

Citricultor

Fundecitrus
SCIENCE AND SUSTAINABILITY
IN CITRICULTURE



Monitored efficacy

AVALIA PSILÍDEO (PSYLLID EVALUATION) IS THE NEW TOOL DEVELOPED
BY FUNDECITRUS TO ENABLE CITRUS GROWERS TO CHECK THE INSECTICIDES
WITH THE BEST ERADICATION TEST RESULTS IN GROVES

Citricultor

CITRICULTOR magazine is a free publication edited by the Fundo de Defesa da Citricultura - Fundecitrus. Fundecitrus, a world reference in science for citriculture, is a non-profit private institution established in 1977 and maintained by citrus growers and processors in the state of São Paulo, Brazil, to foster the sustainable development of the Brazilian citrus belt.

Contact information

Cell Phone/WhatsApp: + 55 (16) 99629-2471

Email: comunicacao@fundecitrus.com.br

Website: www.fundecitrus.com.br

Responsible journalist:

Rafael de Paula (MTb 62.159/SP)

Coverage and publishing:

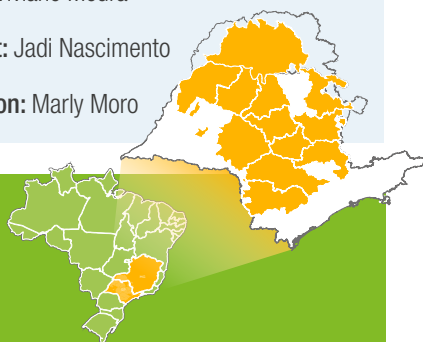
Rafael de Paula, Rodrigo Brandão and Daniele Merola (Rebeca Come Terra); and Michael Harteman

Graphic design: Juliana Retamero and Flavio Silva

Review: Viviane Moura

Assistant: Jadi Nascimento

Translation: Marly Moro



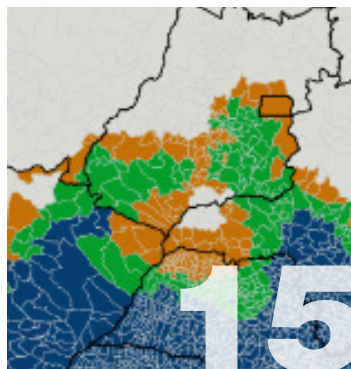
BRAZILIAN CITRUS BELT

The São Paulo and West-Southwest Minas Gerais citrus belt, located in the Southeast region of Brazil and comprised of approximately 350 cities, is the main orange juice producing region in the planet: three out of five glasses of orange juice consumed in the world are produced here. In this region, citriculture creates 200 thousand direct and indirect jobs and collects 189 million dollars in taxes.



INTERVIEW

Leandro Peña, Spanish researcher, talks about biotechnology strategies for citrus farming



AVALIA PSILÍDEO

A tool that enables the analysis of insecticide efficacy for psyllid management

ZARC CITROS

A project that estimates climate risks for citrus production outside the citrus belt



RESEARCH

Discover the effects caused by the greening bacteria on psyllids

PES

Ten years of a research project that changed the citrus farming scenario



The groves of the future

BIOTECHNOLOGICAL STRATEGIES DEVELOPED BY FUNDECITRUS CAN ENHANCE THE VIABILITY OF CITRUS FARMING IN SÃO PAULO AND MINAS GERAIS, PROMOTING SUSTAINABLE GREENING CONTROL

Two decades ago, the presence of greening was confirmed in Brazil in the area of Araraquara city, the geographic center of the state of São Paulo. Nowadays, nearly 38% of orange trees in the Citrus Belt of São Paulo and West-Southwest Minas Gerais are infected with the disease. Driven by economic and social losses over the past two decades, many people have left the business. Any honest assessment would acknowledge the disease as a serious threat to the industry. Relentless citrus greening disease has left its mark of destruction across citrus-growing regions in Asia, Africa, and the Americas. The disease poses such a serious threat that Europe, as a purely preventative measure, invested €8 million (roughly R\$43 million) from 2019 to 2023 in the Pre-HLB project. This consortium, comprised of 24 research centers from ten countries including Fundecitrus, aimed to develop sustainable strategies to control greening.

This is not pessimism, but

rather an acknowledgment that the situation demands an immediate call to action. The latest news, in fact, is quite encouraging. The São Paulo state government has shown concern and interest in assuming important responsibilities for greening control, prioritizing public awareness and inspections alongside research funding. As to disease control, citrus growers have not only improved their management practices but also undertaken related projects. One such project involves establishing new citrus plan-

tations beyond the traditional boundaries of the citrus belt, expanding production to new territories. Fundecitrus, through proprietary practices and partnerships with domestic and international institutions, has been a continuous supporter of citrus growers in R&D and technology transfer. Their primary focus is on developing long-lasting solutions, primarily through the application of biotechnology.

And there is more good news to report. Addressing a challenge as serious as greening requires medium and long-term perspectives. And these promising developments bring hope to citrus growers, reinforcing their focus and directing all efforts to control greening with the knowledge and tools currently available. In the following interview, Spanish scientist specializing in plant molecular biology Leandro Peña, with the Superior Council for Scientific Research (CSIC), a state agency based in Madrid, and the Polytechnic University of Valencia (UPV) and consultant

BIOTECHNOLOGY
ALLOWS FOR ADVANCES
THAT OTHER GENETIC
IMPROVEMENT
TECHNOLOGIES CANNOT
ACHIEVE





Leandro Peña,
specialist in plant molecular biology

door was then open to possibilities provided by genetic engineering: modifying proteins which offer beneficial properties for us. One example is insulin, used to control blood sugar levels. Another example is the vaccines developed for Covid-19, which involved not one, but several biotechnologies. The highly successful messenger RNA vaccine technology earned the 2023 Nobel Prize in Medicine for its developers, Hungarian biochemist Katalin Karikó and American doctor Drew Weissman.

