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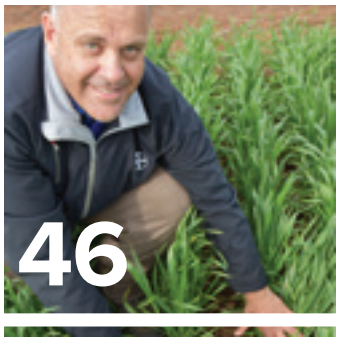


## EXTENSIVE TRIALS, RESULTS REINFORCE STRONG CONFIDENCE IN NEW HERBICIDE


## AG INDUSTRY STANDOUTS RECOGNISED BY SYNGENTA GROWTH AWARDS




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# RNA BREAKTHROUGH CREATES CROPS THAT CAN GROW 50 PERCENT MORE POTATOES AND RICE

Manipulating RNA can allow plants to yield dramatically more crops, as well as increasing drought tolerance, announced a group of scientists from the University of Chicago, Peking University and Guizhou University.

In initial tests, adding a gene encoding for a protein called FTO to both rice and potato plants increased their yield by 50% in field tests. The plants grew significantly larger, produced longer root systems and were better able to tolerate drought stress. Analysis also showed that the plants had increased their rate of photosynthesis.

**"The change really is dramatic," said University of Chicago Prof. Chuan He, who together with Prof. Guifang Jia at Peking University, led the research. "What's more, it worked with almost every type of plant we tried it with so far, and it's a very simple modification to make."**

The researchers are hopeful about the potential of this breakthrough, especially in the face of climate change and other pressures on crop systems worldwide.

"This really provides the possibility of engineering plants to potentially improve the ecosystem as global warming proceeds," said He, who is the John T. Wilson Distinguished Service Professor of Chemistry, Biochemistry and Molecular Biology. "We rely on plants for many, many things -- everything from wood, food, and medicine, to flowers and oil -- and this potentially offers a way to increase the stock material we can get from most plants."

**Rice nudged along**

For decades, scientists have been working to boost crop production in the face of an increasingly unstable climate and a growing global population. But such processes are usually complicated, and often result only in incremental changes.

The way this discovery came about was quite different.

Many of us remember RNA from high school biology, where we were taught that the RNA molecule reads DNA, then makes proteins to carry out tasks. But in 2011, He's lab opened an entire new field of research by discovering the keys to a different way that genes are expressed in mammals. It turns out that RNA doesn't simply read the DNA blueprint and carry it out blindly; the cell itself can also regulate which parts of the blueprint get expressed. It does so by placing chemical markers onto RNA to modulate which proteins are made and how many.

He and his colleagues immediately realised that this had major implications for biology. Since then, his team and others around the world have been trying to flesh out our understanding of the process and what it affects in animals, plants and different human diseases; for example, He is a co-founder of a biotech company now developing new anti-cancer medicines based on targeting RNA modification proteins.

He and Guifang Jia, a former UChicago postdoctoral researcher who is now an associate professor at Peking University, began to wonder how it affected plant biology.

They focused on a protein called FTO, the first known protein that erases chemical marks on RNA, which Jia found as a postdoctoral researcher in He's group at UChicago. The scientists knew it worked on RNA to affect cell growth in humans and other animals, so they tried inserting the gene for it into rice plants -- and then watched in amazement as the plants took off.

"I think right then was when all of us realised we were doing something special," He said.

The rice plants grew three times more rice under laboratory conditions. When they tried it out in real field tests, the plants

grew 50% more mass and yielded 50% more rice. They grew longer roots, photosynthesised more efficiently, and could better withstand stress from drought.

The scientists repeated the experiments with potato plants, which are part of a completely different family. The results were the same.

"That suggested a degree of universality that was extremely exciting," He said.

It took the scientists longer to begin to understand how this was happening. Further experiments showed that FTO started working early in the plant's development, boosting the total amount of biomass it produced.

The scientists think that FTO controls a process known as m6A, which is a key modification of RNA. In this scenario, FTO works by erasing m6A RNA to muffle some of the signals that tell plants to slow down and reduce growth. Imagine a road with lots of stoplights; if scientists cover up the red lights and leave the green, more and more cars can move along the road.

Overall, the modified plants produced significantly more RNA than control plants.

**Modifying the process**

The process described in this paper involves using an animal FTO gene in a plant. But once scientists fully understand this growth mechanism, He thinks there could be alternate ways to get the same effect.

"It seems that plants already have this layer of regulation, and all we did is tap into it," He said. "So the next step would be to discover how to do it using the plant's existing genetics."

He can imagine all sorts of uses down the road -- and he's working with the university and the Polsky Center for Entrepreneurship and Innovation to explore the possibilities.

"Even beyond food, there are other consequences of climate change," said He. "Perhaps we could engineer grasses in threatened areas that can withstand drought. Perhaps we could teach a tree in the Midwest to grow longer roots, so that it's less likely to be toppled during strong storms. There are so many potential applications."

**Journal Reference:**

Qiong Yu, Shun Liu, Lu Yu, Yu Xiao, Shasha Zhang, Xueping Wang, Yingying Xu, Hong Yu, Yulong Li, Junbo Yang, Jun Tang, Hong-Chao Duan, Lian-Huan Wei, Haiyan Zhang, Jiangbo Wei, Qian Tang, Chunling Wang, Wutong Zhang, Ye Wang, Peizhe Song, Qiang Lu, Wei Zhang, Shunqing Dong, Baoan Song, Chuan He, Guifang Jia. RNA demethylation increases the yield and biomass of rice and potato plants in field trials. Nature Biotechnology, 2021; DOI: 10.1038/s41587-021-00982-9

# SCIENTISTS IDENTIFY PROTEIN THAT ACTIVATES PLANT RESPONSE TO NITROGEN DEFICIENCY

Nitrates are critical for the growth of plants, so plants have evolved sophisticated mechanisms to ensure sufficient nitrate uptake from their environments. In a new study published in Nature Plants, researchers at Nagoya University, Japan, have identified a plant enzyme that is key to activating a nitrate uptake mechanism in response to nitrogen starvation. This finding explains how plants meet their needs in challenging environments, opening doors to improving agriculture in such environments.

When nitrate levels are plentiful in a plant's environment, a plant can achieve adequate nitrate uptake levels by relying on what plant biologists call a "low-affinity transport system." But when nitrates become scarce in a plant's local environment, it may need to switch to a more powerful nitrate uptake mechanism known as a "high-affinity transport system." In Arabidopsis plants, which frequently serve as model organisms for plant biology research, the NRT2.1 protein plays an important role in the high-affinity transport system. Interestingly, when Arabidopsis plants synthesise the NRT2.1 protein, they initially produce an inactive protein that can later be activated when the high-affinity transport system is needed.

This synthesis of a nonfunctioning protein that can later be activated intrigued Dr. Yoshikatsu Matsubayashi of Nagoya University, but he sees a certain logic in this preparatory protein synthesis; he notes, "Proteins cannot be synthesised when the nitrogen deficiency occurs." In other words, plants need to synthesise the proteins in a high-affinity transport system before a nitrogen deficiency necessitates the use of those proteins, because nitrogen deficiency itself makes it difficult to synthesise new proteins. In order to better understand this remarkable system, Dr. Matsubayashi and his colleagues set out to identify the protein that activates NRT2.1 in response to nitrogen starvation.

Previous studies had shown that a peptide called CEP found in plant roots plays an important role in activating biochemical pathways that respond to nitrogen starvation, so the researchers focused their investigation on the CEP and its downstream CEPD pathway. Their experiments soon drew their attention to a protein called At4g32950. The researchers found that this protein responds to nitrogen starvation by activating the NRT2.1 protein. It achieves this activation by removing a phosphate group from a specific location on the NRT2.1 protein, so the investigators decided to give the At4g32950 protein a new name: CEPD-induced phosphatase, or "CEPH" for short.

CEPH is found mainly in the cells close to the surface of the Arabidopsis plant's roots, which is an optimal location for activating a system that evolved for rapid nitrate uptake from the environment. As expected, using laboratory methods to inactivate the gene that encodes CEPH impaired the ability of Arabidopsis plants to use the high-affinity transport system for rapid nitrate uptake, and this meant that the modified plants had lower internal nitrate levels and grew to smaller sizes.

Collectively, these results indicate that CEPH plays a critical role in responding to nitrogen starvation through its activation of the NRT2.1 protein. Dr. Matsubayashi sees considerable potential utility in CEPH as a genetic engineering tool, as he notes,

> **"Artificially enhancing CEPH activity could enable scientists to create plants that grow even in soils with low nutrient levels."**

Such findings could change the way agriculture and food security are handled.

**Journal Reference:**

Yuri Ohkubo, Keiko Kuwata, Yoshikatsu Matsubayashi. A type 2C protein phosphatase activates high-affinity nitrate uptake by dephosphorylating NRT2.1. Nature Plants, 2021; 7 (3): 310 DOI: 10.1038/s41477-021-00870-9

# THE BEST STRAWBERRIES TO GROW IN HOT LOCATIONS

It's strawberry season in many parts of the U.S, and supermarkets are teeming with these fresh heart-shaped treats.

Although the bright red, juicy fruit can grow almost anywhere with lots of sunlight, production in some hot, dry regions is a challenge.

Now, researchers reporting in ACS' Journal of Agricultural Food and Chemistry have identified five cultivars that are best suited for this climate, which could help farmers and consumers get the most fragrant, sweetest berries.

Most strawberries commercially grown in the U.S. come from California and Florida. With the expansion of local farmer's markets and people's excitement about fresh berries, growers in other states are trying to increase production.

In Texas, for example, current commercial operations grow a few of the "day-neutral" and "spring-bearing" varieties that have a potentially high fruit output.

But there are hundreds of options, including some that are more heat tolerant, and many factors to consider when choosing cultivars to grow that will produce strawberries appealing to consumers.

So, Xiaofen Du and colleagues wanted to determine which ones grow well in Texas' semi-arid, hot environment and have the most desirable berry characteristics -- information that could help growers in similar climates.

The researchers grew 10 common strawberry cultivars in northwest Texas, comparing seven spring-bearing and three day-neutral varieties.

First, they monitored plant growth and yields and found eight of the cultivars had plant survival rates of more than 96% before the first harvest.

Overall, the day-neutral varieties had the lowest total berry weight per plant.

Then, the team measured ripe berries' characteristics, including colour, sugar content, acidity and aroma compounds.

Their results showed red intensity was not linked to berry sweetness; in fact, the redder varieties had more citric acid, which made them taste more sour than sweet.

Taste tests on berry purees showed that desirable flavours were related to the varieties' sugar content and 20 aroma compounds.

Perhaps surprisingly, tasters ranked the two varieties that grew the fewest and smallest fruits as having the most intense flavours.

The researchers concluded that five cultivars -- Albion, Sweet Charlie, Camarosa, Camino Real and Chandler -- can grow well in Texas' climate and have the best flavour and aroma.

**Journal Reference:**

Gabrielle Scott, Cierra Williams, Russell W. Wallace, Xiaofen Du. Exploring Plant Performance, Fruit Physicochemical Characteristics, Volatile Profiles, and Sensory Properties of Day-Neutral and Short-Day Strawberry Cultivars Grown in Texas. Journal of Agricultural and Food Chemistry, 2021; DOI: 10.1021/acs.jafc.1c00915

# BEE-IMPERSONATING FLIES SHOW POLLINATOR POTENTIAL

A tiny bee imposter, the syrphid fly, may be a big help to some gardens and farms, new research from Washington State University shows.

An observational study in Western Washington found that out of more than 2,400 pollinator visits to flowers at urban and rural farms about 35% of were made by flies -- most of which were the black-and-yellow-striped syrphid flies, also called hover flies. For a few plants, including peas, kale and lilies, flies were the only pollinators observed. Overall, bees were still the most common, accounting for about 61% of floral visits, but the rest were made by other insects and spiders.

**"We found that there really were a dramatic number of pollinators visiting flowers that were not bees," said Rae Olsson, a WSU post-doctoral fellow and lead author of the study published in Food Webs. "The majority of the non-bee pollinators were flies, and most of those were syrphid flies which is a group that commonly mimics bees."**

Syrphid flies' bee-like colours probably help them avoid predators who are afraid of getting stung, but they are true flies with two wings as opposed to bees which have four. The flies might have additional benefits for plants, Olsson added, since as juveniles they eat pests like aphids. As adults, they consume nectar and visit flowers so have the potential to move pollen the same way that bees do, though it is less intentional than bees who collect pollen to feed their young.

For the study, the researchers surveyed plants and pollinating insects and spiders on 19 rural farms and 17 urban farms and gardens along the Interstate 5 corridor in Western Washington. They conducted surveys six separate times over two years. In addition to the visits by bees and syrphid flies, they also catalogued more rare visits by other arthropods including wasps, lacewings, spiders, butterflies, dragonflies, beetles and ants -- all with visits of less than 4%.

Olsson first noticed the many different non-bee pollinators while working on a bee-survey project led by Elias Bloom, a recent WSU doctoral graduate. The results of this study underscore the need for researchers as well as gardeners and farmers to pay more attention to alternative pollinators, Olsson said, and hoped that similar studies would be conducted in other regions of the country.

"Bee populations are declining, and we are trying to help them, but there's room at the table for all the pollinators," Olsson said. "There are a lot of conservation and monitoring efforts for bees, but that doesn't extend to some of the other pollinators. I think people will be surprised to find that there are a lot more different types of pollinating insects -- all we really need to do is to start paying a little more attention to them."

The study also noted pollinator differences between rural and urban spaces. Observations sites in urban areas showed a greater diversity of pollinators corresponding with the wider range of plants grown in city gardens and smaller-sized farms. Rural farms with their larger fields of plants had a greater abundance.

For every grower, urban or rural, who is interested in increasing the number and diversity of pollinators visiting their fields or gardens, Olsson recommended increasing the variety of flowering plants.

Making sure that something is flowering all throughout the season, even if on the edge of a field, will support the biodiversity of pollinators because their different life stages happen at different times of the year.

"Some pollinators like certain butterflies and moths are only present in a pollinating form for a small period of time," Olsson said. "They may only live for a few days as adults, so when they emerge and are ready to pollinate, it's good to make sure that you have something for them to eat."

**Journal Reference:**

Rachel L. Olsson, Matthew R. Brousil, Robert E. Clark, Quinlyn Baine, David W. Crowder. Interactions between plants and pollinators across urban and rural farming landscapes [illegible] e00194 DOI: 10.1016/j.fooweb.2021.e00194

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# 70-YEAR-OLD COFFEE-KILLING FUNGUS BROUGHT BACK TO LIFE TO FIGHT THE DISEASE

Researchers have re-animated specimens of a fungus that causes coffee wilt to discover how the disease evolved and how its spread can be prevented.

Coffee Wilt Disease is caused by a fungus that has led to devastating outbreaks since the 1920s in sub-Saharan Africa, and currently affects two of Africa's most popular coffee varieties: Arabica and Robusta.

The new research shows that the fungus likely boosted its ability to infect coffee plants by acquiring genes from a closely related fungus, which causes wilt disease on a wide range of crops, including Panama disease in bananas.

The researchers say this knowledge could help farmers reduce the risk of new disease strains emerging, for example by not planting coffee together with other crops or by preventing the build-up of plant debris that could harbour the related fungus.

The research team, from Imperial College London, the University of Oxford, and the agricultural not-for-profit CABI, also say that studying historical samples in CABI's culture collection could provide a wealth of insights into how crop diseases evolve and find new, sustainable ways to fight them. The study is published today in BMC Genomics.

First author of the study Lily Peck is studying on the Science and Solutions for a Changing Planet Doctoral Training Partnership at the Grantham Institute and the Department of Life Sciences at Imperial. She said: "Using ever-higher volumes of chemicals and fungicides to fight emerging crop diseases is neither sustainable nor affordable for many growers.

**"If we can instead understand how new types of diseases evolve, we can give growers the knowledge they need to reduce the risk of new diseases emerging in the first place."**

The team re-animated cryogenically frozen samples of the fungus that causes Coffee Wilt Disease. There have been two serious outbreaks of the disease, in the 1920s-1950s and between the 1990s-2000s, and it still causes damage. For example, in 2011, 55,000 Robusta coffee trees were killed by wilt in Tanzania, destroying 160T of coffee in the process -- equivalent to over 22 million cups of coffee.

In the outbreak beginning in the 1920s, Coffee Wilt Disease infected a wide range of coffee varieties, and was eventually brought under control in the 1950s by management practices such as burning infected trees, seeking natural resistance in coffee, and breeding programs that selected for more resistant plant varieties.

However, the disease re-emerged in the 1970s and spread extensively through the 1990s-2000s. Two separate disease populations have been identified with each only infecting specific types of coffee: one infecting Arabica coffee in Ethiopia, and the other infecting Robusta coffee in east and central Africa. The team wanted to investigate how the two strains had emerged.

In a secure lab at CABI, they re-awakened two strains from the original outbreak, collected in the 1950s and deposited into CABI's collection, and two strains each from the two coffee-specific fungal strains, with the most recent from 2003. They then sequenced the genomes of the fungi and examined their DNA for evidence of changes that could have helped them infect these specific coffee varieties.

They discovered the newer, variety-specific fungi have larger genomes than the earlier strains, and they identified genes that could have helped the fungi overcome plants' defences and survive within the plants to trigger disease.

These genes were also found to be highly similar to those found in a different, closely related fungus that affects over 120 different crops, including bananas in sub-Saharan Africa, causing Panama disease, which is currently devastating today's most popular variety, the Cavendish banana.

While strains of this banana-infecting fungus are known to be able to swap genes, conferring the ability to infect new varieties, the potential transfer of their genes to a different species of fungi has not been seen before. However, the team note that the two species sometimes live in close proximity on the roots of coffee and banana plants, and so it is possible that the coffee fungus gained these advantageous genes from its normally banana-based neighbour.

