Increasing the aluminium resistance of wheat

doi:10.1093/aob/mcq058

Al³⁺ toxicity is a major limitation to plant production on acidic soils. Many plants have evolved mechanisms to overcome this stress and the genes controlling these mechanisms have been identified in some species. **Pereira *et al.* (pp. 205–214)** engineer greater Al³⁺ resistance in wheat, *Triticum aestivum*, by over-expressing its own resistance gene, *TaALMT1*. The results demonstrate that biotechnology can be used to increase the production of major food crops on acid soils.

Genetic improvement for phosphorus efficiency in soybean (Review)

doi:10.1093/aob/mcq029

Developing P-efficient soybean varieties is a sustainable and economical approach to soybean production on low P soils. **Wang *et al.* (pp. 215–222)** summarize the possible mechanisms leading to P efficiency, and consider genetic strategies to improve this characteristic in soybean, with examples from several case studies. They indicate that substantial efforts are now focusing on increasing soybean P efficiency through ‘root breeding’.

Root QTLs and phosphorus efficiency in soybean

doi:10.1093/aob/mcq097

Identification of QTLs that confer superior root systems could enhance genetic improvement of P efficiency in soybean, *Glycine max*. **Liang *et al.* (pp. 223–234)** construct a soybean genetic map based on field data from 106 recombinant inbred lines (RILs), and find 31 putative QTLs for root and P efficiency traits. The results suggest that the region close to the SSR marker Satt519 on the B1 linkage group may have a good potential for future genetic improvement of P efficiency in soybean.

Plant Cuttings

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News in Botany: Nigel Chaffey presents a round-up of plant-based items from the world's media

It's an ill wind ...?

Wood (aka ‘the really hard stuff inside trees’) is as ancient a building material and engineering solution as they come, but new uses are still being found for timber in the most unlikely of applications. Take for instance

wind- and water-powered turbines. Loved and hated in equal measure, they are often proposed as an environmentally friendly, sustainable way to reduce our dependence upon non-renewable fossil fuels by turning air and water currents into electricity. What may help to tip the balance in their favour is news that Hydra Tidal Energy Technology AS (a Norwegian company that aims to develop competitive technology solutions for electricity production from low-speed water currents) is to use laminated pine for their turbines’ blades (http://www.forskningsradet.no/en/Newsarticle/Laminated_wood_to_be_used_for_offshore_turbine_blades/1253954822447).

Hydra Tidal will install a full-scale (1.5-MW) prototype of its tidal energy plant at Gimsøstraumen, a marine channel in Norway’s Nordland County. The Morild floating power plant will be moored to the seabed and mostly submerged, with turbine wings spanning a diameter of 23 metres and deployed in July 2010. Wood has not been used in modern turbine blade designs for decades. But company founder and R&D Director Svein D. Henriksen extols the virtues of wood for such applications, ‘Wood is a porous, homogenous material – so it has better mechanical and hydrological characteristics than today’s conventional materials such as composites and steel’. Furthermore, using wood in turbine blades is also an environmentally sound choice (and won’t hurt the company’s image, either). All of which also goes to prove the old adage that what goes around comes around. Find out more at <http://www.hydratidal.com/>.

Image: Dirk Ingo Franke, Wikimedia Commons.

Mulch ado about nothing?

Many factors affect plant growth and development, and Man has manipulated most of them for millennia to boost yields, etc. But some things couldn't have been anticipated – well, not the 10 000 or so years ago when agriculture was being 'invented' anyway.

Take, for instance, the revelation

that the colour of the plastic mulch used for okra (*Abelmoschus esculentus*) cultivation significantly affects growth and yield. Whilst it is acknowledged that covering the soil with plastic – 'mulching' – helps to warm the soil and improve water retention (well, of the water that gets through the plastic, anyway!), surely few could have predicted that Ladies' Fingers (as okra is alternatively known) would exhibit a colour preference. However, Garry Gordon and colleagues (*HortTechnology* **20**: 224–233, 2010) found that the use of darker (black, blue, red) -coloured plastic mulches increased early and total yield of okra compared with bare soil with and without row cover. For completeness it should be noted that the team tested five mulch colours: black, white, red, silver and blue. However, they do caution that their data do not show an economic advantage for blue over black mulch for bhindi (in Hindi, as okra is better known in curry houses). On a related mulching note, fungus-lovers will surely be interested to learn that mushrooms grown on mulch (of the more traditional botanical kind) made from leaves of bay (*Laurus nobilis*) and eucalyptus (*Eucalyptus* spp.) undergo changes in flavour – and colour to a lesser degree; those grown on bay leaves are better in quality (<http://www.alphagalileo.org/ViewItem.aspx?ItemId=72242&CultureCode=en>). Who did this? A team from the Biotechnology Research Institute at the General San Martín National University in Argentina. Why? To reduce and recycle waste products – such as bay and eucalyptus leaves – from the essential oils industry. And for the mycophilous epicurian cognoscenti amongst you, the official verdict of the expert gastronomic judges was that leaf-grown mushrooms had an increased 'mushroomy' flavour(!). Now that's the sort of insight that doesn't leave much room for further comment from me!