ARE THERE EXAMPLES IN AGRIBUSINESS?

Almost all corn, soybeans and cotton grown in Brazil, Argentina, the United States, and Canada are genetically modified organisms [GMO] to be resistant to pests or herbicides. Herbicide resistance has changed soybean farming practices around the world. Biotechnology's importance boomed in the 20th century and is poised to become even more groundbreaking in the 21st century.

IS BIOTECHNOLOGY A SUSTAINABLE PATH?

Yes, provided you use the tools that make the technology sustainable. Technology, in itself, is just technology. But let's assume that it is possible and viable to use a gene of plant origin to, for example, produce a molecule that specifically harms the psyllid or kills the bacteria that causes greening. In this case, logi-

for the Greening Resistance Project of Fundecitrus – led by researcher Nelson Wulff – details the institution's strategies to overcome the biggest phytosanitary challenge in the history of global citrus farming.

Everything from 2004 on is in the past, and nothing can be changed. What can be done is shaping the future to preserve the economic, social, environmental, nutritional, and cultural wealth created by this agribusiness that is part of our history.

WHY CAN BIOTECHNOLOGY BE A SOLUTION TO GREENING?

Because biotechnology allows for highly targeted modifications, such as inserting a gene in a plant that make it repels psyllids or resists to the

greening bacterium. And biotechnology can achieve this while preserving the original character of the orange tree, that is, a Valencia orange tree can undergo this specific improvement and remain a Valencia orange tree. Therefore, biotechnology allows for advances that other genetic improvement technologies cannot achieve.

WHAT ADVANCES HAS BIOTECHNOLOGY BROUGHT TO HUMANITY?

The roots of biotechnology can be traced back to when humans first used yeast to make wine, beer, bread, and cheese. This is ancient biotechnology. Modern biotechnology took off in the 20th century with the ability to work with DNA, the molecule of life. The



THE RESULTS WE HAVE TODAY SHOW THAT THE INCIDENCE OF GREENING IN ORANGE TREES WITH A HIGH CAPACITY TO EMIT REPELLENT VOLATILES IS MUCH LOWER THAN IN CONTROLS

CONTRACT THE DISEASE. HOWEVER, EVEN BEFORE THE ONSET OF RESISTANCE, BIOTECHNOLOGY ITSELF MAY OFFER SIGNIFICANT RESULTS TO CONTROL GREENING, SUCH AS REPELLENCY AND TRAP PLANTS. PLEASE DISCUSS THESE CONCEPTS.

cally, it is a sustainable technology since it significantly reduces the reliance on pesticides in agriculture. Biotechnology can provide solutions that make citrus farming more sustainable.

IN RELATION TO MARKETS, HOW IS THE WORLD ACCEPTING BIOTECHNOLOGY?

In the USA, biotechnology is becoming ever more streamlined and considering that the Americans are very pragmatic, they say that GMOs have been around for 30 years with no negative effects, no negative effects have been reported for people, nor for the environment. Therefore, it is much easier nowadays to approve these materials, and many are not even considered GMO. Many possible modifications do not even require complex regulation in the USA.

IS THE CRISPR SYSTEM (AN ACRONYM FOR A GENOME EDITING TECHNIQUE) AN EXAMPLE?

Yes. CTNBio [*National Biosafety Technical Commission, a multidisciplinary collegial body that provides technical consultancy support and advice to the Federal Government, In Brazil*] accepts both GMOs, that is, those that received genes from another donor organism, and materials that have been created using gene editing techniques like CRISPR. But the approval process for gene editing moves faster.

WHAT ABOUT IN EUROPE?

In Europe, the situation is getting better. The European Parliament is considering a proposal to differentiate biotechnology from other methods, paving the way for more flexible legislation. Thus, CRISPR would no longer be considered transgenic. And, in fact, CRISPR is not transgenics, it is a genetic modification of the organism itself. If things continue as they are going, the European Union may adopt CRISPR technology within the next few years. It's a matter of time.

WHAT ABOUT IN ASIA?

In general, Asia is also embracing all these technologies. The stricter areas regarding these new biotechnologies in agriculture are Europe and New Zealand.

THE MAIN OBJECTIVE OF BIOTECHNOLOGY IN CITRUS FARMING IN RELATION TO GREENING IS TO REACH A RESISTANT PLANT, THAT IS, AN ORANGE TREE THAT, EVEN WHEN ATTACKED BY AN INFECTIOUS PSYLLID, DOES NOT

At Fundecitrus, we began a project to identify the compounds in guava trees responsible for generating the level of volatiles that make them repellent to psyllids. We discovered that the level of this same volatile is naturally very low in orange trees. After ten years of research, in 2019, complying with all the Brazilian regulations, that is, with the government authorization, we planted 30 hectares to investigate these genetically modified orange trees in the field to produce and emit more repellent compounds. The results we have today [*April 2024*] show that the incidence of greening in orange trees with a high capacity to emit repellent volatiles is much lower than in controls [*conventional plants, with no genetic changes*]. The incidence drops to a level low enough for this to be a very promising control strategy.

AND THE TRAP PLANT?