Coffee and bananas are often grown together, as coffee plants like the shade provided by the taller banana plants. The researchers say their study could suggest not growing crops with closely related diseases together, like banana and coffee, could reduce the possibility of new strains of coffee-killing fungi evolving.

The researchers are now using the re-animated strains to infect coffee plants in the lab, in order to study exactly how the fungus infects the plant, potentially providing other ways to prevent the disease taking hold.

The insights could also be applied to different crop plants, where other closely related plant pathogens could make similar leaps, causing new diseases to emerge. Having shown the value of examining historical specimens of plant disease, the team plan to replicate the study with other diseases stored in CABI's collection, which hosts 30,000 specimens collected from around the world over the past 100 years.

Lead researcher Professor Timothy Barraclough, from the Department of Zoology at Oxford and the Department of Life Sciences at Imperial, said: "The historical approach shows us what happens to a plant pathogen before and after a new outbreak of disease occurs. We can then study the mechanisms of evolution and improve predictions of how similar outbreaks could occur in the future.

"Our aim is to replicate this study for many plant pathogens, eventually drawing up a 'rule book' of how pathogenicity evolves, helping us to prevent future outbreaks where possible."

**Journal Reference:**

Lily D. Peck, Reuben W. Nowell, Julie Flood, Matthew R. Ryan, Timothy G. Barraclough. Historical genomics reveals the evolutionary mechanisms behind multiple outbreaks of the host-specific coffee wilt pathogen Fusarium xylarioides. BMC Genomics, 2021; 22 (1) DOI: 10.1186/s12864-021-07700-4

# TOMATO FRUITS SEND ELECTRICAL WARNINGS TO THE REST OF THE PLANT WHEN ATTACKED BY INSECT

A recent study in Frontiers in Sustainable Food Systems shows that the fruits of a type of tomato plant send electrical signals to the rest of the plant when they are infested by caterpillars. Plants have a multitude of chemical and hormonal signalling pathways, which are generally transmitted through the sap (the nutrient-rich water that moves through the plant). In the case of fruits, nutrients flow exclusively to the fruit and there has been little research into whether there is any communication in the opposite direction--i.e. from fruit to plant.

"We usually forget that a plant's fruits are living and semiautonomous parts of their mother-plants, far more complex than we currently think. Since fruits are part of the plant, made of the same tissues of the leaves and stems, why couldn't they communicate with the plant, informing it about what they are experiencing, just like regular leaves do?" says first author Dr Gabriela Niemeyer Reissig, of the Federal University of Pelotas, Brazil. "What we found is that fruits can share important information such as caterpillar attacks--which is a serious issue for a plant--with the rest of the plant, and that can probably prepare other parts of the plant for the same attack."

**A tomato's defense**

To test the hypothesis that fruits communicate by electrical signals, Niemeyer Reissig and her collaborators placed tomato plants in a Faraday's cage with electrodes at the ends of the branches connecting the fruits to the plant. They then measured the electrical responses before, during and after the fruits had been attacked by Helicoverpa armigera caterpillars for 24 hours. The team also used machine learning to identify patterns in the signals.

The results showed a clear difference between the signals before and after attack. In addition, the authors measured the biochemical responses, such as defensive chemicals like hydrogen peroxide, across other parts of the plant. This showed that these defences were triggered even in parts of the plant that were far away from the damage caused by the caterpillars.

The authors emphasise that these are still early results. Their measurements provide a "big picture" view of all of the electrical signals, rather than distinguishing individual signals more precisely. It will also be interesting to see whether this phenomenon holds true for other plant species, as well as different types of threats.

That said, this novel use of machine learning appears to have very high potential for answering these and other future questions. The technique may also provide new--and possibly more environmentally friendly--approaches for insect control in agriculture.

**"If studies like ours continue to advance and the techniques for measuring electrical signals in open environments continue to improve, it will be possible to detect infestation of agricultural pests quite early, allowing for less aggressive control measures and more accurate insect management," explains Niemeyer Reissig. "Understanding how the plant interacts with its fruits, and the fruits among themselves, may bring insights about how to 'manipulate' this communication for enhancing fruit quality, resistance to pests and shelf life after harvest."**

# RESEARCHERS FIND TOXIN FROM MAPLE TREE IN COW'S MILK

Cows can pass on the hypoglycin A toxin through their milk, a study by the Martin Luther University Halle-Wittenberg (MLU) and the Leibniz Institute of Plant Biochemistry (IPB) in Toxins shows. The substance can cause severe symptoms in humans and animals. Small amounts of the toxin were detected in the raw milk of cows that grazed in a pasture exposed to sycamore maple. The team calls for further investigations to realistically assess the potential dangers.

High concentrations of hypoglycin A can be found in unripe akee and lychee fruit and in the seeds and seedlings of various maple trees. These include, for example, the sycamore maple, which is common throughout Europe. The toxin can cause severe illness in humans. In 2017, a team of researchers in India was able to prove that the toxin was responsible for the sudden death of several hundred children in the country who had previously eaten large quantities of lychee. "The substance interferes with the body's energy metabolism. One typical symptom in humans is very low blood sugar levels," says Professor Annette Zeyner from the Institute of Agricultural and Nutritional Sciences at MLU. In 2013, hypoglycin A from maple trees was also found to cause atypical myopathy in horses -- a puzzling disease that is often fatal for animals kept on a pasture.

Zeyner and her team joined forces with Dr Jörg Ziegler from IPB to discover whether hypoglycin A could also be detected in the raw milk of cows. "Maple trees are widespread and grazing cows is a common practice. Thus, it seemed logical that cows -- like horses -- would eat the seeds or seedlings of maple trees, thereby ingesting the toxins," explains Zeyner. For the new study, the team examined samples from dairy farmers in northern Germany. Only milk provided directly from the farms was analysed. "We did not analyse samples from individual cows; instead, we sampled the milk from several cows which was stored in collection tanks," says Zeyner.

The samples were analysed using a special form of mass spectrometry which can detect even tiny amounts of a substance. The result: "We detected hypoglycin A only in two samples of raw milk from the one of the farms whose pasture contained a single maple tree," says Zeyner. The concentration of the substance was 17 and 69 micrograms per litre of milk. "These are low and widely varying concentrations. But considering that there was only one tree in the pasture and the sample came from a collection tank, it was surprising that we were able to detect anything at all," explains Zeyner. The toxin could not be detected in any of the other samples.

"Our study is the first to show that cows appear to ingest parts of the sycamore maple containing the toxin, which is then transferred to their milk. Many other questions arise from this finding," says the researcher in summary. It is still unclear, for example, how much toxin the cows have to ingest for there to be detectable traces in their milk. Follow-up studies will be needed to determine whether the substance is destroyed when the milk is processed or even whether this low concentration is a cause for concern, and how it can be prevented.

**Journal Reference:**

Mandy Bochnia, Jörg Ziegler, Maren Glatter, Annette Zeyner. Hypoglycin A in Cow's Milk—A Pilot Study. Toxins, 2021; 13 (6): 381 DOI: 10.3390/toxins13060381

# GOOD FOOD IN A NICE SETTING: WILD BEES NEED DIVERSE AGRICULTURAL LANDSCAPES

Mass-flowering crops such as oilseed rape or faba bean (also known as broad bean) provide valuable sources of food for bees, which, in turn, contribute to the pollination of both the crops and nearby wild plants when they visit. But not every arable crop that produces flowers is visited by the same bees. A team from the University of Göttingen and the Julius Kühn Institute (JKI) in Braunschweig has investigated how the habitat diversity of the agricultural landscape and the cultivation of different mass-flowering crops affect wild bees. The research shows that diverse agricultural landscapes increase the species richness of wild bees. Flowering arable crops with different flower shapes support different wild bee species. The results of the study have been published in Landscape Ecology.

The research team recorded wild bees in flower-rich, semi-natural habitats such as hedgerows and flower strips in a total of 30 different agricultural landscapes, each covering one square kilometre, near Göttingen, Itzehoe and Leipzig. Researchers counted the number of bees along standardised sections and used a hand net to catch them and identify the species. The landscapes used in the study differed in their diversity and in the proportion of land covered by rapeseed and faba beans.

**"The shape of the flower is an important criterion for determining which wild bee species will collect nectar from its flowers," says PhD student Felix Kirsch from the University of Göttingen, who conducted the study as part of his Master's thesis.**

"For example, the shape of the flower must fit the bee's body size and the length of its tongue. Nectar is easily accessible from rapeseed flowers, while the nectar of faba bean is hidden deep inside the flowers."

"Our study shows that faba beans promote social wild bees, especially long-tongued bumblebees," explains Dr Doreen Gabriel from the JKI in Braunschweig. A different picture emerged in landscapes with large amounts of oilseed rape: here, the study found that the proportion of solitary wild bees, which often have a smaller body size, was higher. "The cultivation of a certain mass-flowering crop is not sufficient to maintain diverse bee communities, which in turn ensure the pollination success of many flowering arable crops and wild plants," says first author Nicole Beyer, a postdoctoral researcher in the Functional Agrobiodiversity Department at Göttingen University. The head of the department, Professor Catrin Westphal, concludes: "Our results show convincingly that diverse, flowering arable crops and especially diverse semi-natural habitats in the agricultural landscape are necessary to support a broad range of wild bee species."

**Journal Reference:**
Nicole Beyer, Felix Kirsch, Doreen Gabriel, Catrin Westphal. Identity of mass-flowering crops moderates functional trait composition of pollinator communities. Landscape Ecology, 2021; DOI: 10.1007/s10980-021-01261-3

# NEW FINDINGS TO BOOST BARLEY YIELDS AT HIGHER TEMPERATURES

An international team of researchers has identified a novel mechanism in barley plants, which could help crop growers achieve high yields as temperatures rise.

With grain production highly sensitive to changing environmental conditions, rising temperatures are known to reduce the number of seeds that can be produced on each plant. One solution is to increase the number of flowers or branches on each 'spike', which is the reproductive structure from which grain is harvested.

In a study published in Nature Plants, research led by Professor Dabing Zhang from the University of Adelaide's Waite Research Institute and Shanghai Jiao Tong University's Joint Lab for Plant Science and Breeding, explored the possibility of increasing seed production through the reproductive mechanisms in plants that respond to high temperatures.

"Cereal crops such as wheat and barley are worth over $12B to the Australian economy," said lead author Dr Gang Li with the University of Adelaide's Waite Research Institute.

**"Genes that control the amount of grain produced per plant under higher temperatures are really attractive targets for breeders and researchers, particularly in the face of changing environmental conditions.**

"It has long been presumed that environmental cues such as temperature are responsible for the diversity of the biological structures between cereals. However the mechanisms behind the structural changes have been largely unknown, which is why this study is important."

In the study, Professor Zhang's team found a novel mechanism by which a barley protein, known as HvMADS1, regulates the number of flowers generated on each spike, in response to high temperatures. The researchers were able to demonstrate that HvMADS1 is critical in maintaining an unbranched barley spike under high ambient temperatures.

Using a highly-efficient genome editing technique, the researchers were able to generate new plants that lack HvMADS1 function, effectively converting an unbranched barley spike into a branched structure, bearing more flowers at high ambient temperatures.

"This could ultimately result in the production of more grain per plant," said Dr Li.

Co-author Associate Professor Matthew Tucker, Deputy Director of the Waite Research Institute said: "This study reveals a new role of this protein family in responding to thermal change and directing the composition of flowers on a stem.

"With short to medium temperature rises predicted globally, plant scientists and breeders have an enormous challenge ahead of them to generate crop yields needed to feed growing populations in higher temperatures.

"By having a better understanding of the genes underpinning desirable plant traits in response to temperature scientists can offer insights into breeding climate-smart plants to sustain productivity."

The researchers say this work provides new avenues for crop breeding potential to overcome the traditional compromise between heat tolerance and high yield.

"This collaborative research demonstrates the importance of international partnerships in delivering fundamental scientific breakthroughs, and the value of gene editing strategies in crops, which are routinely used at the Waite Research Institute at the University of Adelaide," said Associate Professor Tucker.

**Journal Reference:**

Gang Li, Hendrik N. J. Kuijer, Xiujuan Yang, Huiran Liu, Chaoqun Shen, Jin Shi, Natalie Betts, Matthew R. Tucker, Wanqi Liang, Robbie Waugh, Rachel A. Burton, Dabing Zhang. MADS1 maintains barley spike morphology at high ambient temperatures. Nature Plants, 2021; DOI: 10.1038/s41477-021-00957-3

# ILLUMINATING THE MECHANISM BEHIND HOW PLANTS REGULATE STARCH SYNTHESIS

A Kobe University research group led by Associate Professor FUKAYAMA Hiroshi of the Graduate School of Agricultural Science has used rice to successfully illuminate the mechanism by which plants regulate the amount of starch produced via photosynthesis. This knowledge could contribute towards improving the quality and yield of agricultural crops.

These research results were published in the international scientific journal Plant, Cell & Environment on May 14, 2021.

**Main Points**

- Plants convert carbon dioxide (CO2) into organic substances (such as starch) via photosynthesis. If a plant is growing in conditions where there is an elevated concentration of CO2, the amount of starch it produces increases.
- CRCT (*1) protein levels increase when CO2 concentrations are elevated. This protein has been thought to promote starch synthesis but how it does this was previously unknown.
- The research group revealed that 14-3-3 proteins (*2) play a role in CRCT-mediated regulation of starch synthesis.
- They indicated the possibility that CRCT moves into and becomes activated in the starch-storing parenchyma cells after being synthesised in the phloem's vascular bundles.
- The researchers also revealed that CRCT binds to regulation sites on multiple starch synthesis-related genes and is a transcriptional activator protein.
- Synthesising starch is a vital process for plants. The illumination of the regulatory mechanism behind this process will be useful for improving crop productivity and quality.

**Research Background**

The increased concentration of CO2 in the atmosphere is the main cause of global warming, which is a worldwide issue. However, it has been said that this could benefit plants as they convert CO2 into starch via photosynthesis. If a crop is grown in conditions where there is an elevated concentration of CO2, starch synthesis is accelerated, resulting in vigorous growth and increased yield. CO2-Responsive CCT protein (CRCT) is activated in conditions where CO2 concentration is high, however its function remained unknown. This research group has been investigating these proteins using rice plants, and previously discovered that CRCT is an important protein that regulates starch synthesis. In their latest findings, the group have revealed how CRCT regulates this process, which was not understood until now.

**Research Methodology and Findings**

Various proteins are required for starch synthesis in plants, including glucose 6-phosphate/phosphate translocator, ADP-glucose pyrophosphorylase, starch synthase and starch branching enzyme. The researchers hypothesised that CRCT regulates the expression of multiple genes corresponding to these starch synthesis-related proteins. Proteins that regulate gene expression are called transcription factors. In many cases, these transcription factors form a complex with another protein. When the researchers analysed the volume of CRCT inside a plant, they discovered that it can form a complex with some types of protein. To investigate this further, they performed an analysis using an antibody that specifically binds to CRCT, which revealed that CRCT binds to 14-3-3 proteins. From another analysis, this time using green fluorescent proteins, the research group illuminated that CRCT and 14-3-3 protein form a complex inside the nucleus. They also indicated the possibility that CRCT moves into and becomes activated in the starch-storing parenchyma cells after being synthesised in the phloem's vascular bundles. Furthermore, the researchers revealed that CRCT promotes transcription by binding to regions that regulate the expression of multiple starch synthesis-related genes.

It is known that there is a negative correlation between the expression of 14-3-3 proteins and the amount of starch. However, our results showed that there is a positive correlation between the amount of starch and the expression of CRCT. Consequently, the research group assumes that 14-3-3 protein and CRCT form an inactive complex.

**Further Developments**

Starch synthesis is indispensable for plants, and CRCT, which regulates this process, is a prime target for efforts to improve crop quality and productivity. In addition, CRCT is a gene that is activated under conditions where there is an elevated concentration of CO2, and this knowledge will be useful for selecting suitable rice cultivars for such environments in the future. Furthermore, similar genes to CRCT have been found in every plant investigated so far. The research group is also currently investigating CRCT function in potato, a staple starch crop.

From an academic standpoint, there are still questions that need to be answered. Looking at the current research results, it can be supposed that CRCT proteins move between cells but the underlying mechanism is not known. Furthermore, it is not understood how CRCT changes its own expression level in response to CO2 concentrations and sugar levels. If the mechanism behind CRCT-mediated regulation of starch synthesis can be fully illuminated, it will be possible to make even greater improvements to agricultural crops.

**Glossary**

1. CRCT: CRCT stands for CO2-Responsive CCT protein. It is a protein found in plants, the accumulation of which increases if CO2 concentrations are high (or possibly in response to increased sugar concentrations). It is believed to promote starch synthesis.

2. 14-3-3 proteins: A family of proteins that are expressed in the cells of all eukaryotic organisms (plants, animals etc.). They are known to play roles in signal transmission and metabolic regulation among other things.

**Journal Reference:**

Hiroshi Fukayama, Fumihiro Miyagawa, Naoki Shibatani, Aiko Koudou, Daisuke Sasayama, Tomoko Hatanaka, Tetsushi Azuma, Yasuo Yamauchi, Daisuke Matsuoka, Ryutaro Morita. CO 2 - responsive CCT protein interacts with 14- 3- 3 proteins and controls the expression of starch synthesis–related genes. Plant, Cell & Environment, 2021; DOI: 10.1111/pce.14084

# STINKWEED COULD MAKE A CLEANER BIO-JET FUEL, STUDY FINDS

A common farm weed could make a "greener" jet fuel with fewer production-related environmental impacts than other biofuels, a new study indicates.