Image: JM Prouty, Wikimedia Commons.

Troughing at the trophic canteen

Although ecology is quite complicated, to a large extent feeding relationships are relatively straightforward: plants photosynthesise and make food, animals eat plants. You certainly do not expect both the primary producers and animal consumers to compete for the same 'prey'. Yet that's precisely what appears to be happening in the case of insectivorous plants, according to a study by David Jennings and colleagues (*Proceedings of the Royal Society B*, doi:10.1098/rspb.2010.0465). To examine potential competition between these taxa, the team studied dietary and microhabitat overlap between pink sundews (*Drosera capillaris*) and wolf spiders (Lycosidae), both in

the field and in the laboratory (using tanks to mimic their boggy habitat). In the wild, insect-eating wolf spiders (*Sosippus floridanus*) live close to the ground in wetland regions of southern Florida (USA), which areas are also home to pink sundew. The spider builds dense webs to catch its prey (flies, crickets, ants and other insects); the sundew catches insects by trapping them in a sticky mucous it secretes onto its leaves, and then digests them using enzymes also secreted for the purpose. Direct field observations showed that sundews and spiders had a high dietary overlap with each other and with the available arthropod prey. Both were found more frequently in quadrats with more abundant prey; within quadrats, spiders constructed larger webs and located them further away from sundews as the total sundew trapping area increased, presumably to reduce competition. Spiders also constructed larger webs when fewer prey were available. In the lab, sundews produced more leaves and seeds when spiders were absent from their tanks than when they were present. When spiders and sundews were placed in the same tank, the spiders ate most of the insects before they could be captured by the plants, and the plants produced fewer leaves, seeds and flowers. The results demonstrate that the presence of spiders reduced sundew fitness and the study is touted as the first to demonstrate a land plant and animal competing directly for food. In such a competitive situation any feature that confers an advantage will give its owner an edge. To that end I wonder if the pink sundew has gone down the route taken by another famous insectivorous plant, the pitcher plant (*Nepenthes rafflesiana*)? A study by Bruno Di Giusto *et al.* (*Journal of Ecology*, doi:10.1111/j.1365-2745.2010.01665.x) identified >50 volatile compounds emitted by that plant's carnivorous pitchers that are used to 'mediate prey attraction' (which is, I believe, a euphemism for 'luring unsuspecting invertebrates to their deaths'). And bloodthirsty plants appear to be a bit of a hot topic at the moment, with the award of the latest *Annals'* Graduate Prize going to a paper detailing research on the equally famous Venus flytrap (*Annals of Botany* **105**: 37–44; see feature below). With all these hungry plants around there must be a lot of nervous insects out there ...

Image: Petr Dlouhý, Wikimedia Commons.

European banks merge

Sadly, not a welcome reduction in the number of the financial institutions behind much of the current global economic crisis, but a rationalisation of molecular biology data repositories. On 10th May 2010 the European Nucleotide Archive (ENA; www.ebi.ac.uk/ena) was launched as Europe's primary access point to globally comprehensive DNA and RNA sequence information (<http://www.ebi.ac.uk/Information/News/pdf/Press10May10.pdf>). ENA consolidates three major sequence resources: EMBL (European Molecular Biology Laboratory)-Bank, Europe's primary source of curated public-domain nucleotide information; the European Trace Archive (which contains raw data from electrophoresis-based sequencing machines); and the Sequence Read Archive (SRA), a newly established repository for raw data from next-generation sequencing platforms. EMBL was the first organisation in the world to

make nucleotide sequence data publicly available, and its data and services are constantly changing to reflect growing volumes of sequence information, ever-improving sequencing technology and the broadening of applications to which sequencing is now put. The launch of ENA is a new phase of this continuous evolutionary process. ENA is developed and maintained at the EMBL–European Bioinformatics Institute under the guidance of the International Nucleotide Sequence Database Collaboration’s International Advisory Committee (INSDC; www.insdc.org/) and a newly formed Scientific Advisory Board. Provision of nucleotide sequence data to ENA or its INSDC partners has become a central and mandatory step in the dissemination of research findings to the scientific community, and data submitted to ENA will continue to undergo a variety of validation steps that include automated quality checking and, where possible, manual inspection and curation. A factsheet explaining the architecture of the ENA and what this consolidation offers to users can be downloaded from www.ebi.ac.uk/Information/Brochures/pdf/ENA_May2010.pdf.