Orange jasmine [*an ornamental plant with dense bushes originating from southeastern Europe and northern Africa*] and Curry leaf or Bergera [*a genus originating in India that has the curry tree, used as a seasoning, as*



Team responsible for growing the plants for research in the Fundecitrus greenhouses



Fundecitrus Biotech Lab team: responsible for the development of repellent plants

the best-known species], relatives of citrus, are far more attractive to the psyllid than the orange tree. In that same experiment [on orange trees genetically modified to emit high levels of repellent volatiles], we placed orange jasmine on the edges of the squares [plots]. And after nearly five years, today's results show that in orange trees close to these myrtles the incidence of the disease is also lower, as the orange jasmine attracted the psyllid. Therefore, on the one hand, we have a repelling strategy and, on the other, a strategy of attracting the psyllid in the orange jasmine or bergera, whose leaves and fruits are not used for human consumption, so they can be frequently treated with insecticides. The psyllid is concentrated in the orange jasmine or bergera and killed. In the future, we intend to genetically modify the bergera so that it kills the psyllid eliminating the need to use insecticides. How? Through a toxin, the insecticidal peptide, which kills the psyllid. This is the project of the future, which Fundecitrus is wor-

king on in partnership with the University of Durham in the United Kingdom and with CSIC (see more in the article on page 7).

UNTIL WE REACH THESE ADVANCES THAT BIOTECHNOLOGY IS SEEKING, WHAT MESSAGE WOULD YOU LIKE TO SHARE WITH BRAZILIAN CITRUS GROWERS?

The Brazilian citrus grower must remain firm, following the control measures that Fundecitrus recommends. We are at a very delicate moment. In certain regions, psyllid populations have become resistant to some molecules leading to the need to rotate the molecules. We must remain highly rigorous in psyllid control. This includes eliminating diseased plants, meticulous inspections for sick plants, the quality of the applications and all that, until effective biotechnological solutions complement these conventional measures.

WHAT WAS FUNDECITRUS LIKE IN 2009, WHEN THE INSTITUTION STARTED EXPLORING BIOTECHNOLOGY, AND WHAT IS FUNDECITRUS LIKE IN 2024?

In 2009, we started from scratch, hiring staff, training the team we were forming, building greenhouses and laboratories, collaborating with partners because we didn't have the facilities to investigate volatiles and psyllid behavior. We proposed an action plan to CTNBio, received authorizations, and conducted several field trials over these 15 years. Today, we have the largest experiment on genetically modified orange trees in the world with results that demonstrate the potential for psyllid repellency through the emission of volatiles. We have a highly qualified biotechnology team, adequate structure, and key collaborations in Brazil and globally. Internationally, Fundecitrus is generally recognized as a world benchmark in research focused on the control of citrus pests and diseases, especially greening. 🍊

Ideal groves: paths to construction

CITRUS FARMING OF THE FUTURE WILL HAVE ORANGE TREES REPELLENT TO THE PSYLLID AND BARRIER SYSTEMS AT THE EDGE CAPABLE OF MITIGATING THE INTRUSION OF THE INSECT IN THE GROVES; MEASURES WILL BE ESSENTIAL TO LIMIT GREENING EXPANSION

**THE NEW GROVE FORMAT
WILL ADOPT A PSYLLID
MANAGEMENT STRATEGY
CALLED PUSH, PULL,
AND KILL**

It is in biotechnology that a large part of the citrus industry's efforts and investments are focused on mitigating the incidence of greening in groves in the citrus belt. If, on the one hand, no cure exists for diseased plants, on the other, researchers are actively developing ways to modify orange trees and the environment around the groves so as to make it harder for psyllids to thrive. The ideal grove envisioned by Fundecitrus researchers, in collaboration with the Spanish National Research Council (CSIC)/Polytechnic University of Valencia (UPV) and Durham University (England), requires a careful selection of the planting location. An isolated area of five to ten kilometers from urban areas and even other citrus producers is capable of drastically reducing the presence of the insect. However, these isolated areas still require action from external greening management teams.

The next step after selecting the area is defining the layout of plots, the trap plant cultivation lines, and the use of semi-dwarfing rootstocks (smaller plants, with fewer shoots) and the cultivation of genetically modified orange trees to repel the psyllid attacks. "Biotechnology will

greatly change the configuration of groves. The new layout will include an attraction area, with species aimed to keep psyllids away from the rest of the grove. Although it has plants, it functions as a firebreak, preventing pests from entering the grove. Instead of the insect dispersing throughout the property with no control, thus increasing losses and spreading the disease, the citrus grower will sacrifice the first meters of the grove, in a planned manner, but will ensure a more effective management in the productive area", explains the general manager of Fundecitrus, Juliano Ayres.

ENCIRCLING THE PSYLLIDS

The new grove format will adopt a psyllid management strategy called push, pull, and kill, which will work together, integrating a barrier planting system (*see more on page 9*). This way, all efforts will be directed at making it difficult for the insect to enter the grove. The first barrier proposed by the researchers is set before the grove is re-

ached with the creation of a "refuge and sacrifice area" formed by orange trees on vigorous rootstocks and by curry trees (*Bergera koenigii*) that will serve as bait to attract the psyllid. "The most vigorous orange trees have a higher shoot production capacity, and the curry trees are also highly attractive for the psyllid to feed on. This creates favorable conditions for attracting the insect and concentrating populations, which can be eliminated by insecticide application before entering the grove," explains Fundecitrus researcher Marcelo Miranda.

Although the orange trees in this area will, over time, suffer from the effects of the disease, the curry trees, which are excellent hosts for the psyllids, do not multiply the bacteria that causes greening. The psyllid does not acquire the greening bacteria, therefore, individuals that eventually do not die while feeding on the trap plant will not transmit the disease. This planting combination, if well managed, could offer promising results in blocking the insect, according to the researcher. And, in the future, this combination may be even more effective.

Biotechnology research is committed to developing a

genetically modified plant for the production of peptide, a natural toxin lethal to the psyllid, thus reducing the use of insecticides. "This way, in the future, we will be able to count on a plant that attracts and kills the psyllid. This will also have a very positive impact on sustainability by reducing the uses of control products", adds Fundecitrus researcher Nelson Wulff.