Growing the weed, pennycress -- often called stinkweed -- as a crop requires less fertiliser and fewer pesticides than other plants that can be used to make renewable jet fuel, according to the study. Pennycress also requires fewer farm operations, such as soil tilling, than other potential biofuel crops, reducing the associated environmental costs. Those costs include carbon dioxide emissions that cause the climate to change, as well as other emissions that pollute the air.

Environmental impacts could be further mitigated through farm management techniques that keep fertiliser on fields, rather than allowing it to run off into nearby watersheds, the study suggests. Such techniques can add to the financial cost of growing crops, but reduce their environmental footprints.

"Reducing greenhouse gas emissions from air travel will mean not just incremental changes, but a fundamental change in how we have been producing fuel and where that fuel comes from," said Ajay Shah, senior author of the study and associate professor of food, agricultural and biological engineering at The Ohio State University in Wooster. "And what we found is that pennycress might make a very good alternative fuel, especially when you consider the environmental costs of producing it."

The study was published recently online in the journal Applied Energy.

For this study, the researchers estimated the environmental impacts of growing pennycress, transporting it to a biorefinery and converting it to a usable jet fuel. They also accounted for the environmental costs of burning leftover byproducts of refining the pennycress seed into fuel.

Those environmental costs include fertiliser and pesticide use, water consumption and the energy required to harvest and transport pennycress seeds from a farm to a biorefinery and process them into usable fuel.

The researchers built computer models to determine how much total energy it would take to produce jet fuel from pennycress seeds and compared those estimates with the energy needed for producing biofuels from other crops. The data for the models came from existing studies about biofuel production.

Their models showed that it took about half as much energy to produce jet fuel from pennycress as it did to produce jet fuel from canola or sunflowers, two other potential bio-jet fuel crops. Pennycress oil production used about a third as much energy as soybean oil production, the researchers found, and the energy needed for turning pennycress into jet fuel was about the same as that used to produce fuel from the flowering plant camelina, another biofuel crop.

Renewable jetfuels are not yet financially competitive with fossil fuel-based fuels, Shah said. But calculating the environmental impacts of alternative bio-based fuels should help both farmers and policymakers as they try to limit carbon dioxide in the Earth's atmosphere and, hopefully, to slow or stop climate change.

"Pennycress also makes an appealing alternative jet fuel because of its growing season," Shah said. "It is a winter cover crop that can be grown between corn season and soybean season, giving the same body of farmland an extra production cycle each year.

**"Pennycress can be planted when corn is still standing in the field, before the corn harvest," he said. "And it can be harvested before the soybean crops are planted. The bottom line is it can be used as a cover crop, it doesn't divert any agricultural production land, and it has suitable properties for renewable jet fuel production."**

Greenhouse gas emissions from air travel contribute to climate change, accounting for about 2% of all human-induced carbon-dioxide emissions, according to various groups that study the effects of transportation on climate change.

"Reducing those emissions will almost certainly mean finding cleaner alternatives to jet fuels made from fossil fuels," Shah said. "Studies like this one can help determine the best alternative.

"When it comes to pennycress, production and logistics are the big contributors to both the environmental impacts and the costs, and those are the challenge areas - they have to be streamlined and solved to make it more efficient," he said. "If we could improve those areas, we could make production more energy-efficient and substantially lower the costs and environmental impacts."

**Journal Reference:**

Gang Li, Hendrik N. J. Kuijer, Xiujuan Yang, Huiran Liu, Chaoqun Shen, Jin Shi, Natalie Betts, Matthew R. Tucker, Wanqi Liang, Robbie Waugh, Rachel A. Burton, Dabing Zhang. MADS1 maintains barley spike morphology at high ambient temperatures. Nature Plants, 2021; DOI: 10.1038/s41477-021-00957-3

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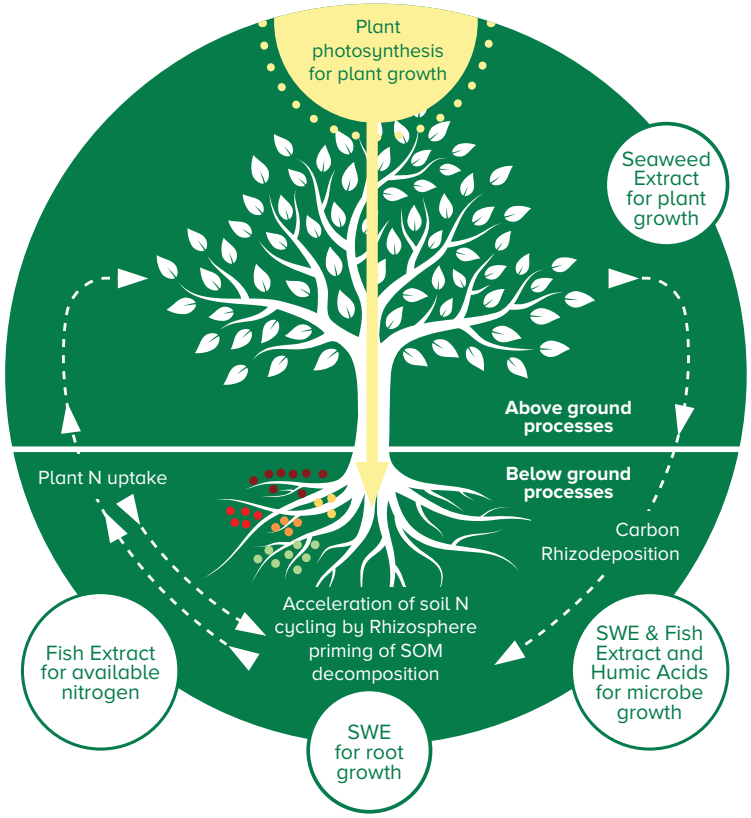


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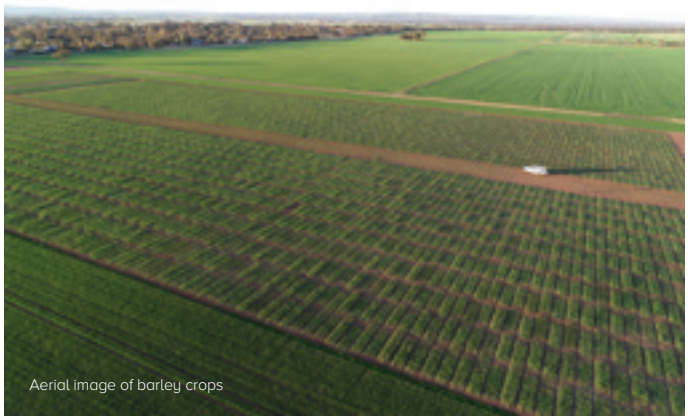
# BOOSTING BARLEY PRODUCTION FROM THE GROUND UP

Researchers are taking to the skies to help see what is happening underground in a new project that aims to improve one of Australia's largest grain crops - barley.

University of Queensland's Associate Professor Lee Hickey is leading a study investigating ways to optimise root systems and help barley growers improve yield stability, particularly in the dry seasons.



Aerial image of barley crops

"For a century, plant breeders have focused on what happens above the ground in terms of adapting crops to diverse production environments," Dr Hickey said.

"Barley breeders have traditionally focused on breeding for traits that are visible such as plant height and flowering time.

"Over the years, important root traits could have been inadvertently selected but there may be a lot more we can achieve."

The project will employ cutting-edge technologies to fast-track barley breeding for diverse production environments in Western Australia, Victoria, South Australia, New South Wales and Queensland.

The research team will make use of advances in remote sensing technology such as drones fitted with multispectral cameras.

Barley field trial in Warwick, Queensland (photo credit QAAFI)

**"With the new sensors we can fly drones across field experiments to measure traits the eye can't see like canopy temperature, and this can tell us a lot about how much water the crop is using," Dr Hickey said.**

The team will match this data with soil coring samples taken in the field to better understand the relationship between canopy traits and root traits.

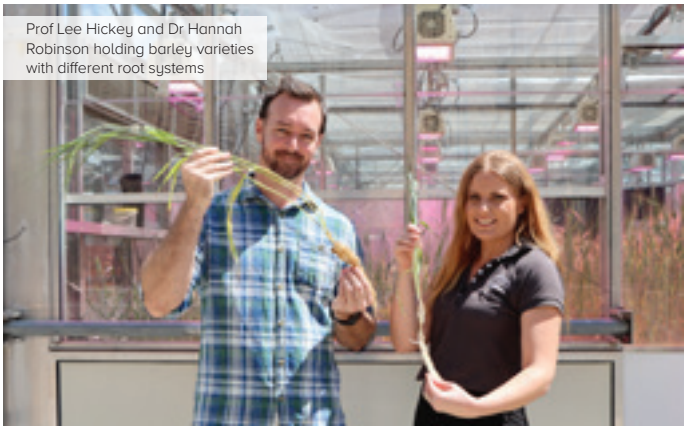
"Understanding the value of different root traits is key," he said.

"On farms with deep soils that rely on stored soil moisture, a deeper root system could improve access to moisture in dry seasons.

"However, more vigorous root growth in the upper soil layers could be advantageous for crops grown on shallow soils that rely on rainfall during the growing season."

Another tool is CRISPR genome-editing technology, which could assist researchers in engineering novel genetic variation by targeting key genes that influence root system development.

"If we can successfully harness the new technologies to improve root systems in barley, this approach could also be used in breeding programs for other major cereals such as wheat and oats," Dr Hickey said.



Prof Lee Hickey and Dr Hannah Robinson holding barley varieties with different root systems

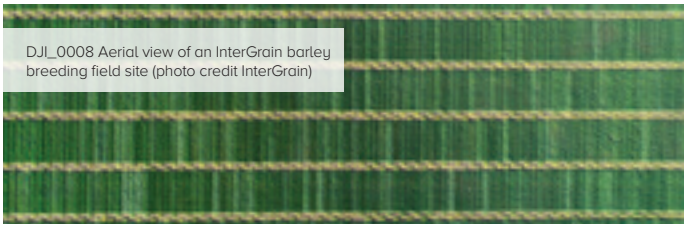
The 'Digging deeper to improve yield stability' project is in partnership with InterGrain and the Australian National University and funded by an Australian Research Council Linkage grant.

InterGrain barley breeder Dr Hannah Robinson said a big part of the research would focus on creating an "optimum root shape" for varying soil profiles across Australia, tailoring barley root systems to be better adapted to Australia's diverse environment and production systems.

"This should improve water and nutrient extraction, and thus ultimately yield, in the variable and changing climates we now face in Australia," Dr Robinson said.

"It is about validating what is the best for each unique soil profile and environment, then breeding varieties with optimised root systems adapted to those environments across Australia."

Barley is the second largest grain crop in Australia with the industry valued at $3 billion per year.



DJI_0008 Aerial view of an InterGrain barley breeding field site (photo credit InterGrain)

# STOP AND THINK ABOUT THE RISK OF SPRAY DRIFT

Managing the risk of spray drift is one of the most important aspects of agrichemical use, particularly in many parts of regional Victoria where a diverse range of agricultural industries often coexist side by side.

Maintaining consumer confidence in agrichemical usage is increasingly important to support domestic and international markets. While most users are diligent in their use of agrichemicals, each year the department responds to 30-plus complaints about inappropriate use.

All agrichemical users have an ethical, legal and environmental responsibility to prevent the chemical you are spraying from drifting from the target crop or activity.

Agriculture Victoria Acting Statewide Chemical Standards Officer Felicity Collins said the aim should always be to achieve maximum application on the target with minimal off-target incidents.

“This results in improved chemical effectiveness and reduced damage and/or contamination of neighbouring crops or nearby sensitive areas,” Ms Collins said.

“Damage or contamination to all crop types or pastures from any chemical can occur. All chemicals are capable of drift and chemical users should never be complacent.”

**“The implications of spray drift incidents are distressing for farmers and others impacted and may be devastating for the environment. When chemical users do not manage drift, they can cause thousands of dollars of damage to a neighbouring crop.**

“For example, if a contaminated pasture is grazed by livestock such as dairy, the milk may not be fit of sale and the dairy farmer is required to discard the milk,” she said.

Spray drift that causes damage or contaminates another farmer’s crop or produce is an offence in Victoria under the Agricultural and Veterinary Chemicals (Control of Use) Act 1992.

Ms Collins said there is plenty of technology available to prevent spray drift, and accessible information on how to manage drift.

Effective application will minimise the risks of off-target damage. Some best management practices include:

- Always check for susceptible crops or pasture in the area
- Check for sensitive areas such as houses, schools, native vegetation and waterways
- Always read and follow the product label directions. Some labels specify a minimum droplet size, wind speed range, buffer zones and boom height that legally must be followed by the user
- Monitor weather conditions carefully. Don’t spray if conditions are not suitable and stop spraying if conditions change and become unstable
- Use the largest droplet size possible that will give adequate spray coverage
- Keep boom height to a minimum
- Targets vary in their ability to collect or capture spray droplets. Fallow paddocks or seedling crops have poor catching surfaces. Well grown, leafy crops are efficient collectors of droplets
- Utilise buffer zones between that target area and susceptible crop or sensitive area where no chemical is applied. This allows droplets to settle before potentially leaving your farm.

For more information on managing spray drift visit www.agriculture.vic.gov.au/spraydrift or talk to one of our chemical standards officers by calling our Customer Contact Centre on 136 186.

# “WHEN THE GOING GETS TOUGH, THE TOUGH GET GOING”

Throughout the central west and northern regions of New South Wales farmers have been struggling to complete their wheat and chick pea seeding programs due to the continuous rainfall events during June. These conditions are expected to persist in the short term according to the Bureau of Meteorology's climate outlook for June to August 2021 (published on 27 May 2021), which predicts there is a greater than 60% chance of above average rainfall across much of New South Wales and south-east Queensland.

As a result of the forecast rainfall and stored soil moisture from rainfall to date it is likely to be sufficient to support above average crop and pasture production across most of the New South Wales and south-east Queensland region.

In line with this forecast and the current tough planting conditions farmers and their agronomists are starting to replace the original area set aside for wheat and chickpeas with plantings of spring crops such as sorghum.

An alternative option to planting sorghum is to plant Super High Oleic (SHO) Safflower.

Safflower has been grown across grain growing regions for over 30 years. It was traditionally grown as a spring planted crop in the higher rainfall and irrigated regions of South East South Australia, the West Wimmera and Western Victoria. From time to time it was grown as a ‘spring salvage crop’ in grain growing regions where it was too wet to plant autumn crops or autumn planted crops had failed due to the wet winter conditions.

It is safflowers deep tap root that can penetrate into saturated soil that allows it to take advantage of these wet soil conditions across a range of soil types including sodic and saline soils. Together with the development of the industrial lubricant market for SHO safflower, it has become a very real opportunity for planting in spring across the central west and northern New South Wales grain growing regions as well as the traditional growing regions in South East South Australia, the West Wimmera and Western Victoria.

CSIRO together with the support of GRDC developed SHO safflower to produce a superior quality oil which is being targeted for the industrial lubricant market and high value ‘specialty’ consumer market. Through the use of CSIRO’s proprietary technology their scientists were able to develop SHO Safflower which consistently delivers extremely high levels of oleic acid (>90%) in the oil when compared to alternate plant-based sources of Oleic Acid (e.g. palm, canola, sunflowers, soybeans).

Melbourne based company GO resources was appointed the exclusive licensee for the development and commercialisation of SHO safflower crop and the oil derived from the crop for use the industrial lubricant market and high value ‘specialty’ consumer market.

In terms of SHO safflower agronomy, it is recommended that for spring planting in 2021 the ideal planting window extends from mid/late-August through to mid/late September with a seeding rate of 18 kg/ha – 20 kg/ha with harvest occurring in February – early March. Depending on planting conditions later planting can be undertaken in more southern regions. With regard to plant nutrition its requirements are very similar to that of wheat. Currently, the number of pre-emergent and post-emergent herbicide options has been extended to include products such as propyzamide, Prosulfocarb + S-Metolachlor, S-Metolachlor, Clethodim and Metsulfuron methyl.

The second commercial year of release in 2020 saw an increase in the area of SHO Safflowers planted across south-east Queensland, New South Wales and Victoria to approximately 4,500 hectares. On the back of a very tough season in 2019, this allowed both growers and advisors a closer look at what safflower can do in more favourable conditions.

In 2020, GO Resources appointed DeltaAg and their recent acquisition NorthWestAg to be its supply chain partner for south-east Queensland, New South Wales together with the north-east, Mallee and Wimmera regions of Victoria. This was followed by the appointment in 2021 of WesternAg to be its supply chain partner for the south-east of South Australia, the West Wimmera and Western District regions of Victoria. DeltaAg and WesternAg will be responsible for supply of planting seed, signing of GO Resources grower contracts and for providing growers and their advisors/consultants information on growing SHO safflower in 2021 and in the forthcoming years ahead. In addition to these responsibilities both companies will be undertaking a range of market development activities including establishment of demonstration sites, field days and communications in relation to SHO Safflower. SHO Safflower planting seed is available in 750kg bulker bags and 20 kg standard bags from DeltaAg and WesternAg.

For further information related to SHO safflower contracts or agronomy please contact your nearest DeltaAg/ NorthWestAg or WesternAg branch or David Hudson, GO Resources (0418 951 479)

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# STRIKING A BALANCE: TRADE-OFFS SHAPE FLOWER DIVERSITY

Flowers come in a multitude of shapes and colours. Now, an international research team led by a researcher from Japan has proposed the novel hypothesis that trade-offs caused by different visitors may play an important role in shaping this floral diversity.

In a study published last month, the team explored how the close associations between flowers and the animals that visit them influence flower evolution.

Visitors to flowers may be beneficial, like pollinators, or detrimental, like pollen thieves. All of these visitors interact with flowers in different ways and exert different selection pressures on flower traits such as colour and scent. For example, a scent that attracts one pollinator may deter other potential pollinators. In this case, the flower would be expected to cater to the best pollinator.