Image: Wikimedia Commons.

Herbicide-homing bugs

Much as we humans like to control what plants grow where, and when, we need to be mindful of the potential consequences of those actions. This is a particular concern in the case of weed-controlling herbicides. Although we are arrogant enough to think that such chemicals are specific and only target the plant we aim them at, we may unwittingly be storing up problems for future generations (of plants, human offspring, and other biota . . .) if they persist in the environment long afterwards. Take atrazine (2-chloro-4-(ethylamine)-6-(isopropylamine)-s-triazine), for instance. Widely employed as a herbicide, its use is controversial due to its effects on non-target species, such as on amphibians, and because of widespread contamination of waterways and drinking water supplies. Although prohibited in the European Union, it is still one of the world’s most widely used herbicides [<http://en.wikipedia.org/wiki/Atrazine>]. Great news then that Sinha *et al.* (*Nature Chemical Biology*, doi:10.1038/nchembio.369) have exploited the natural ability of *Escherichia coli* (alias *E. coli*) to find nutrients in the environment to engineer a bacterium that actively seeks and destroys atrazine. In an elegant series of steps, the team used an atrazine-binding RNA molecule (a synthetic riboswitch) to reprogramme the *E.coli* to migrate toward the herbicide. As the icing on the cake, the group also showed that by incorporating a gene from an atrazine catabolic pathway the microbes would not only find but also destroy the herbicide. This demonstration is widely lauded as a generally applicable synthetic biology approach to remediate hazardous chemicals in the environment and illustrates how bacteria can be reprogrammed to perform

multiple complex tasks. In a timely underlining of the potential health hazards and collateral damage posed by this soil-applied potent phytocide, work by Tillitt and colleagues (*Aquatic Toxicology*, doi:10.1016/j.aquatox.2010.04.011) found that atrazine reduces reproduction in fathead minnows (which are fish – most definitely not plants – and definitely not resident in the soil!). And if that’s not bad enough, a rather damning policy perspective by Jason Rohr and Krista McCoy (*Conservation Letters*, doi:10.1111/j.1755-263X.2010.00114.x) – ostensibly presenting a practical guide to reducing conflicts of interest so as to preserve environmental health and scientific credibility – cites a 2008 critical review of the effects of atrazine on fish, amphibians and aquatic reptiles that they claim ‘misrepresented over 50 studies and contained 122 inaccurate and 22 misleading statements’ (http://www.sciencenews.org/view/generic/id/58945/title/Atrazine_paper%E2%80%99s_challenge_Who%E2%80%99s_responsible_for_accuracy%3F). A situation probably best summed up in the words of one of The Moody Blues’ greatest hits, ‘just what the truth is I can’t say any more’*. Perhaps somebody should engineer another bug to ‘sniff-out’ bad atrazine science?

Image: Nicolle Rager Fuller, US National Science Foundation.

Heroic plant bites the dust

‘I don’t know, just when you’ve started to make a few honest dollars growing a cash crop that’s in global demand, your fields gets hit by a fungus infection. It’s just not fair’. That, or something similar, must have been going through the mind of farmers in Helmand and Kandahar provinces of Afghanistan recently as a fungus – as yet unidentified - is thought to have infected about half of the country’s crop of opium

poppy (*Papaver somniferum*; http://news.bbc.co.uk/1/hi/world/south_asia/8679203.stm, and [/8319249.stm](http://news.bbc.co.uk/1/hi/world/south_asia/8319249.stm)). It is feared that this year’s opium production could be reduced by a quarter compared with last year. As a consequence the price of opium in the region has already risen by approx. 50 %, with knock-on effects expected worldwide since Afghanistan produces 92 % of the world’s opium. Notwithstanding its attendant devastating global consequences of drug-related addiction, deaths and crime, sales of opium are also widely acknowledged as generating substantial sums of money that support the Taliban insurgency in Afghanistan. So, opium poppy: essential cash crop for poverty-stricken Afghan farmers, or evil weed financing international terrorism that must be rooted out at all costs? A tricky question to answer. Nevertheless, and as shocking as this threat to poppies may be, a potentially more serious problem is the fungal onslaught faced by the world’s wheat harvest as it was recently announced that four new mutations of Ug99, a race of black stem rust (*Puccinia graminis tritici*), have overcome existing sources of genetic resistance developed to safeguard the world’s wheat crop (<http://www.physorg.com/news/194098643.html>). The St. Petersburg meeting organised