REPELLENT ORANGE TREES

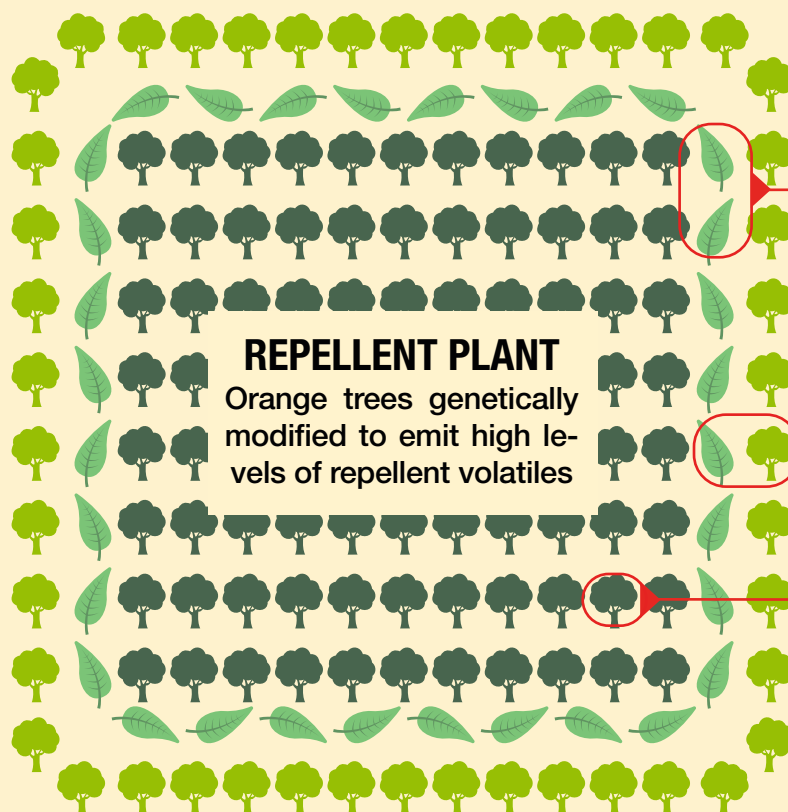
The design of the grove itself will be an ally in the configuration of this new format of orange tree cultivation. This will depend on the development and viability of genetically modified oran-

ge trees, capable of repelling the psyllid. The most recent research in biotechnology for citriculture stems from the observation of plantations of tangerine trees interspersed with guava trees in Vietnam, which were visited in 2008 by a group of researchers and citrus leaders, including Joseph Marie Bové, mentor of the project and considered the most brilliant scientist and visionary of global citrus farming, who passed away in 2016, together with Leandro Peña (*read interview on page 3*) and Juliano Ayres. "The caryophyllene compound was discovered as the main volatile element in guava leaves, according to analyzes initiated in 2009, in Spain," recalls Peña.

Esalq/USP researchers, José Maurício Bento and José Roberto Postali Parra, concluded that the volatiles in guava leaves repelled the psyllid. Then, Peña's team and the Fundecitrus team, led by researcher Haroldo Volpe, demonstrated the repellency of caryophyllene to the psyllid. Therefore, the researchers became aware that this effect could contribute to the development of the orange tree of the future. Finally, Peña's team and Fundecitrus, by means of the work conducted by Volpe and Rodrigo Facchini, observed the release of large amounts of caryophyllene by genetically modified plants, as well as the repellent activity to psyllids in laboratory experiments. "Af-

ENCIRCLING THE PSYLLIDS

In the grove of the future, all efforts are focused on preventing the psyllid from intruding; if it does, it must be expelled to the refuge and sacrifice area, where it will be killed with fewer insecticide applications or even with no insecticide, when we reach the curry trees with peptide



ter all field tests have been completed, the current expectation is to develop orange trees with the capacity to increase the release of this compound, already present in their leaves, but in small quantities compared to guava trees, in order to repel psyllids in orange groves," Peña explains.

The research team believes that combining repellency with fewer new shoots will lead to a lower incidence of greening in groves. "For this reason, the new grove must be composed of repellent orange trees combined with semi-dwarfing rootstocks. This format favors management because it generates fewer shoots and makes spraying easier. In the future, this combination will

even contribute to semi-mechanized and mechanized harvesting processes," says Wulff.

The new grove format includes the use of processed kaolin as part of the grove management strategy. "When applied to plants, the product forms a white film that may disrupt the psyllid's ability to find the host plants, thus reducing the number of adult insects landing on them. In addition, kaolin can further reduce psyllid feeding and oviposition", says Miranda.

Ayres sees global citrus farming reaping significant benefits from research advancements, with the current period as a bridge until the full potential of biotechnology is realized. In

the future, producers will need significant adaptive capacity to balance ecological responsibility, economic viability, and social fairness. "Today, we understand much more about psyllid behavior and the infection process. Our future goal is to restrict the spread of citrus greening disease. Everything is very promising, but we should not ignore what we have scientific evidence that has been successful in managing the disease and the psyllid. We cannot fail to rotate the modes of action of insecticides, eliminate diseased plants and maintain the appropriate spraying frequency, with the required quality within a regionalized action," concludes Ayres. 🍊

CURRY TREES

Plant that does not multiply the greening bacteria and is extremely attractive to the psyllid. When insects gather around this edge, they are killed by the insecticide



CURRY TREES OF THE FUTURE

Curry trees genetically modified to produce a natural toxin that kills psyllids, reducing the need for insecticide