“On the basis of this theory, you’d expect that flowers would mostly be visited by one particular group of pollinators,” says lead author of the study, Professor Kazuharu Ohashi. “But flowers often host many different visitors at the same time and flowers appear to meet the needs of multiple visitors. The question we wanted to answer is how this happens in nature.”

Balancing the demands of multiple visitors involves trade-offs. For example, diurnal bees and nocturnal moths can both pollinate goat willow but prefer different smells. A floral scent adapted to only one of these animals would mean missed opportunities for pollination by the other. To see how these types of visitor-mediated trade-offs affect the evolution of flowers, the researchers developed a conceptual framework to examine the different types of trade-offs and how flowers might adapt. They then looked at previous studies of flower-animal interactions to see whether the research supported the proposed framework.

What they found was a variety of strategies for mitigating trade-offs. In the case of goat willow, flowers produce different scents during the day and night, and therefore attract both types of pollinator. Another example is floral colour change as a strategy to attract both bees and flies. Retaining old flowers could attract opportunistic foragers like flies, while repelling smart foragers like bees. The colour change in flowers as they age could reduce this trade-off by allowing bees to select young, rewarding flowers. Many other strategies were noted, all of which involved acquiring novel combinations of traits to attract, or exclude, different visitors.

“Most flowers are ecologically generalised and the assumption to date has been that this is a suboptimal solution,” explains Professor Ohashi. “But our findings suggest that interactions with multiple animals can actually be optimised by minimising trade-offs in various ways, and such evolutionary processes may have enriched the diversity of flowers.”

The discrepancy between observed flower visitors and those predicted on the basis of a flower’s traits has long been a topic of debate. Taking visitor-mediated trade-offs into account in future studies of flower evolution may help settle that argument.

**Journal Reference:**

Andrew A. Walker, Samuel D. Robinson, Jean-Paul V. Paluzzi, David J. Merritt, Samantha A. Nixon, Christina I. Schroeder, Jiayi Jin, Mohaddeseh Hedayati Goudarzi, Andrew C. Kotze, Zoltan Dekan, Andy Sombke, Paul F. Alewood, Bryan G. Fry, Marc E. Epstein, Irina Vetter, Glenn F. King. Production, composition, and mode of action of the painful defensive venom produced by a limacodid caterpillar, Doratifera vulnerans. Proceedings of the National Academy of Sciences, 2021; 118 (18): e2023815118 DOI: 10.1073/pnas.2023815118

# A CAFFEINE BUZZ HELPS BEES LEARN TO FIND SPECIFIC FLOWERS

There's nothing like a shot of espresso when you need to get some studying done -- and now, it seems like bees learn better with a jolt of their favourite caffeine-laced nectar, too. In a paper published July 28 in the journal Current Biology, researchers have shown that feeding bumble bees caffeine helps them better remember the smell of a specific flower with nectar inside. While previous studies have shown that bees like caffeine and will more frequently visit caffeinated flowers to get it, this is the first study to show that consuming caffeine in their nest actually helps bees find certain flowers outside of the nest.

"When you give bees caffeine, they don't do anything like fly in loops, but do seem to be more motivated and more efficient," says Sarah Arnold, a researcher at the Natural Resources Institute (NRI) of the University of Greenwich in the UK. "We wanted to see if providing caffeine would help their brains create a positive association between a certain flower odour and a sugar reward."

Choosing the best flower for food isn't as easy as it seems for bees. "It's really quite a challenging environment out there for bumble bees because they don't have extraordinarily sharp vision at long range," Arnold says. "They need to rely on a lot of cues, such as their sense of smell, to find good flowers."

Scientists already know that caffeine, which is found naturally in plants like coffee and citrus, plays a role in converting bees into faithful customers of caffeinated flowers. But previous experiments where bees showed a preference for the smell of flowers with caffeinated nectar have mostly been designed to give bees caffeine at the flower itself. With that setup, it's difficult to pinpoint the role caffeine plays: do caffeinated bees actually have better memories, or do they just crave the caffeine?

To answer this question, Arnold and the team (including researchers from NRI and also NIAB EMR, a horticultural research organisation in the UK) decided to instead give the bees caffeine at their nest while they learned to associate a specific smell -- a synthetic odour blend that mimics the scent of a strawberry flower -- with a delicious sugar solution. Importantly, afterwards, when they were sent out to forage for food and chose the strawberry-scented flowers, they would be rewarded with a sugary, but decaffeinated, nectar.

So, postdoctoral researcher Jan-Hendrik Dudenhöffer divided 86 previously untrained bumblebees into three groups. He primed the first group of bees with the strawberry odour and a caffeinated sugar solution. He gave the second group of bees the strawberry odour and sugar solution -- allowing them to learn the positive association between the two but without the caffeine boost -- and the third group of bees the sugar solution without any linked scent.

Then, he set individual bees loose in a flight arena, where they had to choose between two types of robotic flowers: either flowers with the strawberry odour they were already exposed to, or distractor flowers with another odour.

If they hadn't learned a positive association between the strawberry flower odour and nectar reward, then they'd likely visit the two types of flower equally. However, 70.4% of the caffeinated bees visited the strawberry flowers first -- much higher than chance. In comparison, 60% of the bees given the strawberry odour and sugar but without caffeine, and 44.8% of the bees given only sugar, initially chose the strawberry flowers. This suggests that caffeine did have a noticeable impact in improving the bees' ability to recognise a strawberry flower from its odour and to remember that it has their desired nectar.

However, this preference didn't last long. The caffeinated bees quickly got over their early preference for strawberry flowers and began visiting the other type of flower almost equally too.

"This is something we could have anticipated, because the bees got sugar no matter if they visited the target flower or the distractor flower," says Arnold. "In some ways, they were unlearning just as fast as they were learning."

The researchers also noticed that caffeine had a subtle effect on the bees' "handling speed," or the number of flowers they were visiting in a given amount of time. All bees got faster over time, but the caffeine bees improved the most rapidly, which suggests that caffeine may also improve motor learning skills.

These findings have big implications for agriculture, says Arnold. She points to strawberry farmers, who are likely buying several dozen, or perhaps hundreds, of boxes of commercial bumblebees every year -- many of which may stray toward neighbouring wildflowers instead of the intended strawberries.

**But by teaching the bees to prefer the crop with caffeine, Arnold says, "we leave wildflower resources for the wild bees, and the growers are getting more value for their money spent on the nests. It's a win-win solution for everybody."**

**Journal Reference:**

Sarah E.J. Arnold, Jan-Hendrik Dudenhöffer, Michelle T. Fountain, Katie L. James, David R. Hall, Dudley I. Farman, Felix L. Wäckers, Philip C. Stevenson. Bumble bees show an induced preference for flowers when primed with caffeinated nectar and a target floral odor. Current Biology, 2021; DOI: 10.1016/j.cub.2021.06.068

# UNTRAINED BEER DRINKERS CAN TASTE DIFFERENT BARLEY GENOTYPES

PULLMAN, Wash. - When it comes to craft beer, the flavour doesn't have to be all in the hops. As a panel of amateur beer tasters at Washington State University recently demonstrated, malted barley, the number one ingredient in beer besides water, can have a range of desirable flavours too.

Researchers recruited a panel of about 100 craft beer drinkers to taste some so-called SMaSH beers--those brewed with a single barley malt and single hop. All the beers contained the same hop variety, called Tahoma, but each had a malt from a different barley genotype, or genetic makeup. Trained tasters can distinguish these easily, but even the untrained panel could taste the difference among five different barley varieties--and definitely favoured some more than others.

"We found that the untrained panelists could differentiate among the barley breeding lines in the beer," said Evan Craine, a WSU doctoral student and first author on the study in the Journal of Food Science. "They did a good job of selecting attributes that revealed distinctive profiles for each of the beers."

The panel generally preferred the four barley breeding lines developed at WSU over the control, known as Copeland, a high-quality malting barley widely grown in Washington state. The panelists were able to easily identify the flavour profiles of the beers, such as one with a "fruity and sweet aromatic" flavour and another with a "citrus" profile made with a barley called Palmer, a variety recently released by WSU for commercial use.

While the untrained panel could distinguish flavours from brewed beers, they were not as adept at tasting the differences among "hot steep" samples which are made by combining hot water and ground barley malt before filtering. This creates a sweet liquid--similar to that made by brewers before yeast is added to create alcohol.

The researchers had hoped amateur beer tasters could distinguish flavour differences in the hot steep as it would shorten the testing process for new barley varieties. Corresponding author Kevin Murphy was not ready to give up on the method.

"Hot steep malt still shows a lot of promise," said Murphy, a WSU associate professor of crop and soil sciences. "The next step would be testing it with a trained panel to see if they can distinguish barley varieties. Ideally, we would just set it out to consumers because hot steep malting is great outreach. It gets people involved. They love tasting and talking about it."

While U.S. craft beer drinkers are known for their love of hop-heavy India Pale Ales, the results of this study add evidence that barley malts might be another good way to develop new beers.

For this study, Craine and Murphy worked with Scott Fisk, a faculty research assistant at Oregon State University, to create the malts and brewer Aaron Hart of Moscow Brewing Company to develop the beers, using hops only to add a little bitterness to balance the sweetness from the malt. These types of beers are called "malt-forward." They can be light or strong flavoured, ranging in types from lagers and pilsners to ambers and stouts. Hart called the beers developed for this study "American Pale Ales."

More variety from malt-forward beers can potentially benefit not only beer lovers but also the environment and brewers' bottom lines, said Craine.

**"In terms of sustainability, hops can be pretty resource intensive, and at least around us in Pullman, we can grow barley that's just rain fed," he said. "Hops can also be really expensive. Brewers are already buying the malt, so if we can find ways to increase the flavour contribution from the malt, hopefully, they can rely less on the hops and save money."**

While the hops craze is continuing, the malt-forward beers have the potential to spur the next evolution in craft brewing, said Murphy.

"Just as craft beer flavour has evolved in the last 20 years, we can expect it to continue to change over the next 20, and the new frontier will be adding different barley flavours or barley-hop combinations," he said. "I don't know how many people knew about IPAs 20 years ago, and they exploded. Brewers are very innovative, and I am very excited to see where this goes in the future."

# NEW TOOL TO HELP FARMERS MAKE CROP INPUT DECISIONS

Reducing greenhouse gas emissions (GHGs) and nitrogen water pollution from agriculture are top environmental priorities in the United States. Key to achieving climate goals is helping producers navigate carbon markets, while also helping the environment and improving farm income.

A new tool developed by a University of Minnesota research team allows farmers to create a budget balance sheet of any nitrogen reduction plans and see the economic and environmental cost, return and margins, all customised to fields under their management.

"With these numbers in mind, farmers can make more informed decisions on nitrogen mitigation that not only saves them money, but also significantly reduces pollutants to the environment," said Zhenong Jin, who led the research and is an assistant professor in the Department of Bioproducts and Biosystems Engineering (BBE) in the College of Food, Agricultural and Natural Resource Sciences (CFANS).

Previous tools did not allow for customised predictions for every field in the U.S. corn belt, as the computational and storage costs of running these crop models at large scale would be very expensive.

As outlined in an article published in IOPscience, the research team built a series of machine-learning-based metamodels that can almost perfectly mimic a well-tested crop model at much faster speeds. Using the metamodels, they generated millions of scenario simulations and investigated two fundamental sustainability questions -- where are the mitigation hotspots, and how much mitigation can be expected under different management scenarios.

"We synthesised four simulated indicators of agroecosystem sustainability -- yield, N2O emissions, nitrogen leaching, and changes in soil organic carbon -- into economic net societal benefits as the basis for identifying hotspots and infeasible land for mitigation," said Taegon Kim, CFANS research associate in the BBE department. The societal benefits include cost savings from GHG mitigation, as well as improved water and air quality.

"By providing key sustainability indicators related to upstream crop production, our metamodels can be a useful tool for food companies to quantify the emissions in their supply chain and distinguish mitigation options for setting sustainability goals," said Timothy Smith, professor of Sustainable Systems Management and International Business Management in CFANS's BBE department.

The study, conducted in the U.S. Midwest corn belt, found that:

- Reducing nitrogen fertiliser by 10% leads to 9.8% less N2O emissions and 9.6% less nitrogen leaching, at the cost of 4.9% more soil organic carbon depletion, but only a 0.6% yield reduction over the study region.
- The estimated net total annual social benefits are worth $395 million (uncertainty ranges from $114 million to nearly $1.3 billion), including a savings of $334 million by avoiding GHG emissions and water pollution, $100 million using less fertiliser, and a negative $40 million due to yield losses.
- More than 50% of the net social benefits come from 20% of the study areas, thus can be viewed as hot spots where actions should be prioritised.

**"Our analysis revealed hot spots where excessive nitrogen fertiliser can be cut without yield penalty," said Jin. "We noticed in some places that reducing nitrogen-related pollution comes at a cost of depleting organic carbon in soil, suggesting that other regenerative practices, such as cover cropping, need to be bundled with nitrogen management."**

In the future, the team will expand the framework presented in this study and develop more advanced and accurate carbon qualification models through a combination of process-based models, artificial intelligence and remote sensing.

This research was funded by the University of Minnesota AGREETT program, the National Science Foundation and the U.S. Department of Energy Advanced Research Projects Agency-Energy (ARPA-E).

**Journal Reference:**

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# FIRST COTTON CROP PLANTED IN QUEENSLAND'S LOCKYER VALLEY IN 22 YEARS

The Lockyer Valley might be known as Queensland's 'salad bowl', but the Brimblecombe family of Moira Farming at Forest Hill have been exploring opportunities with cotton.

Farm Manager, Mitch Brimblecombe's grandfather Alan was a pioneering cotton grower for forty years, but since the late 1990s, the family business has focused primarily on vegetables and grain.

"We're a mixed cropping operation," explains Mitch.

"We predominantly grow horticultural crops – corn, beans, broccoli, onions, carrots but also some grain and fodder."

After closely observing other demonstration trials in the region, Mitch saw the potential for cotton as a substitute for sorghum in his rotation this season.

"Here in the Lockyer Valley, we've been in drought for a little while now. We haven't been capturing fresh water, which we're dependent on to grow our horticultural crops," said Mitch.

"We do have salt water available in our bores, and we needed a salt-tolerant crop to utilise that water. We know that cotton is salt tolerant; and that was our main reason we decided to try cotton this year."

With agronomy support from Cotton Grower Services (CGS) and Cotton Seed Distributors (CSD), Mitch is growing forty hectares of irrigated cotton and ten hectares of dryland cotton with the variety Sicot 748B3F.

Moira Farming is also part of CSD's variety trial program, testing the suitability of different varieties for their production system.

**"A fair bit of research went into planning our first crop. We worked quite closely with the crew at CGS, CSD and also Bayer; so it's just been great having that guidance throughout the whole season.**

Mitch says he has been impressed with the open and transparent nature of the cotton industry.

"Going into the cotton season, I didn't comprehend how open the whole industry is for sharing information."

Agronomically and operationally, Mitch has found cotton to be a great fit into his farm rotation.

"Irrigating the cotton has been quite an easy transition for us; we're using the same infrastructure that we're using for our other crops.

"The pest control hasn't been too bad at all – Bollgard® 3 has really taken care of that for us. The only thing we've needed to spray for is a few mirids.

"Our business is quite a labour intensive business and having cotton doesn't draw away from our horticultural labour demand.

And with final yields ranging from 10.7 to 12.7 bales per hectare (irrigated), it's been a positive experience for Mitch.

"It's certainly a crop I'd recommend to other growers in the Lockyer Valley."

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# COLOUR AND FLAVOUR: PIGMENTS PLAY A ROLE IN CREATING TASTY TOMATOES

The flavour of a tomato is an interaction between its taste and aroma. Now, researchers from Japan and the United States have revealed that the pigments that determine the colours of tomatoes also affect their flavour.

In a study published this month, researchers from University of Tsukuba developed a new method to rapidly measure the pigment profiles of tomatoes and used the technique to explore how pigments affect the taste and aroma of different tomato varieties.

The colour of tomatoes is produced by combinations of different types of pigments, including carotenoids and chlorophylls. These pigments can also affect the accumulation of flavory-related compounds such as sugars, which affect the taste of tomatoes, and volatile organic compounds (VOCs), which determine the aroma. As tomato fruits ripen from green to red, the amounts of pigments and flavour-related compounds change but until now the relationship between colour and flavour has been unclear.

**"Pigments like carotenoids have no taste," says lead author Professor Miyako Kusano, "but they are precursors for compounds called apocarotenoid-VOCs (AC-VOCs) which produce the fruity/floral smell of tomatoes and increase the perception of sweetness -- characteristics that appeal to consumers."**

Traditional methods for identifying and measuring pigments can be slow, so the researchers developed a simple method to rapidly analyse large numbers of samples. Using the new technique, the team measured the amounts of carotenoids and chlorophylls in 157 different varieties of tomato and then analysed the flavours of each variety to find the links between pigments and flavour.

The results showed that tomato varieties with an abundance of chlorophyll also had a high sugar content, contributing to a sweet taste. They also found that the carotenoid profiles of the fruit reflected the appearance of the fruit, as well as AC-VOC levels.

"The pigment profile of one of the orange-coloured varieties called "Dixie Golden Giant" was particularly interesting," explains Professor Kusano. "It had very high levels of AC-VOCs, but the carotenoid content wasn't that high. We discovered that the pigment prolycopene was abundant in this variety, which explained the high AC-VOC levels."

The carotenoid content of fruit is influenced by growing conditions, like temperature and amount of light. By looking at the pigment profiles and AC-VOC content of fruits in different environments, it may be possible to find ways of improving AC-VOC production, which is good for both consumers and producers.

Given its speed, the new method developed by the team is a powerful tool for analysing pigment concentrations in large numbers of samples and could also be used for other fruits and vegetables.

