mesotrione, 40% with topramezone and 43% with the nicosulfuron/safener combination. In contrast, sucrose levels in the corn dropped.

Your sweetness is my weakness

It remains unclear precisely how these changes affect the flavour of sweetcorn, although Dr Cutulle thinks they are probably big enough to be noticeable. He suggests that further studies are carried out to look into the matter using panels of people carrying out tastings. Perhaps more importantly, the findings show that pesticides are capable of transforming crops in ways that shape their nutritional value. Some of these, like the iron-enhancing property of nicosulfuron combined with the safener, could help with iron deficiency in diets, which is responsible for a number of severe health conditions, such as anaemia.

Other factors, however, might not be so welcome. The fructose-enriching aspects of herbicides may make sweetcorn even sweeter, but that could be detrimental to health because fructose is increasingly being implicated in a number of illnesses, such as fatty-liver disease and diabetes. Working out how to grow the best crops has become a lot more complicated. ■

The limits of biology

Waiting for rain

Life clings on even in the driest corners of Earth

IT DOES not rain much in the Atacama desert. A 1,000km strip of land running along the Chilean coast, it is Earth's driest desert outside its poles. Average annual rainfall in certain parts can be as low as a millimetre or two a year, and some Atacaman weather stations have never seen a drop of water.

Yet it does rain occasionally. And as Dirk Schulze-Makuch, an astrobiologist at the Technical University of Berlin, and his colleagues report in *Proceedings of the National Academy of Sciences*, a desert downpour in 2015 offered the perfect natural experiment for probing the limits of what sorts of conditions life can tolerate.

The Atacama is not quite lifeless. A few specialised animals and plants scrape a living in the less arid parts. And scientists have found evidence of microbial life even in the very driest areas. What is less clear, though, is whether those microbes are natives able to endure such extreme aridity, perhaps by becoming dormant, or whether they are merely the dead remains of interlopers, blown in on the wind but unable to survive in their harsh new environment.

The rains offered a chance to check. If the microbes were alive, or dormant, then the rain should have ushered in a brief golden age of growth, as the scarcest resource in the ecosystem—water—became briefly abundant. If the desert was merely ▸▸