REFUGE AND SACRIFICE AREA

Curry trees and orange trees with vigorous rootstock, with more shoots

SEMI-DWARFING ROOTSTOCKS

Smaller plants, as they have fewer shoots

KAOLIN

Non-toxic substance used in the grove to repel the psyllid

EFFICIENCY

The larger the planted area, the better the results

Psyllid control: monitored efficacy

AVALIA PSILÍDEO (PSYLLID EVALUATION), A NEW TOOL CREATED BY FUNDECITRUS THAT ENABLES CITRUS GROWERS TO CHECK THE INSECTICIDES WITH THE BEST ERADICATION RESULTS

Controlling the psyllid population is one of the main pillars for fighting greening. With the increase of the insect prevalence in the citrus belt, mainly due to resistance development, the rotation of modes of action and the choice of insecticides with good control efficacy became fundamental for the good management of psyllids. In order to allow citrus growers to easily and quickly monitor which products provide appropriate control of the insect, Fundecitrus launched *Avalia Psilídeo* in January. This tool works in

an integrated manner with the latest research on the performance of insecticides against the psyllid.

"The platform stores results of insecticide efficacy experiments on psyllid populations which are collected in the field in different regions of the citrus belt. These results will be constantly updated as more experiments are carried out, which will be highly beneficial to producers, who will be able to quickly and easily monitor which products offer a good control efficacy," explains Fundecitrus Researcher, Wellington Ivo Eduardo.



RESISTANCE

Avalia Psilídeo stemmed from the need of constantly monitoring the effectiveness of insecticides in view of resistance cases recorded in the citrus belt. "Resistance to pyrethroid and neonicotinoid groups and, more recently, to malathion, triggers an important alert for the entire sector. In order to enable citrus growers to perform management using products that offer good psyllid control, field professionals need information about strategies that truly work, with satisfactory control effectiveness based on consistent experiments," says Fundecitrus researcher and project coordinator, Marcelo Miranda.

The tool results from cooperative work on several fronts. "Several sectors are engaged to

THE TOOL SHOWS DYNAMIC RESULTS OF EXPERIMENTS TO IMPROVE PSYLLID MANAGEMENT IN GROVES

make the tool successful. These include citrus growers, in the field, who detect high populations, and the Fundecitrus teams: Technology Transfer, which collects the insects; and the R&D team, which carries out experiments with psyllids; up until the release of results back to farmers," explains Miranda.

HIGH QUALITY MANAGEMENT

The fight against greening is structurally based on the so-called management tri-

pod (*read more on page 13*), which consists of planting healthy seedlings, eliminating diseased plants and controlling the psyllid. In order effectively manage the insect, it is important to prevent the natural selection of resistant psyllids, that is, individual insects capable of surviving pesticide sprayings and of passing this trait on to their offspring. In the opinion of Fundecitrus general manager, Juliano Ayres, everyone has a role to play in the fight against greening. "Now it is important that everyone uses the tool and rotates products according to the data provided by *Avalia Psilídeo* (Psyllid Evaluation). This is a fundamental pillar in insect management," he concludes. 🍊



Lucas Ferrante, citrus grower in Olímpia (SP state)

GREAT HELP IN THE FIELD

In Olímpia (SP state), on the São Domingos farm, the number of psyllids captured has fallen by 50% since the management teams started to adopt effective insecticides to control the insect population. Good results started to show after following the guidelines given by Fundecitrus to farm employees. The farm has 28,000 orange trees, whose average age is 1.5 year. With *Avalia Psilídeo*, the management is expected to become

even better. "The new tool is of utmost importance since greening can only be defeated with high-quality management. And that's exactly what we got here!

Now, we will be able to closely monitor the performance of products available on the market so that our decision-making is always based on quality information. The fight against greening is our 1st, 2nd and 3rd priority," says Lucas Ferrante, owner of LF Citros and of the farm.

GREENING MANAGEMENT TRIPOD



PLANTING OF HEALTHY SEEDLINGS

Purchase of seedlings from high-quality, regulated nurseries

ELIMINATION OF DISEASED PLANTS

Eliminating symptomatic plants is mandatory until the eighth year after planting



PSYLLID CONTROL

- Rotate products with at least three modes of action;
- Apply at intervals of 7 days during shoot growth and ≤ 14 days to prevent psyllid development;
- Use insecticides with proven efficacy, according to the product label doses;
- Spray ensuring adequate coverage throughout the canopy

HOW AVALIA PSILÍDEO WORKS:

INITIAL SCREEN

When opening the tool, citrus growers have access to general information about the experiments. At the top of the screen, the number of studies carried out and the number of psyllids collected can be checked for different regions of the citrus belt. This information supports the conclusions provided.

RESULTS

Results can be viewed in two ways. In the “efficacy” screen, the general panel shows the results of the proportion of tested populations in which the insecticide controlled 80% or more of psyllids. On the “mortality” screen, it is possible to see the results of the overall average mortality rate of psyllids for the different insecticides tested.

FILTERING

In the right corner of the screen, the producer can choose filter options such as: date of the experiment, chemical group, active ingredient and days of confinement (time that the insect remained confined in the sprayed rootstock).

REGIONS

By clicking on one of the insecticides, it is possible to check on the “Phytosanitary Alert Region” map the regions where psyllids used in trials were collected and the respective insecticide used. By hovering the mouse over an area on the map, citrus growers can see the region and the number of experiments performed with psyllids in that location.