The article, "High-throughput chlorophyll and carotenoid profiling reveals positive associations with sugar and apocarotenoid volatile content in fruits of tomato varieties in modern and wild accessions," was published in Metabolites.

This work was funded by the "Sustainable Food Security Research Project" in the form of an operational grant from the National University Corporation and The Yanmar Environmental Sustainability Support Association, Japan. This work was also supported by the JSPS KAKENHI Grant Number 19K05711 and by a grant from the National Science Foundation (IOS 1855585). The authors declare no competing interests.

**Journal Reference:**

Yusuke Aono, Yonathan Asikin, Ning Wang, Denise Tieman, Harry Klee, Miyako Kusano. High-Throughput Chlorophyll and Carotenoid Profiling Reveals Positive Associations with Sugar and Apocarotenoid Volatile Content in Fruits of Tomato Varieties in Modern and Wild Accessions. Metabolites, 2021; 11 (6): 398 DOI: 10.3390/metabo11060398

# PORTABLE CHEMISTRY KIT SWEETENS NATIVE BUSH FRUIT PRODUCTION

Indigenous communities can now assess the quality and sweetness of their wild-harvested native bush fruits in the field, rather than sending samples off to food science laboratories.

A prototype digital and portable bush fruits chemistry toolkit has been developed by University of Queensland researchers for communities to use on site, to measure key market attributes of popular bush fruits like Kakadu, Green and Burdekin plums.

ARC Training Centre for Uniquely Australian Foods Director at UQ, Professor Yasmina Sultanbawa, said the kit would help support the knowledge already present in communities by providing scientific measurements to support their own observations.

“For instance, people in the community know which trees have the sweetest fruit – but now with help of the toolkit, they can measure the sugar levels of fruit on the tree to get an external measure of its sweetness.

“Indigenous enterprises and interested buyers need to know product supply logistical measurements like the weight and size of the fruit (its pulp to seed ratio); how much sugar and salt content and acidity levels are in the fruit; and moisture levels.”

Professor Sultanbawa said this type of information was required to help understand the stability of the product, its suitability to be processed into a dehydrated powder, and to determine the type of packaging required.

“The toolkit has been designed to address these questions and will be tailored according to the needs of each Indigenous enterprise, depending on their current activities along the value chain.

“By ensuring consistently high-quality products, these enterprises are likely to get repeat, increased and new business, resulting in greater economic and social benefits delivered back into communities.

Dr Anh Phan demonstrates use of callipers to measure fruit to seed ratio – equipment included in the chemistry toolkit, Coopers Plains Lab, June

“Plus, the tool kit can be used to provide information on seasonality, growing conditions and plant physiology for Indigenous enterprises to own and share with future generations.”

The toolkit, developed by UQ’s Dr Anh Phan, was also supported by funding from the Cooperative Research Centre for Developing Northern Australia as part of the Australian Government’s CRC program, and can be used with any native bush fruit.

Djungan Paul Neal, Community Enterprise Developer at the Yarrabah Aboriginal Shire Council, whose community will house one of two chemistry test kits, said the kit empowered communities.

**“We are interested in developing a commercially viable native foods industry, in partnership with industry and research organisations, that utilises traditional knowledge and science, and is led by Aboriginal people with governing intellectual property principles in place,” Mr Neal said.**

All the intellectual property generated in these projects will be owned by Indigenous partners.

Professor Sultanbawa said the research team was investigating different sensing technologies communities could use on site to measure other key properties of their fruit, such as vitamin levels, traceability, and provenance.

Image: Dr Anh Phan demonstrates use of callipers to measure fruit to seed ratio – equipment included in the chemistry toolkit, Coopers Plains Lab

Image: Selina Fyfe

# IN PLANT CELLS, A CONSERVED MECHANISM FOR PERCEIVING MECHANICAL FORCE RESIDES IN UNEXPECTED LOCATION

Minuscule tunnels through the cell membrane help cells to perceive and respond to mechanical forces, such as pressure or touch. A new study in the journal Science is among the first to directly investigate what one type of these mechanosensitive ion channels is doing in the tip-growing cells in moss and pollen tubes of flowering plants, and how.

Biologists led by Elizabeth Haswell at Washington University in St. Louis discovered that so-called PIEZO channels are not found along the plasma membrane in plant cells as they are in animal cells.

Instead, they observed that PIEZO channels have retreated into the plant cell, an unexpected discovery. PIEZO channels are found deeper within the cell, in the membranes of vacuoles -- the large, intracellular organelles that help maintain cell turgor and fulfill a number of other roles in the plant cell.

**"PIEZO channels in plants play a dramatic and critical role in regulating the shape of the vacuole and how much membrane there is," said Haswell, a professor of biology in Arts & Sciences and a Howard Hughes Medical Institute-Simons Faculty Scholar.**

"This is the first example of PIEZO channels involved in regulating organelle morphology," she said. "The data we present could lead to new lines of investigation for both plant and animal PIEZO homologs."

As the name suggests, mechanosensitive ion channels are paths, or tunnels, through cell membranes that respond to mechanical forces. Under certain forces a channel opens, allowing the flow of ions across the membrane.

In humans, PIEZO channels are essential for life; without them, cell development halts. They are recognised for their role in perceiving light touch, shear force and compressive force. Dysfunction in PIEZO channels has been linked to multiple human diseases.

PIEZO channels were first identified in plant genomes in 2010. After a decade of research on animal homologs, this new research shines a spotlight on plant cells and explores how they differ from animal cells. Other research teams have recently shown that PIEZO channels are involved in mechanical sensing in plant roots.

The researchers made their initial discoveries using the tip-growing cells of a somewhat atypical model plant, spreading earthmoss (Physcomitrium patens).

But the scientists were able to extend their findings beyond moss to cells from other distantly related plants, including in pollen tubes in a classic model, the flowering plant Arabidopsis thaliana.

"Mosses are one of the groups that comprise the bryophytes, which are the second largest land plant lineage," said Ivan Radin, a research scientist in the Haswell laboratory and first author of the new paper.

"When we can show that the same thing happens both in moss and a flowering plant, as we did here, the most likely conclusion is that the process is ancestral -- it's at least as old as the land plants are," Radin said, noting that land plants colonized Earth about a half a billion years ago.

Radin became the Haswell laboratory's de facto moss specialist with coaching from co-author Magdalena Bezanilla, a professor of biological sciences at Dartmouth University. Bezanilla previously worked with Washington University's Ralph Quatrano, emeritus dean and the Spencer T. Olin Professor Emeritus of Biology, who was an early adopter of moss.

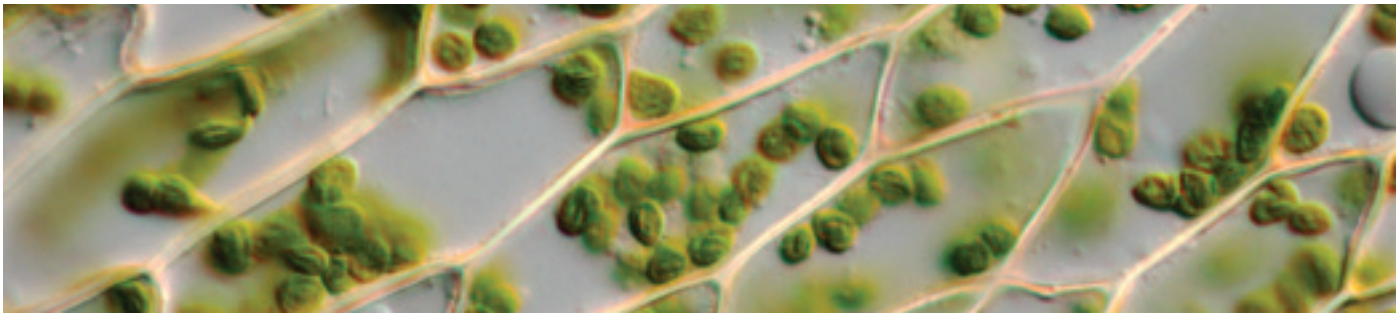
"The more time passes, the more we love it," Radin said. "Moss proved to be an exceptionally good model."

As a next step in this research, scientists in the Haswell laboratory are now conducting additional experiments to show how external and internal forces directly affect PIEZO channels in moss cells.

"Plant PIEZO channels are likely to be controlled by membrane tension in plants the same way they are in animals," Haswell said. The scientists are also exploring the evolution of these channels in algae.

Now they know where PIEZO channels are found in the cell, Haswell and her team are poised to find out what these proteins are doing in the vacuoles.

"We are looking at how PIEZO channel activation results in membrane elaboration and how it is regulated," Haswell said. "We want to know how the localisation evolved and what it does in other cell types. We plan to compare and contrast the structure and function with the animal channels and in organisms across the green lineage."



**Journal Reference:**

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# WESTERN AG APPOINTED EXCLUSIVE RIGHTS PARTNER OF GO RESOURCES SUPER HIGH OLEIC SAFFLOWER

GO Resources has appointed Western AG as its Super High Oleic (SHO) Safflower's seed supply chain partner with exclusive rights for SE South Australia, West Wimmera and Western Victoria. In this role, Western AG will be responsible for supply of planting seed, signing of GO Resources grower contracts and for providing growers, and their advisors/consultants, information on growing SHO safflower in 2021 and in the forthcoming years ahead. In addition to these responsibilities, Western AG will also be undertaking a range of market development activities including establishment of demonstration sites, field days and communications in relation to SHO Safflower.

As a crop, Safflowers have not been grown on any wide scale for nearly 20 years in the original home of safflower which was as a Spring crop in the SE South Australia, West Wimmera and Western Victoria, primarily due to a lack of consistent marketing options. GO Resources, in conjunction with CSIRO and support of the GRDC, has now developed a high-grade specialty Safflower oil for the industrial market which will see the re-introduction of this crop on a renewed scale. Last year was the second commercial year of SHO safflower with just on 4,500ha grown from Goondiwindi in the Sth Queensland to the Western District in Victoria. GO Resources is now looking for a constant increase in growth for this crop with an eventual target of 100,000ha over the coming years.

The Western AG group is a leading independent agribusiness that began operations in April 2005 with a primary aim of supplying high quality agronomic advice with seed, fertiliser and crop protection products to clientele within the Western District region of Victoria. The company has now grown to provide services to over 2000 farming clients that manage over 400,000ha of various crops and pastures. Western AG has 12 retail outlets and a market leading agronomy base of 29 agronomist/consultants that underpins a comprehensive market and advisory offering to clients.

One key benefit of SHO Safflower is the relative steady 'farm gate' contract price which has been maintained for purchase of SHO Safflower grain from growers at harvest, versus the fluctuations which can occur with crops such as canola. Consistent with this commitment in 2021, GO Resources (via Western AG) are offering to growers a contract price of $650/tonne at the 'farm gate'. This is the same contract price offered in 2020, despite the fluctuations in prices of many other crops.

**2021 SHO Safflower Contract and Planting Seed Access**

- In 2021, GO Resources production contracts for farmers growing SHO safflower will be available through all Western AG branches.
- SHO Safflower planting seed will be available from Western AG branches in either 750kg bulker bags or 20kg bags.
- In 2021, farmers who may wish to grow SHO safflower again in 2022 will be allowed to retain seed from their 2021 crop for planting next year.

Despite recent difficult seasons, Western AG are confident that SHO Safflower can again become part of farmers dryland and irrigated crop rotations throughout the SE South Australia, West Wimmera and Western Victoria.

For further information, please visit: https://www.westernag.com.au or contact your nearest Western AG branch, or David Hudson, GO Resources (0418 951 479)

**Journal Reference:**

For further information related to SHO safflower contracts or agronomy please contact your nearest DeltaAg/ NorthWestAg or WesternAg branch or David Hudson, GO Resources (0418 951 479)

# PLANT ROOT-ASSOCIATED BACTERIA PREFERENTIALLY COLONISE THEIR NATIVE HOST-PLANT ROOTS

An international team of researchers from the Max Planck Institute for Plant Breeding Research and the University of Åarhus in Denmark has discovered that bacteria from the plant microbiota are adapted to their host species.

In a newly published study, they show how root-associated bacteria have a competitive advantage when colonising their native host, which allows them to invade an already established microbiota.

Plants, including crops such as rice and wheat, obtain their essential mineral nutrients and water through their roots, making them an important interface between plants and the soil environment.

The roots of land plants associate with a wide range of microbes -- including bacteria -- that are recruited from the surrounding soil and assemble into structured communities known as the root microbiota.

These microbial communities are sustained by the plant host, which provides them with nutrients, primarily in the form of organic carbon compounds secreted by the root.

In turn, these commensal bacteria mediate multiple processes that are beneficial to their plant host, such as providing defence against pathogens, improving nutrient mobilisation from the soil and positively impacting growth.

Given their importance for plant health, the study of the root microbiota has evolved into a promising research field that aims to understand how these interactions occur, and could eventually help increase the yield and resilience of crop plants.

Although it is well known that plants secrete diverse small molecules into the soil via their roots that serve as chemoattractants for root colonisation by a subset of soil-dwelling bacteria, the degree of active selection performed by the host and the extent to which root-associated microbial communities are adapted to specific plant species remain largely unknown.

In a new study published in Nature Microbiology, a team of researchers from the Department of Plant-Microbe Interactions at the MPIPZ in Cologne, Germany, and Århus University in Denmark, aimed to gain a deeper understanding of these complex multi-species interactions.

As a first step in this quest, they established a comprehensive collection of root-derived bacteria from the model legume Lotus japonicus, a small proportion of which are symbiotic bacteria that fix atmospheric nitrogen for plant growth.

Together with an already established culture collection from roots of the model crucifer Arabidopsis thaliana, synthetic microbial communities (SynComs) were designed to explore the microbiota assembly of different plant species.

Although the bacterial communities of the two plants were similar, the researchers observed a clear preference by these bacteria to colonise their native host. This preference was mediated by a higher competitiveness displayed by multiple bacterial species when colonising their host of origin compared to those originally isolated from the other host.

Strikingly, host preference was only observed in a community context, where different microbes compete among each other, but not when individual bacterial species were allowed to colonise the plant roots in the absence of competition.

Analysis of gene expression of both plant species when interacting with different synthetic communities further showed that this process was at least in part driven by the host. Intriguingly, root colonisation by native and non-native SynComs exhibited contrasting gene expression profiles for a number of well-known regulators of plant immunity.

Based on this observation, the authors then hypothesised that native strains have a competitive advantage when colonising the roots of their corresponding host plant via the formation of species-specific host niches.

To test this hypothesis, the scientists performed a series of complex experiments, where SynComs from different host species were allowed to invade already established root-associated bacterial communities in host and non-host plants.

Their results showed that native SynComs had a competitive advantage when invading an already established microbiota in their host plant, indicating that adaptation of commensal bacteria to their native plant species leads to increased invasiveness and persistence.

**To quote Kathrin Wippel, first author of the study: "We were amazed to learn that root colonisation by native and non-native SynComs resulted in differential transcriptional reprogramming of plant roots, possibly contributing to the formation of specific root niches for native commensal bacteria. These findings indicate that diverse soil-dwelling bacteria associate with and prefer a specific host plant, similar to pathogens or beneficial symbionts of plants."**

These findings could have a meaningful impact on agriculture, as they highlight the importance of competitiveness between different bacteria and the impact of host preference for successful root colonisation. Probiotic inoculants tailored to specific crop plants with an enhanced capacity to invade and persist in standing microbial communities could help overcome the variation in efficacy of currently used biologicals in agriculture.

**Journal Reference:**

Kathrin Wippel, Ke Tao, Yulong Niu, Rafal Zgadzaj, Niklas Kiel, Rui Guan, Eik Dahms, Pengfan Zhang, Dorthe B. Jensen, Elke Logemann, Simona Radutoiu, Paul Schulze-Lefert, Ruben Garrido-Oter. Host preference and invasiveness of commensal bacteria in the Lotus and Arabidopsis root microbiota. Nature Microbiology, 2021; DOI: 10.1038/s41564-021-00941-9

# TRILOGY 631 FORMULATED TO BOOST NATURAL PLANT GROWTH

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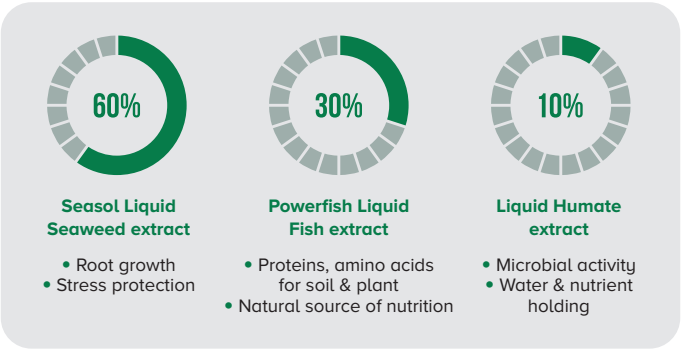
- Powerfish Liquid Fish extract for available organic nitrogen - providing free amino acids.
- Liquid Organic Humate extract for available carbon - providing Humic acids and Fulvic acids.

In combination with growing plants, Seasol Trilogy 631 supplements the soil ecosystem processes needed for plant productivity and enhanced soil fertility by:

- **Enhancing plant and root growth** - plants then pump additional root exudates (photosynthate carbon) into the soil and feed soil microbiology at the rhizosphere.
- **Supplying the soil carbon and nitrogen cycle** - with available organic nitrogen and accessible carbon.
- **Supplying plants with amino acids** - and peptides for enhanced plant growth.
- **Leave the soil with Soil Organic Matter** - from increased plant and microbe organic matter.
- **Converting more sunlight** - due to increased plant growth, plants produce more photosynthate, pump relatively more exudates into the soil and enhance the functioning of the overall soil ecosystem.

Productive soils rely on soil ecosystem processes and the nitrogen and carbon cycles being synchronised. However, in depleted soils that are farmed intensely with limited crop diversity, the natural ecosystem processes become disconnected. Similarly, a dependency upon inorganic fertilizer eventually results in fragmented biological, plant, soil and microbe ecosystems.