by the Borlaug Global Rust Initiative heard that the new races have acquired the ability to defeat two of the most important stem rust-resistant genes, which are widely used in most of the world's wheat breeding programmes. This upgraded threat – it is not actually 'news' since cereals and fungi have been engaged in their very own 'tit-for-tat' (aka quid pro quo) arms race for millennia – poses a clear and present danger to wheat, one of the world's most important staple food crops. Hopefully, some comfort may be gleaned from a report that Bangladesh recently approved the release of a new wheat variety with resistance to Ug99 (<http://blog.cimmyt.org/?p=3326>). 'Bari Gom 26' – commonly known as 'Hashi', and previously called 'BAW 1064' – has 'CIMMYT parental lines in its pedigree, fairly good resistance against variants of Ug99, and impressive agronomic performance'. Notwithstanding suggestions that the US military has developed a cluster bomb to deliver Ug99 spores (http://en.wikipedia.org/wiki/M115_bomb), it is to be hoped that the Afghan farmers' concerns that NATO troops in that country are responsible for the poppy fungus outbreak are unfounded. Finally, for those of you keen to get your hands on food statistics, FAOSTAT crop production figures will become free-access from 1st July 2010 (<http://faostat.fao.org/site/372/default.aspx>). Would-be users should note the following words of caution though, 'please be aware that this is a very large database with a total of over 3 billion records. You should therefore refrain from performing unlimited multi-dimensional queries and downloads. And, large sized queries and downloads not supported by the memory or CPU of your machines may result in long times of executions but also may crash your browser at some point. We recommend using multiple queries or the bulk downloading feature for queries with more than 4000 records at a time'.

Image: Wikimedia Commons.

The single helix, a double-edged sword? (or Ivy, in a league of its own)

Although they may look pretty, plant-clad external walls of houses and offices have often been viewed with suspicion as there is a widely held belief that the plants may actually cause damage to the buildings they cling on to. As

another in our series of 'counter-intuitive stories', researchers at Oxford University (UK) have discovered that far from being harmful, extra-mural ivy (*Hedera helix*) can actually be beneficial (<http://www.physorg.com/news193055372.html>). Acting as a thermal shield, the verdant coating protects the underlying edifice from extremes of temperature, which might otherwise cause the walls to crack. This must come as very welcome news to English Heritage – who commissioned Prof. Heather Viles of Oxford's School of Geography and the Environment to undertake the study – as the charity owns and maintains hundreds of the UK's oldest properties, many of which have ivy-coated exteriors. As a

bonus, the ivy was also found to absorb some of the harmful pollutants in the atmosphere. Walls where ivy was growing were less prone to the damaging effects of freezing temperatures, temperature fluctuations, pollution and salts than exposed walls without ivy. However, the benefits apply only to intact walls; where walls are damaged the ivy readily insinuates itself in to existing cracks and holes. If separate studies are initiated for each of the many different murephyes, that could be a job for life for the research team involved, and a lovely way to spend your time. Now, if only the National Trust could be persuaded to initiate its own investigation for its stunning array of UK stately homes that would be a bonus (because – allegedly – its cream teas are the best in the world and poking about in the shrubbery is both hungry and thirsty work!). To find out more about the named UK organisations' charitable work see <http://www.english-heritage.org.uk/> and <http://www.nationaltrust.org.uk/main/w-index.htm>.

Image: Derek Ramsey, Wikimedia Commons.

A manuscript in a thousand

One of the joys of being a Handling Editor for the *Annals of Botany* is discovering little gems that can – often unexpectedly – turn up. As readers should know,

all manuscripts are rigorously reviewed and, more often than not, revision is required before they can be accepted for publication. Occasionally (very occasionally; in fact less than one in a thousand submissions), though, an acceptable manuscript is so well drafted that it can be published without revision. Such is the case with the study by Katherine Downes *et al.* (*Annals of Botany*, August issue; doi:10.1093/aob/mcq118) on the role of smoke in germination of *Tersonia cyathiflora* (Button Creeper). They demonstrate that whilst this species does germinate in response to smoke, it does not do so in response to karrikinolide (KAR1, 3-methyl-2H-furo[2,3-c]pyran-2-one), the widely regarded smoke-induced germination-promoter. Is *Tersonia cyathiflora* (a monotypic, fire-ephemeral, endemic Australian genus in the Gyrostemonaceae with an obligate requirement for smoke to germinate) just an antipodean oddity? Or proof of the idiosyncratic ways of Nature and a testament to the fact that generalisations in (plant) science should always be viewed with caution? For the record – and sadly – this was not a manuscript that I 'handled'.

Image: Downes *et al.*, *Annals of Botany* 106(2).

* [I know it's annoying you, so to put you out of your collective misery the Moody Blues' song alluded to above is ... Nights in white satin.]

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