WATCH THE AVALIA PSILÍDEO VIDEO TUTORIAL



Eficácia
 Eficácia ≥ 80%

Qtd. experimentos
60

Qtd. repetições
2684

Qtd. psilídeos
26840

EFICÁCIA
MORTALIDADE

Data do experimento
 28/04/2023 05/03/2024
 Limpar Filtros

Grupo químico
 Todos

Ingrediente ativo*
 Todos

Dias após o confinamento
7

Ingrediente ativo*	Nº de pop. do psilídeo com eficácia do produto (≥ 80%)
Abamectina 18 + Ciantraniliprole 60 SC (0,4)**	36/36(100%)
Ciantraniliprole 100 OD (0,25)	26/26(100%)
Cloridrato de formetanato 500 SP (0,4)	38/39(97%)
Espinetoram 250 WG (0,16)	32/34(94%)
Sulfoxaflor 240 SC (0,5)**	22/24(91%)
Acetamiprido 250 + Bifentrina 250 WG (0,2)	8/11(72%)
Imidacloprido 200 SC (0,5)	32/50(64%)
Malationa 1000 EC (3)	17/53(32%)
Fenpropatrina 300 EC (0,4)	1/4(25%)
Bifentrina 100 EC (0,4)	9/48(18%)
Flupiradifurona 200 SL (1)	1/20(5%)
Alfa-cipermetrina 7,5 + Teflubenzurom 7,5 SC (0,5)	0/6(0%)
Beta-ciflutrina 125 SC (0,25)	0/5(0%)
Não tratado	0/60(0%)
Tiametoxam 250 WG (0,2)	0/8(0%)
Tiametoxam 250 WG (0,3)	0/6(0%)
Zeta-cipermetrina 200 + bifentrina 180 EC (0,2)	0/7(0%)
Zeta-cipermetrina 350 EC (0,4)	0/7(0%)

Região do Alerta Fitossanitário
 Cinturão Citrícola de SP e Triângulo/Sudoeste Mineiro

- Bebedouro
- Santa Cruz do Rio P...
- Araçuaia
- Avaré
- Casa Branca
- Limeira
- Novo Horizonte
- Itapetininga
- Brotas
- Frutal
- Jales
- Lins
- Franca
- São José do Rio Preto

Atualizado em: 18/03/2024

The future avenues for citriculture

A PUBLICATION PREPARED BY EMBRAPA,
IN PARTNERSHIP WITH FUNDECITRUS, ESTIMATES
CLIMATE RISKS FOR CITRUS PRODUCTION IN
EXPANSION REGIONS OF THE CITRUS BELT

With the spread of greening throughout the world, the most devastating citrus disease, regions where orange growing has historically prevailed now suffer from the damage caused by the disease. This is the case of the citrus belt of São Paulo and West-Southwest Minas Gerais, which comprises almost 400 municipalities with citrus-growing properties, a region with the largest orange production in the world. The latest Fundecitrus annual survey on the incidence of the disease in the belt indicates an increase of 56%, jumping from 24% in 2022 to 38% of diseased plants in 2023.

This scenario intensifies the search for other disease-free regions or areas with low levels of the disease. However, it is important that citrus growers know the risks to both greening and citrus production. The Ministry of Agriculture and Livestock (MAPA), in partnership with Embrapa, developed a tool called Agricultural Climate Risk Zoning (Zarc) that has been used to estimate planting and production risks of different crops in Brazil. Recently, Embrapa, in partnership with Fundecitrus, prepared a technical publication that addresses the risks estimated by Zarc for citrus production (Zarc Citros) not only in the current citrus belt, but also in neighboring states,



such as Goiás, Mato Grosso do Sul and Paraná, the so-called the “expanded citrus belt”.

Zarc uses the climate water balance of the crop and considers soil texture, citrus maturation and other parameters to estimate the probability of production loss caused by adverse meteorological events. “The information retrieved from Zarc Citros can be used by technicians and rural producers to evaluate which variety groups are viable in each production region and the best time periods to plant the groves. This allows citrus growers to plan

their investments, seeking lower risk and greater sustainability,” says Maurício Antonio Coelho Filho, researcher at Embrapa and one of the authors of the publication on Zarc.

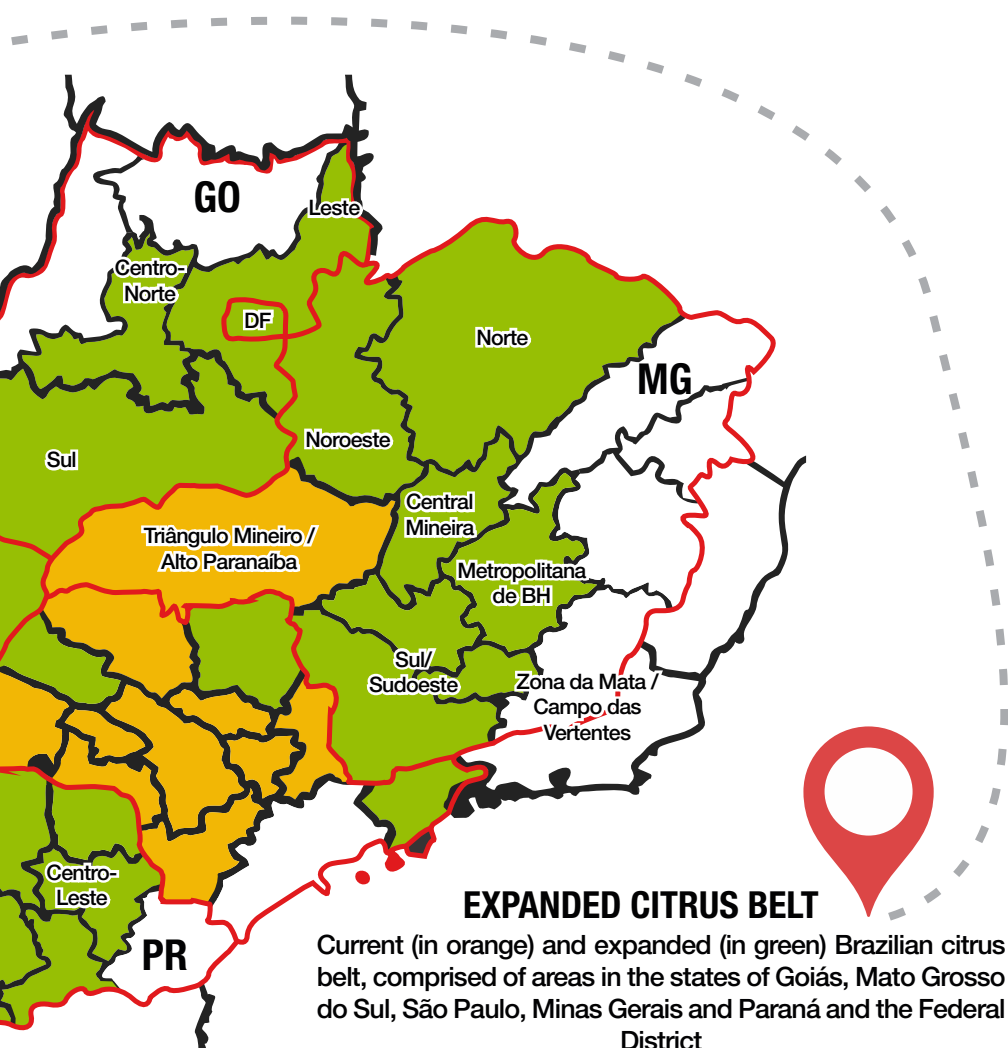
Zarc has been adopted in more than 40 annual and perennial agricultural crops throughout Brazil. “It is a project that was born to offer guidance to the most diverse cultures. Farming and production planning is increasingly an indispensable task for rural producers,” reinforces Zarc coordinator and Embrapa researcher, José Eduardo Monteiro.