# HEMP GOES 'HOT' DUE TO GENETICS, NOT ENVIRONMENTAL STRESS

Contrary to claims that environmental or biological stresses cause an increase in THC production in hemp, a new Cornell University study finds no evidence that stress on hemp plants increases THC concentrations or ratios of CBD to THC.

Growing hemp for CBD (cannabidiol) is a burgeoning industry, but when hemp contains more than the legal limit of THC, the plants can test "hot." State and federal regulations classify hemp as containing 0.3% or less THC; when plants exceed that amount, farmers can lose their entire crop.

"One of our goals in our research and in fulfilling our extension mission is to reduce the risks to growers as much as possible," said Larry Smart, senior author of the study and professor in the horticulture section of the School of Integrative Plant Science in the College of Agriculture and Life Sciences. "With this research, growers should feel some comfort that stresses do not seem to have a strong effect on changing the ratio of CBD to THC."

In the study, lead author Jacob Toth, a graduate student in Smart's lab, created a series of plots in Geneva, New York, that included control plots and five stress treatments applied to three genetically unrelated high-CBD hemp cultivars. Stress treatments included flood conditions; exposure to a plant growth regulator called ethephon, used to promote fruit ripening; powdery mildew; herbicide; and physical wounding. They then tested THC and CBD content over a four-week period when the flowers matured.

"What we found over the weeks that we were sampling, the amounts of CBD and THC went up proportionately in all of these different cultivars for all of these different stresses," Toth said.

By week four, at harvest time, they found that nearly every plant (except those treated with herbicide, which were nearly dead) produced the expected ratio of CBD to THC, with high levels of CBD corresponding to levels of THC above the 0.3% THC threshold.

The study further proves that genetics, rather than environment, determine the THC content and CBD to THC ratios in hemp, Smart said.

More research and breeding is needed to select appropriate genetics that lead to high CBD but low THC, and regulatory testing may be needed earlier, before harvest and before plants reach high THC levels, Toth said.

# BLUSHING PLANTS REVEAL WHEN FUNGI ARE GROWING IN THEIR ROOTS

Almost all crop plants form associations with a particular type of fungi -- called arbuscular mycorrhiza fungi -- in the soil, which greatly expand their root surface area. This mutually beneficial interaction boosts the plant's ability to take up nutrients that are vital for growth.

The more nutrients plants obtain naturally, the less artificial fertilisers are needed. Understanding this natural process, as the first step towards potentially enhancing it, is an ongoing research challenge. Progress is likely to pay huge dividends for agricultural productivity.

In a study published in the journal PLOS Biology, researchers used the bright red pigments of beetroot -- called betalains -- to visually track soil fungi as they colonised plant roots in a living plant.

**"We can now follow how the relationship between the fungi and plant root develops, in real-time, from the moment they come into contact. We previously had no idea about what happened because there was no way to visualise it in a living plant without the use of elaborate microscopy," said Dr Sebastian Schornack, a researcher at the University of Cambridge's Sainsbury Laboratory and joint senior author of the paper.**

To achieve their results, the researchers engineered two model plant species -- a legume and a tobacco plant -- so that they would produce the highly visible betalain pigments when arbuscular mycorrhiza fungi were present in their roots. This involved combining the control regions of two genes activated by mycorrhizal fungi with genes that synthesise red-coloured betalain pigments.

The plants were then grown in a transparent structure so that the root system was visible, and images of the roots could be taken with a flatbed scanner without disturbing the plants.

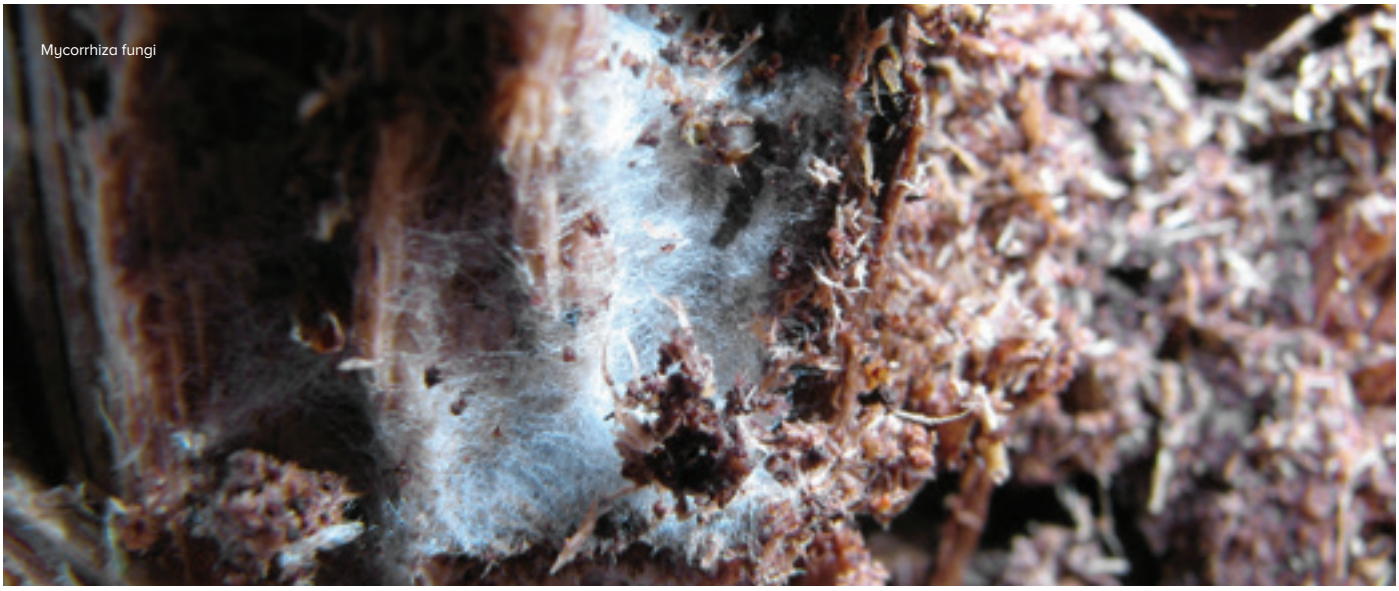
Using their technique, the researchers could select red pigmented parts of the root system to observe the fungus more closely as it entered individual plant cells and formed elaborate tree-like structures -- called arbuscules -- which grow inside the plant's roots. Arbuscules take up nutrients from the soil that would otherwise be beyond the reach of the plant.

Other methods exist to visualise this process, but these involve digging up and killing the plant and the use of chemicals or expensive microscopy. This work makes it possible for the first time to watch by eye and with simple imaging how symbiotic fungi start colonising living plant roots, and inhabit parts of the plant root system over time.

"This is an exciting new tool to visualise this, and other, important plant processes. Beetroot pigments are a distinctive colour, so they're very easy to see. They also have the advantage of being natural plant pigments, so they are well tolerated by plants," said Dr Sam Brockington, a researcher in the University of Cambridge's Department of Plant Sciences, and joint senior author of the paper.

Mycorrhiza fungi are attracting growing interest in agriculture. This new technique provides the ability to 'track and trace' the presence of symbiotic fungi in soils from different sources and locations. The researchers say this will enable the selection of fungi that colonise plants fastest and provide the biggest benefits in agricultural scenarios.

Understanding and exploiting the dynamics of plant root system colonisation by fungi has potential to enhance future crop production in an environmentally sustainable way. If plants can take up more nutrients naturally, this will reduce the need for artificial fertilisers -- saving money and reducing associated water pollution.



Mycorrhiza fungi

**Journal Reference:**

Alfonso Timoneda, Temur Yunusov, Clement Quan, Aleksandr Gavrin, Samuel F. Brockington, Sebastian Schornack. MycoRed: Betalain pigments enable in vivo real-time visualisation of arbuscular mycorrhizal colonisation. PLOS Biology, 2021; 19 (7): e3001326 DOI: 10.1371/journal.pbio.3001326

# SLOWING DOWN GRAPE RIPENING CAN IMPROVE FRUIT QUALITY FOR WINEMAKING

Wine grapes are particularly finicky when it comes to their environment. For instance, heatwaves and droughts lead to earlier berry ripening and lackluster wine. And these types of episodes are expected to intensify as Earth's climate changes. Now, researchers reporting in ACS' Journal of Agricultural and Food Chemistry have tweaked growing conditions for Cabernet Sauvignon grapes to slow down their ripening, which increased the levels of compounds associated with wine's characteristic floral and fruity notes.

As grapes ripen and change colour from light green to deep red, sugars and aroma compounds accumulate in the berries. But, when they ripen quickly because of heat or water stress, the resulting fruits produce a less desirable wine with more alcohol, a duller colour and a lingering taste of cooked fruit. To counteract these negative effects of climate change on wine quality, scientists have been testing different ways to grow the plants. Previous researchers have shown that reducing the crop on the vines can speed-up grape ripening, while more intense irrigation later in the growing season can delay the process. Christopher Ford and colleagues wanted to examine the impacts of these techniques on the chemical components that contribute to the berries' quality.

The researchers grew Cabernet Sauvignon wine grapes at a commercial vineyard in the San Joaquin Valley in California. Then, they either removed a portion of the clusters on the vines, irrigated the plants more during the later growing season, did both or did neither, and collected grapes throughout the ripening period. The plants with the fewest berry clusters had the fastest increase in sugar content and were ripe the earliest for all of the tested conditions. However, the plants that were both thinned and watered more had the slowest rate of sugar accumulation. The researchers found that slowing down grape ripening decreased six-carbon aldehydes and alcohols and 2-isobutyl-3-methoxypyrazine -- associated with green and vegetal wine notes -- and increased norisoprenoids and terpenes -- associated with pleasant floral and fruity wine notes. The longer growing time improved the quality of grapes for winemaking, the researchers explained, but these adaptation strategies should be monitored over several years before changes are made to current practices.

**Journal Reference:**

Pietro Previtali, Nick K. Dokoozlian, Bruce S. Pan, Kerry L. Wilkinson, Christopher M. Ford. Crop Load and Plant Water Status Influence the Ripening Rate and Aroma Development in Berries of Grapevine (Vitis vinifera L.) cv. Cabernet Sauvignon. Journal of Agricultural and Food Chemistry, 2021; DOI: 10.1021/acs.jafc.1c01229

# COMMON WEED COULD SPELL BELLYACHE FOR GLUTEN INTOLERANT

New research has identified proteins in a common weed which could play havoc for Australian farmers growing gluten-free crops, such as millet, buckwheat and sorghum, and people suffering from gluten intolerance.

The gluten-like proteins found in ryegrass could be mixing with crops commonly used as gluten-free products or wheat replacements and causing a reaction among people with coeliac disease or gluten intolerance.

The work, led by Edith Cowan University (ECU) and Australia's national science agency, CSIRO, identified the proteins in 10 cultivars of ryegrass (Lolium species), a costly and invasive family of weeds commonly found in Australian cereal crops.

Dr Sophia Escobar-Correas, a researcher based at ECU and CSIRO said the team identified 19 proteins found in ryegrass which had similar properties to gluten proteins.

**"We have developed a method to detect these ryegrass proteins that allows us to distinguish them from other grains," Dr Escobar-Correas said.**

"While these proteins aren't strictly defined as gluten, they have the potential to trigger reactions for people who are coeliac and those with a gluten intolerance."

This fundamental research helps understand whether ryegrass might be a problem so science can start to determine the impact it might – or might not – be having and devise solutions that give the best outcomes if it is.

Dr Escobar-Correas said the next step is to undertake clinical studies to investigate whether these proteins trigger a coeliac response.

"If these proteins cause a reaction for people with gluten intolerance, then it's important that we develop tests to detect their presence in food products which are otherwise gluten-free," Dr Escobar-Correas said.

**A burgeoning market**

Professor Michelle Colgrave from ECU and CSIRO was a co-author on the research and said it has identified an important potential challenge for gluten-free products

"In 2019, the global market for gluten-free foods was worth around $6.3 billion and its growth shows no sign of slowing," Professor Colgrave said.

"This research will help give consumers and producers confidence that products labelled as gluten-free are free from other proteins which may trigger reactions resulting from agricultural co-mingling."

**Top class weed**

The WA Department of Primary Industries and Regional Development defines a close relative of the species studied in this project, annual ryegrass as one of the most serious and costly weeds across Southern Australia.

Several cultivars of ryegrass are used as feed for livestock and is commonly used as a turf for sports pitches, particularly winter sports, and is famously the grass of choice for tennis courts at Wimbledon.

'Perennial ryegrass contains gluten-like proteins that could contaminate cereal crops' has been published in the journal Frontiers in Nutrition and can be accessed on the journal's webpage.

**Journal Reference:**

This media release was originally published at: https://www.ecu.edu.au/news/latest-news/2021/07/common-weed-could-spell-bellyache-for-gluten-intolerant

# MORE DIVERSITY FOR OUR FARMS AND FORKS

Our planet is home to a rich treasury of plant species. Some 300,000 edible plants are available to feed the world's population, although only a fraction of them is consumed. The three major crops rice, wheat and maize feed half of the world's population.

These cereals have high yields and are staple crops. They are rich in carbohydrates, and thus are efficient calorie sources. In some countries however, they are often the only food source for the poor, and because certain grain crops such as rice contain very few vitamins and minerals, malnutrition and resulting diseases are the outcome.

**Supporting research with neglected crops**

Using additional plant species is important for preventing unbalanced diets and for increasing agricultural biodiversity. In this respect, fruit and vegetable are of crucial importance.

**"Although these orphan crops are often highly important locally and well-adapted to regional climates, they have been neglected in research and breeding activities, since they are minor in terms of global trade," explains Brigitte Poppenberger, Professor of Biotechnology of Horticultural Crops at TUM.**

Therefore, to promote research with neglected crops from Africa, the "African Orphan Crops Consortium" was founded, a consortium of universities, industrial partners and non-governmental organisations that is sequencing the genomes of the 101 most important orphan crop species of Africa, to create essential resources for research and breeding. One of these orphan crops is the leafy vegetable and medicinal plant Ebolo.

Ebolo (Crassocephalum crepidioides), which is used for example in soups, stews and salads, is still mainly collected from the wild. "In some areas, when the demand is high, over-harvesting occurs and threatens natural populations," says Prof. Poppenberger. Therefore, it is important to establish cultivation techniques for plant production and to improve key characteristics through breeding, and for this purpose a research team at TUM has started to analyse the plant in detail.

**Removal of toxins for the domestication of the leafy vegetable Ebolo**

The team, headed by Prof. Poppenberger, in collaboration with Prof. Traud Winkelmann from the Leibniz University of Hannover, has demonstrated that Ebolo synthesises a toxin called jacobine, which is a pyrrolizidine alkaloid. Jacobine is liver-damaging and carcinogenic, even in the smallest of quantities.

"A number of our modern crops such as zucchini, tomatoes, peppers and potatoes can produce highly toxic substances as well, but still, they were domesticated. The removal or reduction of toxins through breeding is often an important step in improving crop species," explains Prof. Poppenberger.

The research team has succeeded in showing that the formation of jacobine is stimulated by nitrogen deficiency, and that it is absent in the related species Crassocephalum rubens. "That is, of course, an important finding. However, we should not rely solely on this related plant, as Crassocephalum crepdioides has other advantages, such as higher yields, even in very poor growth conditions," says Prof. Poppenberger.

**German-Nigerian cooperation to be continued**

The findings regarding the biochemistry and genetics of jacobine biosynthesis will now facilitate the development of cultivation techniques and the breeding of toxin-free varieties, to enable a safe consumption of the plants. Since pyrrolizidine alkaloids are formed by many species as part of the chemical defence system of plants, a more detailed knowledge of the formation of these toxins is also of interest for other plants.

The scientists from Germany and Nigeria will continue to cooperate to promote research with neglected crops. In the case of Ebolo, for example, it will be necessary to test in the fields in Nigeria, if the removal of the toxin has a negative impact on insect resistance. After all, while improved nutritional traits for humans are desired, the plants should not also become 'tastier' for harmful insects.

**Journal Reference:**

The orphan crop Crassocephalum crepidioides accumulates the pyrrolizidine alkaloid jacobine in response to nitrogen starvation 10.3389/fpls.2021.702985

# 'DIGITAL TWIN' CONCEPT BOOSTS FOOD PRODUCTION

Using technology familiar to computer gamers, University of Queensland scientists are creating ‘digital twins’ of mango and macadamia orchards to help boost food production.

Professor Neena Mitter, the Director of the Centre of Horticultural Science at Queensland Alliance for Agriculture and Food Innovation (QAAFI), said it was an example of how computers were changing the industry.

Digital image of mango tree by Dr Liqi Han

“Developing a digital model for an orchard with slow growing crops like mango and macadamia enables us to run virtual experiments at a scale and speed never before possible,” Professor Mitter said.

> **“Digital technologies offer an unprecedented acceleration in innovation will help make food production more productive, resilient, and sustainable."**

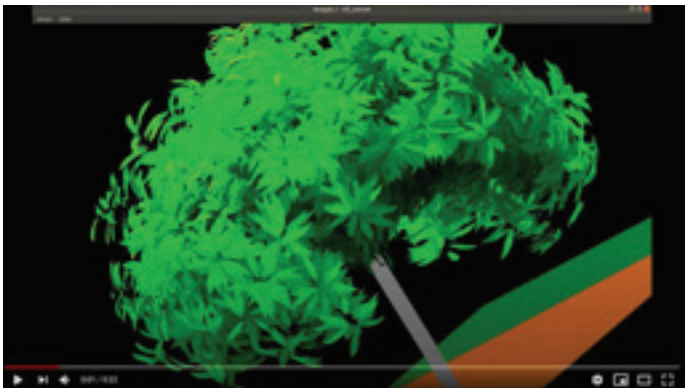
Lead researcher Dr Liqi Han said the technology would particularly benefit slow growing crops like fruit trees.

“The digital modelling provides untapped opportunities for users to rapidly trial new ideas and acquire a reliable indicator of how to best optimise production systems," Dr Han said.

“We call this technology ‘DigiHort’, short for Digital Horticulture.”

The computer simulations can be a conceptual design of an orchard that doesn’t yet exist, a digital twin or detailed replica of an existing orchard, or a digital variant, where changes are made to a digital twin.

“All three forms can be integrated with environmental and management simulators,” Dr Han said.



“For example, this might include sunlight and chemical spray simulations to allow for evaluation and optimisation of orchard management practice.”

Virtual trials start with the design, with software users able to decide where in a landscape to plant trees, the density of the canopies and the configuration of the rows.

Users then consider how the trees are maintained, wielding virtual pruners and testing the impact of different – and even unconventional – tree training systems.

This innovation is based on new LiDAR scanning technology applications undertaken with industry partner, Riegl Australia, and state government research stations in Queensland, Western Australia and Northern Territory.

It relies on High Performance Computing (HPC), which allows Dr Han to run extremely fast virtual experiments without loss of accuracy.

“These days, we talk more and more about precision agriculture,” Dr Han said.

“We enhance precision by looking at the details, such as how much light can be captured by each leaf or fruit, or the distribution of sprayed chemicals across the canopy.

“We can accumulate small benefits into big benefits or prevent big losses from occurring.

“And we’ve found that small differences can have a big impact.”

The DigiHort platform was designed as a decision-support service for industry and will be accessible via the internet.

Dr Liqi Han with the terrestrial LiDAR scanner in the field.

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# DAIRY AUSTRALIA DELIVERS TOOLS AND TECHNOLOGY TO GET DAIRY FARM IRRIGATORS MORE CROP FOR THEIR DROP

Dairy Australia is committed to inspiring dairy businesses to be more agile and responsive through greater integration of technology and data.

The Smarter Irrigation for Profit 2 project, in its second year, is delivering the latest in innovative tools and technology for dairy farmers to enhance their irrigation efficiency.

It builds on the research developed in the three-year Smarter Irrigation for Profit 1 project and tests those findings at Dairy Optimisation Sites across all dairying regions in Australia. These sites are dairy farms that are set up to test the latest in innovative irrigation technology and measure how effective it is in ensuring optimal water efficiency.

To deliver the project, Dairy Australia has partnered with a range of agricultural sectors, as well as the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program.

Managing Director of Dairy Australia, David Nation, said "More dairy farmers than ever are taking advantage of irrigation to increase their production in drier months.

"We want to ensure dairy farmers have access to the latest information to increase pasture and crop yield from their water, to get more crop for their drop."

"The technologies used in the Smarter Irrigation for Profit 2 project help farmers make better irrigation decisions, thereby improving water efficiency and creating more profit," he said.

Technology like soil moisture monitoring probes and apps have been tested on Dairy Optimisation Site farms across Australia, and are available for dairy farmers to use.

**Utilising the technology developed through Smarter Irrigation for Profit**

Dairy Farmers like Will Russell in Bega, New South Wales, have found the technology useful. By utilising soil moisture monitoring and weather forecasting apps like SWAN, he has modified his irrigation scheduling to ensure it is more efficient. "It's made the decision-making process easier," said Will. "The technology we use tells us in black and white 'we need to irrigate now.'"

In Will's experience, using this technology resulted in an increase in dry matter yield, to more than ten tons of dry matter per hectare for the six month irrigation season. "There is no doubt in my mind that knowing when to start irrigating is helping us to produce more feed than before and keep our soil moisture at the right levels. We are growing more feed off the same area, and because of that we're milking more cows than ever before too," Will remarked.

**Get the latest in innovative irrigation technology**

For the latest tools, resources and information visit the Smarter Irrigation for Profit 2 webpage on the Dairy Australia website at dairyaustralia.com.au/SIP2

*The Smarter Irrigation for Profit 2 project is supported by funding from the Australian Government Department of Agriculture Water and the Environment as part of its Rural R&D for Profit program, and Dairy Australia*

# DROUGHT CHANGES RICE ROOT MICROBIOME

Drought can have a lasting impact on the community of microbes that live in and around roots of rice plants, a team led by UC Davis researchers has found. Root-associated microbes help plants take up nutrients from the soil, so the finding could help in understanding how rice responds to dry spells and how it can be made more resilient to drought. The work is published July 22 in Nature Plants.

The root microbiome of irrigated rice plants goes through a sequence of changes as the plants grow and stabilises when they flower. The sequence of changes in the root microbiome is consistent for a particular rice strain and geographic location. Previous work has shown that when a growing rice plant is deprived of water, it hits pause on the succession of changes in the root microbiome.

Venkatesan Sundaresan, distinguished professor of plant biology in the UC Davis College of Biological Sciences and colleagues looked at changes in rice root microbes over time when plants were deprived of water for 11, 21 or 33 days. This kind of intermittent drought condition is more common in rain-fed crops than terminal drought, Sundaresan said.

As expected, the microbe community changes when water is taken away. More surprising is that the changes persisted for weeks after plants were watered again.

"Rice plants carry a 'memory' of the drought episode in their root microbiota, so that plants that have experienced drought can be distinguished solely on the basis of their microbiomes," Sundaresan said.

**Promoting root growth**

The team was able to culture and sequence the most abundant of these persistent microbes. It was a species of Streptomyces that promotes growth of plant roots, a classic response to drought. The bacteria's DNA includes genetic code similar to plant genes for the growth hormone auxin.

"The persistence of changes to the microbiome means that root elongation continues even after drought has ended. This allows the roots to be better prepared to tap deep water," Sundaresan said. For some drought tolerant rice cultivars, after a drought episode, the roots will continue to grow long enough to penetrate the hardpan, he said.

The persistent changes also mean that the microbiome response will be more rapid the next time drought hits, because it is altered from the first drought.

As extreme climate events become more common, crops are likely to experience more intermittent droughts, the authors note. Understanding what makes plants more resilient to drought conditions could help reduce crop losses.

Additional authors on the paper are Christian Santos-Medellin, Zachary Liechty, Joseph Edwards and Bao Nguyen, UC Davis Department of Plant Biology; and Bihua Huang and Bart Weimer, Department of Population Health and Reproduction, 100K Pathogen Genome Project, UC Davis School of Veterinary Medicine. Sundaresan also has a faculty appointment in the Department of Plant Sciences, College of Agricultural and Environmental Sciences. The work was supported by grants from the NSF and U.S. Department of Agriculture.

**Journal Reference:**

Christian Santos-Medellín, Zachary Liechty, Joseph Edwards, Bao Nguyen, Bihua Huang, Bart C. Weimer, Venkatesan Sundaresan. Prolonged drought imparts lasting compositional changes to the rice root microbiome. Nature Plants, 2021; DOI: 10.1038/s41477-021-00967-1

# MATCH WINNING TACTICS PREVENT PESTS AND DISEASE

Finals time – like spring – is in the air and just like your favourite local sports team, farmers are starting to focus on going all the way after a strong season of preparation, hard work and honing tactics.

Agriculture Victoria Grains Industry Biosecurity Officer Jim Moran said winter crops were reaching a critical growth stage and, just like sports finals, would require “match winning tactics” from farmers to achieve the best possible returns.

“Unnecessary yield losses can easily be avoided through good hygiene,” he said.

“Weeds, pests and diseases can arrive as seeds, eggs, spores and other microscopic particles, and they play dirty.”

Mr Moran said farmers could improve their outcomes this season by putting strong hygiene measures in place.

“You need to stop uncontrolled visitors accessing your property to ensure no nasty passengers arrive to spoil your game plan.”

Mr Moran said farmers should ensure vehicles, equipment and/or people are not carrying dirt or plant material, before allowing them onto the productive zones of their properties.

“This could be a boot wash or a high-pressure hose in a vehicle washdown area,” he said.

“Do whatever it takes to ensure arrivals to your property are clean and play by the rules.

“Install a free biosecurity gate sign to alert people that you are serious about biosecurity and they are required to contact you before entering your property.”

As the end of the growing season draws near, rigorous and regular surveillance is required to protect maturing crops from newly introduced weeds, pests and diseases. This will significantly increase the potential to manage any incursions and minimise crop damage and loss of income.

For more information on how to improve outcomes on your farm this season, get your free copy of the Grains Farm Biosecurity Manual and Monitoring Stored Grain on Farm booklet which is available to download at farmbiosecurity.com.au.

Go online for more top tips on Biosecurity (www.farmbiosecurity.com.au) or the Grains on Farm Biosecurity Program (www.plathealthaustralia.com.au/national-programs/grains-farm-biosecurity-program/) via the Plant Health Australia, Farm Biosecurity and Agriculture Victoria (agriculture.vic.gov.au) websites.

For one-one-one farmer support, Mr Moran can also be contacted on 136 186.

# SOLAR-POWERED MICROBES TO FEED THE WORLD?

Microbes have played a key role in our food and drinks -- from cheese to beer -- for millennia but their impact on our nutrition may soon become even more important. The world is facing growing food challenges as the human population continues to increase alongside its demand for resource intensive animal products. If these needs are to be met solely by conventional agriculture, the environmental cost will be huge. An international research team led by a Göttingen University alumnus has now shown that using solar-panels to produce microbial protein -- which is rich not just in proteins but also in other nutrients -- is more sustainable, efficient and environmentally friendly than growing conventional crops. This method uses solar energy, land, nutrients, and carbon dioxide from the air.

Their research was published in Proceedings of the National Academy of Sciences.

Using computer simulations drawing directly from laboratory results, the researchers modelled large-scale microbial food production facilities, which use solar energy, air, water, and nutrients to grow microbes. The protein-rich biomass is harvested and processed, and the resulting powder can be used as feed for animals, or as food for people. The study carried out an analysis of the energy requirements for each step, from the very start to the end product, taking into account: electricity generation (from solar panels), electrochemical production of energy-rich substrate for the microbes, microbe cultivation, harvesting, and processing the protein-rich biomass. Several types of microbes and growth strategies were compared in order to identify the most efficient.

The study found that for each kilo of protein produced, solar-powered microbes require only 10% of the land area compared to even the most efficient plant crop -- soybean. The study calculated that even in northern climates with less sunshine, the yields of solar-powered microbial foods could far outproduce staple crops, while minimising water and fertiliser use. Importantly, this production could also be located in regions not suitable for agriculture, such as deserts.

In previous research, the protein from these types of microbes has shown beneficial effects when fed to livestock and is already produced at large scale in the EU. "We expect that microbial protein will also be beneficial as a supplement to our diets, since it provides a high-quality protein source composed of all essential amino acids, as well as vitamins and minerals," explains first author Dorian Leger, who carried out the work in the MPI of Molecular Plant Physiology while studying at the University of Göttingen, along with colleagues from Italy and Israel.

**"This technology has the potential to support food production while preventing damage to the environment. Current farming methods contribute to polluted ecosystems and depleted water reserves worldwide."**

At the moment, 30-40% of the Earth's land is used for farming, yet one in ten people are undernourished. Leger says, "Integrating the cultivation of nutrient-rich microbes with renewable energy systems, such as solar panels, has the potential to produce more food with less resources. This could free up vast amounts of agricultural land, and, in addition, prevent the further destruction of natural ecosystems thereby making a valuable contribution to conservation and sustainability whilst promoting food availability globally."

**Journal Reference:**

Dorian Leger, Silvio Matassa, Elad Noor, Alon Shepon, Ron Milo, Arren Bar-Even. Photovoltaic-driven microbial protein production can use land and sunlight more efficiently than conventional crops. Proceedings of the National Academy of Sciences, 2021; 118 (26): e2015025118 DOI: 10.1073/pnas.2015025118

# QUEENSLAND SCIENCE MAKES THE AVOCADO PRODUCTION BOTTLENECK TOAST

The world's first Hass avocados produced by trees grafted on tissue culture plants are tasty, healthy, and disease-free, say University of Queensland scientists, who pioneered the break-through technology.

"Trials show that the clonal tissue culture rootstocks are yielding high-quality fruits in the field," said project leader Professor Neena Mitter, Director of UQ's Centre for Horticultural Science.

Economic modelling conducted by the University of Southern Queensland with the Department of Agriculture and Fisheries as part of the project suggests that the tissue culture technology offers a potential 21 per cent return on investment to avocado growers.

"This is a Queensland-owned and invented technology platform validated from lab to orchard, and is now progressing to commercial roll out," Minister for Agricultural Industry Development and Fisheries and Minister for Rural Communities Mark Furner said.

"Queensland produces the majority of Australia's avocados and this innovation offers opportunities for growers across the state."

The tissue culture technology allows for up to 500 times more plants to be grown from a single cutting in 10-12 months – significantly reducing both resources required and the time it currently takes to produce a plant for sale in an orchard.

"We have been successful in rooting multiple industry-relevant avocado rootstocks using our meristem or plant stem cells-based approach to multiply plants," Professor Mitter said.

In trials funded by the Queensland Government's Advance Queensland Innovation Partnerships, tissue culture plants produced in a laboratory and then grafted with Australia's main avocado variety, Hass, have been successfully established in fields in Bundaberg, Tully and Lakeland and two locations in Western Australia – Pemberton and Busselton.

Childers avocado grower Lachlan Donovan has been growing laboratory-propagated avocado trees for the past three years and said that he was pleased with the tree growth and harvest.

"In the past the delay between ordering new trees and planting has been two to three years," Mr Donovan said.

"The biggest advantage of this new technology for us is to be able to get desired rootstocks and varieties into production quickly."

A survey of Australian avocado industry members undertaken by Central Queensland University indicated that 72 per cent cannot access enough plants and nearly half indicated they already have the skills and knowledge to work with tissue culture trees.

The global avocado market was valued at USD 9.14 billion in 2020, with consumers embracing the health benefits of the fruit, which contains fibre, healthy fats and important nutrients.

**"This is a sustainable technology that reduces the need for water, fertilisers, pest management processes and farming land used to produce rootstocks," Professor Mitter said.**

"With traditional avocado propagation, trees must be grown in fields for seed production.

"Another advantage with tissue culture propagation, particularly in this day and age, is that the movement of soil and the biosecurity risks this entails can be eliminated."

Dr Alice Hayward - Novel plant propagation techniques - Avocado tissue lab

# BEE FLIGHT SUFFERS UNDER TEMPERATURE EXTREMES

Rising temperatures could help some northern-latitude bees fly better, but more frequent extreme weather events could push them past their limits.

Bees' flight performance affects their ability to pollinate plants -- a crucial service for many of our crops. Now, researchers from Imperial College London have measured the relationship between bumblebee flight performance and surrounding temperature.

Measuring the motivation of bumblebees to fly and their flight endurance, the team found performance rose rapidly from the lower tested limit of 12oC and peaked between 25-27°C. Beyond this, however, they found performance started to decline.

Their results indicate that whilst bumblebees found in more northern latitudes may see benefits to flight performance under future climate warming, populations in southern latitudes, where temperatures above 27oC are more readily exceeded, may be adversely affected. The results are published today in Functional Ecology.

First author Daniel Kenna, from the Department of Life Sciences (Silwood Park) at Imperial, said: "Climate change is often thought of as being negative for bumblebee species, but depending on where in the world they are, our work suggests it is possible bumblebees will see benefits to aspects of an important behaviour.

"However, more extreme weather events, such as cold snaps and the unprecedented heatwaves experienced in recent years, could consistently push temperatures beyond the comfortable flight range for certain species of bumblebees.

"These risks are particularly pertinent for 'fixed colony' pollinators like bumblebees, which cannot shift their position within a season if conditions become unfavourable, and potentially provide a further explanation as to why losses have been observed at species' southern range limits."

Like most flying insects, air temperature influences bees' body temperature, and body temperature influences flight activity. Too cold and their flight muscles can't function fast enough to support flight; too warm and they could overheat.

To measure how flight is determined by air temperature, the team temporarily attached bumblebees to 'flight mills', which allowed them to fly in circles like a carousel, capturing the distance and speed of flight. They tested bees ranging in body size at temperatures from 12-30°C and used their results to construct a thermal performance curve (TPC).

This TPC predicts that whilst bumblebees can fly around 3km at their thermal optimum, this average flight distance could be reduced to under 1km when temperatures rise to 35°C, and could plummet to just a few hundred metres at a chilly 10°C.

At temperatures of 15°C and below, the team observed that bees were demotivated to fly and frequently would not fly past 100m. Moreover, it was only the bigger sized bees that successfully flew at these low temperatures, suggesting smaller individuals dislike cold days but may benefit more from climate warming.

Lead researcher Dr Richard Gill, from the Department of Life Sciences (Silwood Park) at Imperial, said: "While we still need to understand how these findings translate to factors like foraging return to colonies and pollination provision, as well as applicability to other bumblebee species, the results can help us understand how smaller versus larger flying insects will respond to future climate change.

"It's not just pollination: how different flying insects respond to warming temperatures could also affect the spread of insect-borne diseases and agricultural pest outbreaks that threaten food systems. Applying our experimental setup and findings to other species can help us to understand future insect trends important for managing service delivery or pest control methods."

The team are looking to expand this research to understand how climate warming and extreme weather events can influence the impacts of other stressors, such as pesticide exposure. They are also looking at how the impacts of warming can affect pollination delivery across different types of landscapes.

**Story Source:**

Materials provided by Imperial College London. Original written by Hayley Dunning. Note: Content may be edited for style and length.