**ZARC CITROS ESTIMATES
FOUR CLASSES OF RISK:
UP TO 20%, 30%, 40% AND
ABOVE 40% LIKELIHOOD
OF CROP SHORTAGES**

HOW DOES ZARC WORK?

The model that is currently used by Zarc estimates the risk for five different canopy variety groups, as they have different fruit maturation times and three different types of soil texture (*see more on page 17*), which influence the water storage capacity. Zarc does not consider variations and/or limitations in soil fertility and the occurrence of pests and diseases but it takes into account rain-fed conditions (without irrigation).

The publication estimates four classes of risk: up to 20%, 30%, 40% and above 40% likelihood of crop shortage due to adverse meteorological events, such as thermal and water conditions that are harmful or hinder citrus cultivation, causing significant loss of productivity or high plant mortality (*see more on page 18*). “Simulations are performed, and the risks are based on the flowering period and on the specificities of the fruit development phases. In a practical sense, we can say that if the estimated risk is up to 30%, producers could ex-



TIPOS DE SOLOS



SANDY TEXTURE

Capacity to store up to 42 mm of water in the average effective depth layer of the root system (Ze) of 1 m of citrus



MEDIUM TEXTURE

Capacity to store up to 66 mm of water in the Ze



CLAYISH TEXTURE

Capacity to store up to 90 mm of water in the Ze

perience significant production losses of 3 out of every 10 crop seasons," explains Coelho Filho.

As described on page 25, for Group 3 varieties, from early season to mid-season, for example, a risk of up to 40% was estimated in a large area of the expanded citrus belt, under rain-fed conditions. There are exceptions in some micro-regions where the risk is greater than 40%, such as in part of the Triângulo Mineiro and South of Goiás state and large areas in the North of Goiás and Minas Gerais states, especially in soils with a sandy texture.

When considering the varieties in Group 5, which include late to very late season orange trees, the risk level is even worse in rain-fed conditions. A risk level of up to 20% continues to be observed in some regions of the expanded citrus belt. Some municipalities are an exception in the North of São Paulo state, an area at the border of part of the Triângulo Mineiro and Mato Grosso do Sul state, whose estimated risk level is above 30%. The same is applicable in areas of the Triângulo Mineiro and North of Minas Gerais state, the entire state of Goiás, and a large part of Mato Grosso do Sul state, especially in the case of soils with a sandy texture. In other regions of the expanded citrus belt, the risk ranges from 20% to 40%. This reinforces the need to use irrigation in these regions where risks are higher, especially to obtain good yields in later maturing varieties.

ADVANCES AND PERSPECTIVES

In the opinion of Fundecitrus researcher, Renato Bassanezi, in addition to weighing climate risk, agricultural planning for the planting and production of citrus in new areas must consider the use of healthy seedlings, the appropriate choice of canopy and rootstock variety, planting spacing and a study on the likelihood of disease incidence. "When choosing new planting

VARIETY GROUPS

These are the groups of varieties considered, based on the annual cycle of fruit production and development:

- 1 Very early season
Tahiti acid lime
and lemons
- 2 Early season limes,
oranges, lemons
and tangerines
- 3 Early to mid-season
oranges and
tangerines
- 4 Mid-season
to late-season
oranges and
tangerines
- 5 Late to very late
season oranges