**Journal Reference:**

Daniel Kenna, Samraat Pawar, Richard J. Gill. Thermal flight performance reveals impact of warming on bumblebee foraging potential. Functional Ecology, 2021; DOI: 10.1111/1365-2435.13887

Agronomist Recommend

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# EXTENSIVE TRIALS, RESULTS REINFORCE STRONG CONFIDENCE IN NEW HERBICIDE

Agronomists, farm advisors and rural resellers can have further confidence in the effectiveness of Bayer's new Mateno® Complete grass and broadleaf weed pre-emergent and early post-emergent herbicide set to be registered in time for the 2022 cropping season.

Mateno Complete introduces a new herbicide mode of action for Australian wheat and barley growers, aclonifen (Group 32), an SPS (solanesyl di-phosphate synthase) inhibitor, in a complementary co-formulation with pyroxasulfone (Group 15) and diflufenican (Group 12) herbicides.

Aclonifen is mainly taken up through the leaves of young seedling grass and broadleaf weeds following early post-emergent (EPE) application. For broadleaf weeds yet to emerge at this application timing, uptake is by the hypocotyl of the weeds as they emerge through the soil surface. Aclonifen is active in the meristematic area (growing point), leading to bleaching and chlorosis of leaves and young shoots. This mode of uptake complements that of the other active ingredients, resulting in multiple weed uptake pathways that delivers reliable control across a range of early weed growth stages.

In wheat, Mateno Complete can be used EPE to provide weed control across the complete soil surface profile, including in the furrow, on the furrow shoulder and in the inter-row, or incorporated by sowing (IBS) in both wheat and barley to give reliable control of grass weeds. It offers flexible application rates in wheat, with the higher rate, used IBS, offering a higher level of control of annual ryegrass, barley grass, annual phalaris, silver grass and toad rush and suppression of wild oats, great brome and capeweed. Used EPE, it offers control of small silver grass, toad rush, wild radish, capeweed and prickly lettuce and suppression of annual ryegrass, barley grass and doublegee/spiny emex.

Tim Wilkie, Broadacre Marketing Lead with Bayer, said the new herbicide would effectively extend the window for early weed control.

He said extensive trials supporting its registration demonstrated that Mateno Complete would offer a valuable tool to growers, providing incremental improvements in weed control when compared with existing products and further flexibility in their weed control programs.

Gus MacLennan, Market Development Agronomist with Bayer in New South Wales, said a herbicide controlling both grass and broadleaf weeds with its particular residual activity, as well as providing the benefits of a new mode of action, had not been seen for many years in the industry.

"The flexibility Mateno Complete offers in weed spectrum and use patterns is really unique and it's also expected to be registered for use with disc seeders in wheat. Disc systems are rapidly increasing and there is a lack of registered herbicide options for growers to use with these seeders," Gus said.

He said the majority of the company's trial program in recent years had focused on Mateno Complete, culminating in more than 100 large area evaluation trials on farms across the country this season.

"It was predominantly a small plot program in previous years through to larger, 40 to 100-hectare evaluation trials on farms this season to pressure-test the herbicide under real life, commercial conditions."

Pictured at a Great Southern trial site in Western Australia, local Market Development Agronomist with Bayer, Craig White, inspects the good grass and broadleaf weed control across the complete soil surface provided by an application of the company's soon-to-be released Mateno Complete pre-emergent and early post-emergent herbicide.

He said Mateno Complete was a diverse and flexible product and, hence, the company had thoroughly investigated a range of aspects from crop safety through to weed control efficacy.

"We have looked at different aspects and ensured thoroughness in our investigations. A big part of our program with Mateno Complete is towards ensuring a high level of understanding around the parameters that determine crop safety in our label instructions and recommendations."

"We also have evaluated the herbicide with different machinery, including knife point/press wheel combinations and disc sowing systems, through to assessing its weed control spectrum, activity on different herbicide resistant biotypes and the length of its residual control on various weed species."

Gus said the conclusion was that when applied EPE, following an effective pre-emergent herbicide, Mateno Complete "sits head and shoulders" above many alternate herbicides – "by a fair margin".

"With EPE applications, we have seen residual control of grass and broadleaf weeds push further into the season, in some cases resulting in season-long grass weed control.

"One of the best strategies seen in wheat trials has been to use a suitable pre-emergent herbicide with a different mode of action incorporated by sowing, and then to apply Mateno Complete EPE just after the one-leaf crop growth stage."

Craig White, Market Development Agronomist with Bayer in Western Australia, said the patented synergy between the active ingredients in Mateno Complete provided effective grass and broadleaf weed control and this had been reflected consistently in the trials.

"This herbicide has been developed as a three-way combination of actives. It's a synergistic co-formulation – not just the mixing of some actives to produce a result – and that synergism delivers greater control levels," Craig said.

"Across all the trials, and including in different seasons, paddocks, soil types, stubbles, rotations, environments, rainfall patterns, with different machinery and for different weed spectrums, there has been an overall increase in the weed control percentage compared with alternate herbicides. It continues to deliver consistency of performance – and that generates a high level of confidence in Mateno Complete. And having high confidence in a product is a very important part of overall weed management programs and cropping systems."

He said when Mateno Complete was applied IBS in trials, it achieved similar grass weed control, including of barley grass, to the industry benchmark Sakura® herbicide, however, when applied EPE following an effective pre-emergent herbicide, it improved the control by up to 20pc while, at the same time, providing excellent broadleaf weed control.

Craig added that the extensive Mateno Complete trials over the last number of years also included thorough compatibility investigations and they had highlighted successful results in mixtures with a range of products in both IBS and EPE situations.

At Geraldton in WA, Nick Eyres, Elders, said the new herbicide would be welcomed considering the hard-to-manage weed spectrums in the State's northern wheatbelt.

"We have some pretty awesome populations of annual ryegrass and radish, so coming up with a tool like Mateno Complete that can help us out in that regard is going to be very helpful," Nick said.

At Corrigin in WA, Nutrien agent Angus Sellars, Sellars Ag Services, said Mateno Complete would have a strong fit as an IBS or EPE option for growers.

Gus MacLennan, Market Development Agronomist with Bayer in New South Wales, pictured taking Elders agronomists through the company's disc seeding safety trial with its new Mateno Complete pre-emergent and early post-emergent herbicide near Temora.

"You could play the season a bit. If it's a bit drier, you could go for the post-emergent application for grasses, but also pick up control of a good range of broadleaf weeds and that's pretty exciting," Angus said.

At Naracoorte in South Australia, James Heffernan, Nutrien, said he was extremely excited with Mateno Complete after earlier being involved in some trial work with the product.

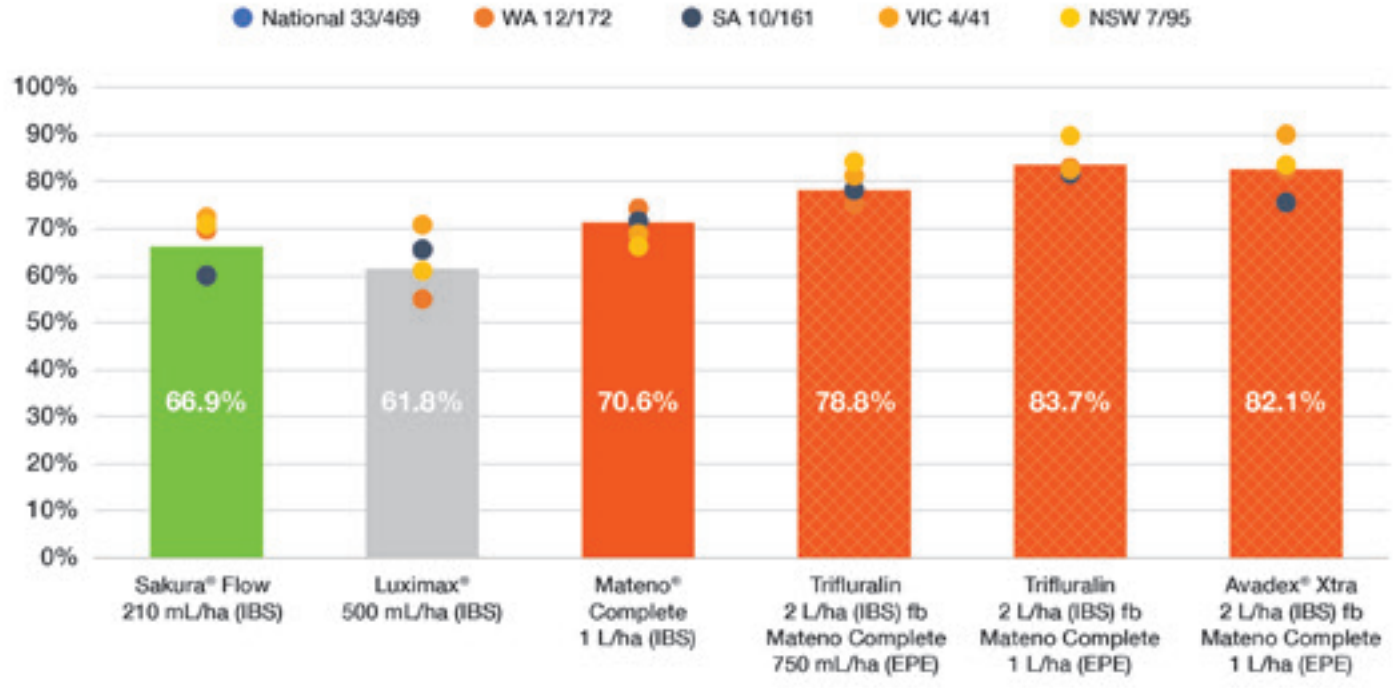
"It will be similar to Sakura for us in terms of a game changer for annual ryegrass control specifically in the high rainfall zone," James said.

At Keith in SA, Scott Hutchings, Cox Rural, said Mateno Complete was the next product to really look forward to.

"Mateno Complete will have an excellent fit because it gives us the option of two different timings and also gives us that extra mode of action to work with," Scott said.

An application for the registration of Mateno Complete has been made. At the time of publication, Mateno Complete is not a registered product.

Mateno® is a Registered Trademark of the Bayer Group.




The "Interactive Trial Assessment (ITA)" is a process created and utilized by Bayer, in which trial attendees are invited to assess the performance of the trial treatments. This independent, anonymous data is then aggregated and reported back to attendees. This graph shows aggregated data from 469 ITA participants across 33 trial sites.

# AG INDUSTRY STANDOUTS RECOGNISED BY SYNGENTA GROWTH AWARDS

Eight of the agri industry's standout growers, advisers and influencers have been named winners in the latest Syngenta Growth Awards, which were announced during a livestream event last week.

The Growth Awards recognise growers, farm advisers and industry innovators from different regions across Australia and New Zealand, showcasing their contribution in one of the following categories: Productivity, Sustainability, Community & People, and Innovator. The program was launched in 2014.

Paul Luxton, Country Head and Managing Director Syngenta ANZ, says the national winners represent the very best of a very strong cohort.

"The standard of nominees, regional winners and national award recipients is as high as it has ever been since the Growth Awards program was launched in 2014," he said. "While we're disappointed we could not celebrate in person with our planned red-carpet gala event due to Covid restrictions, I am proud to see our winners recognised and I am sure they are looking forward to our state-by-state celebrations."

The national winners were selected by an independent judging panel from a pool of more than 40 nominees based across Australia and New Zealand.

"We are fortunate in both Australia and New Zealand to have a wealth of growers, advisers and industry champions who are forever looking for ways to improve, to find new opportunity, to share insights and ideas and to work for the good of the whole industry," Mr Luxton said.

"None of us can do this on our own. We need to collaborate like never before, build trust and continue to deliver amazing results."

He noted that the Growth Awards program aligns with Syngenta's global Good Growth Plan by focusing on sustainable productivity, people & community and accelerating innovation, to bring plant potential to life.

"The creativity, innovation, passion and resilience of people involved in agriculture is inspiring and I look forward to seeing our Growth Awards national winners continue to achieve great things."

**Meet the winners**

To find out more about the winners, head to https://www.syngenta.com.au/growth-awards-2020 where you can read about their backgrounds and where they see opportunity for Australian agriculture.

**Productivity**

This category recognises growers and advisers who use best practice in achieving consistent productivity gains.

**Adam Schreurs**
**Grower, Schreurs & Sons, Clyde, Victoria**

Insights from Adam: "In the past five years, we have relocated our whole vegetable growing business from one location to another 100km away. All the locals said we were crazy, and it would never work and now they are all asking why it didn't happen before."

**Chris Toohey**
**Adviser, Elders, Albury, NSW**

Insights from Chris: "As Australian farmers, I don't think we understand our customer base well enough. We are incredibly good at selling commodities rather than valuing what we produce. There is a huge opportunity to put better value into our products but there has to be the desire to do it."

**Sustainability**

This category recognises growers and advisers who are committed to addressing industry issues to create a sustainable and profitable future.

(Clockwise from top left) Adam Schreurs, Chris Toohey, Linda Peacock, Alex Thomas, Brett South, Simon Doolin, Grace Brennan and Sarah Nolet accepting their awards.

**Simon Doolin**
**Grower, Doolin Agriculture, North Star, NSW**

An insight from Simon: "We learn more from talking to each other than simply attending seminars and are fortunate to be in an industry that shares its knowledge freely in striving towards the same goals – to be efficient, to be economical and to have growth."

**Linda Peacock**
**Adviser, Kiwifruit Vine Health Inc, Tauranga New Zealand**

Insight from Linda: "The value of helping people understand their plants, vines and orchards and become more aware of what's normal for their property, will increase the chance we will detect any new incursion or disease early, and then by having good biosecurity and hygiene practices in place on a daily basis, we could limit the spread and have a good chance at eradication."

**Community and people**

This category recognises growers and advisers who make a leading contribution to their community, workers and fellow growers.

**Brett South**
**Grower, Esperance WA**

Insight from Brett: "If we could establish a network which shows the good side of agriculture, then it could encourage people to come into the industry, and with a social framework in place, that might help. Not only would they try agriculture but if they are supported, they would stay."

**Alex Thomas**
**Adviser and founder of 'plant a seed for safety', Torrens Park, SA**

Insight from Alex: "I have always had a strong desire to give something back to the industry and the community that gave so much to me. I saw a need to change the perception that work health and safety was 'all about paperwork', because it simply doesn't inspire people to make safer, healthier choices."

**Innovator**

This new category, introduced for this round of the Awards, recognises trailblazing growers, advisers and industry influencers who contribute to innovation in agriculture or apply game-changing technologies.

**Sarah Nolet**
**CEO, AgThentic & Farmers2Founders, General Partner, Tenacious Ventures, Sydney, NSW**

Insight from Sarah: "There is an opportunity to promote Australian agricultural innovation and agtech on a global stage. For the past five years, we've been focussing on what was happening overseas and how we could catch up. All the while, there were great things happening in Australia – so now is our opportunity to show we are punching well above our weight. It's a chance to say, look what our innovative farmers, researchers, and entrepreneurs are doing to create and commercialise innovations that can help the agriculture industry here and overseas."

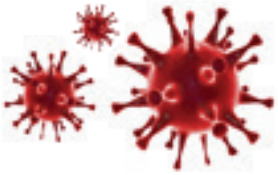
**Judges' choice**

A special discretionary award bestowed by the judging panel on the nominee who has made a significant contribution to the agriculture industry in the areas of sustainability, productivity, innovation, and community and people.

**Grace Brennan**
**Buy from the Bush, Dubbo, NSW**

Insight from Grace: "The launch of the Buy from the Bush campaign which allowed rural businesses to promote their products under the one banner is a career highlight. But stemming from this, my proudest moment was to be invited by the NSW Premier to give the Australia Day address in Sydney in 2020 and tell the story of drought and rural Australia. I hope that a broader audience was listening."

# DEADLY VIRUSES DETECTED IN SEEDS FROM OVERSEAS



A range of vegetable and fruit viruses have been detected in seeds from overseas, demonstrating the significant biosecurity risks that illegal seed imports can pose.

Australian Chief Plant Protection Officer, Dr Gabrielle Vivian-Smith, said a variety of seeds were imported for testing and research purposes and the majority carried viruses of concern.

“Seeds are the most intercepted biosecurity risk item through the mail,” Dr Vivian-Smith said.

“Last year over 55 thousand intercepted mail articles contained seeds, equating to 72 per cent of the total interceptions for the period.

“We knew that seeds could carry a range of biosecurity risks, but through this testing we now know the reality of the risks that we were potentially facing.

“Cucumber, melon and zucchini seeds that were ordered online from overseas were tested for selected viruses that are a biosecurity and agronomic concern.

“The viruses that were detected in the seeds include Melon necrotic spot virus, cucumber green mottle mosaic virus, Squash mosaic virus and potyviruses.

“One or more of the target viruses were detected in 23 of the 31 seed lots that were tested.

**“These viruses are a significant risk to Australia’s vegetable and fruit industries, as well as backyard gardens, our environment, overall plant health.**

“If these seeds were bought by members of the public and planted, it could have led to some devastating results.

“Some seeds cannot be imported to Australia, as the risk of introducing unwanted plant diseases and serious weed species is too high. Others can, provided you meet strict import conditions.

“Our work at the border helps manage the risk of illegal seed imports, but everyone has a role to play in following our conditions.”

To better manage biosecurity risks, last year Australia banned imports of cucumber, melon and zucchini seeds, as well as seeds of other high-risk commodities, through international mail and other pathways.

On-arrival in Australia, biosecurity officers check that imported seeds are free from biosecurity risk material and meet all import conditions. Seeds that do not meet the import conditions may require testing or treatment.

If the biosecurity risk cannot be successfully treated, the seeds will be exported or disposed at the importer’s expense.

Illegal imports of seeds can be subject to enforcement action by the department. There are significant penalties if you are found to have breached Australia’s biosecurity conditions. This can include fines and potential prosecution.

For more information on the biosecurity conditions for seed imports, visit biosecurity.gov.au/individual/online-shopper

Learn more about the testing of seeds from overseas in the Viruses in the cucurbit seeds from on line mail order providers publication.

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