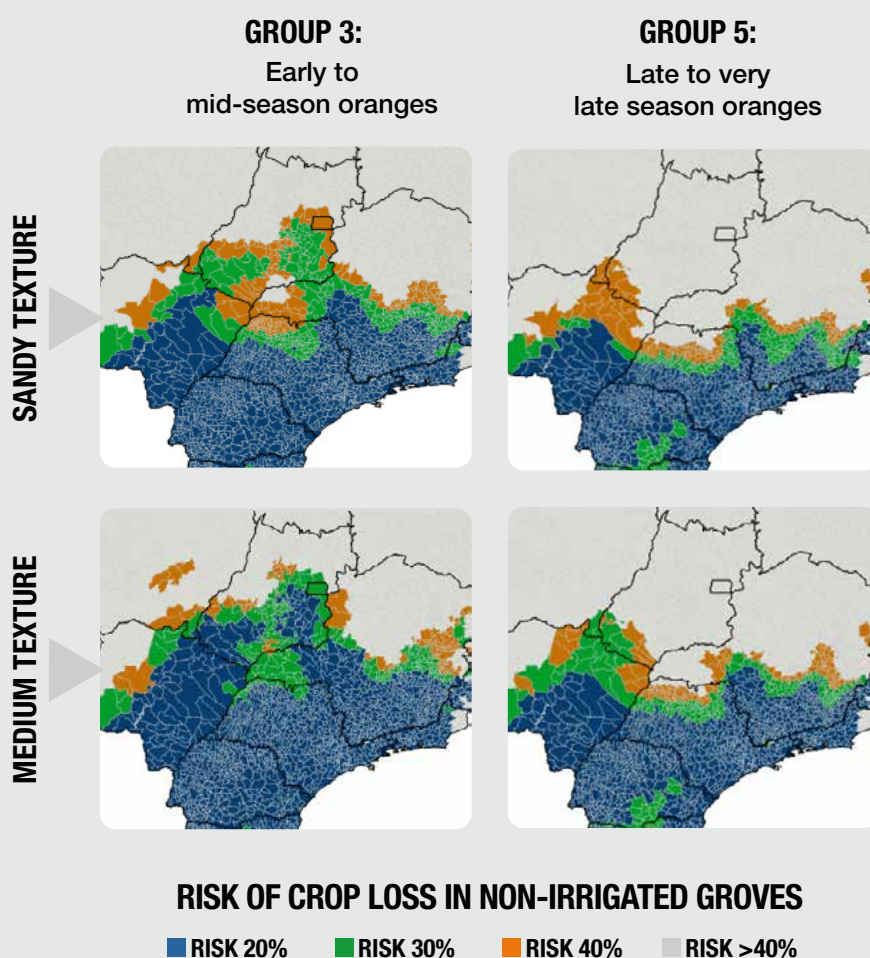
areas, the use of the information provided by Zarc Citros is essential for planning crop planting and production, especially now that greening has been sprawling and has forced citrus growers to search for new areas," he advises.

Embrapa analyst and one of the authors of the study, Alécio Moreira, says that Zarc Citros in citrus farming is yet another important result of the partnership built between Embrapa and Fundecitrus for the benefit of citrus growers. "It is an essential contribution to the sustainability of the sector. This partnership will grow even stronger, and the next steps will involve the development of other models that will indicate the likelihood of the positive presence of the psyllid, which is the vector of the greening bacteria, and of other diseases in the expanded belt, along with the risk level of extreme post-flowering temperatures," he explains. Geraldo Silva Junior, Fundecitrus researcher, adds that these studies will make risk assessment for citrus planting and production even more precise. "This is very important because these are new expansion areas for citrus farming, and they will contribute to citrus growers' decision-making," he says.

The publication included contributions of eight researchers from Embrapa and Fundecitrus: Alécio Souza Moreira, Maurício Antônio Coelho Filho, José Eduardo Boffino de Almeida Monteiro, Daniel de Castro Victoria, Renato Beozzo Bassanezi, Eduardo Augusto Girardi and Francisco Ferraz Laranjeira Barbosa. 🍊

RISKS FOR CITRUS PRODUCTION IN DIFFERENT VARIETY GROUPS AND SOIL TYPES IN THE EXPANDED CITRUS BELT

Zarc takes into account the probability of production losses due to meteorological events



ACCESS THE FULL PUBLICATION HERE



Infected psyllids: biological and behavioral changes

EFFECTS OF GREENING BACTERIA IN INSECTS CHALLENGE MANAGEMENT IN THE FIELD AND PUZZLE THE SCIENTISTS WHO ARE SEARCHING FOR THE PHEROMONE FORMULATION

Greening is one of the biggest challenges ever faced by citrus farming. The need for effective management, which strictly follows the rotation of insecticides with different modes of action, spraying with adequate frequency and elimination of diseased plants are just some of the elements of this challenge, which extend from the field to the laboratories, where researchers seek solutions for managing the psyllid and the disease to which no cure has been found. Recent studies, including a partnership project between Fundecitrus and the University of California, revealed that the greening bacterium (*Candidatus Liberibacter asiaticus*) causes physiological changes in psyllids, posing additional challenges to management strategies. An increase in the number of eggs, more frequent dispersal flights over greater distances, as well as greater attractiveness to the host, are some of the changes observed in contaminated psyllids.

For the Fundecitrus agricultural engineer and post-doctoral student at Esalq-USP, Fernando Amaral, knowing the psyllid is an instrumental factor to fight the disease and the changes in the insect behavior cannot be ignored. "Epidemiologically speaking, the changes we have been observing in psyllid behavior turn it into a much more problematic insect," states Amaral.

These behavioral changes also hinder the development of tools to attract the insect (pheromone) and improve its monitoring (*see more in the highlighted section*). "It is becoming increasingly clear that the psyllid undergoes several changes, and this phenomenon not only poses difficulties to management, but also curbs the development of products to capture the insect," says Fundecitrus researcher, Haroldo Volpe.

MORE EGGS AND REPRODUCTION

Studies published between 2015 and 2024 revealed that

psyllids infected with the greening bacteria, when compared to healthy insects, can lay up to 100% more eggs. "There is consensus that the number of eggs laid increases, which is a quite relevant point as it contributes to the growth of the insect population," explains Amaral.

Increased reproduction may seem to be a direct reflection of the higher number of eggs, but this is not the case. "If a healthy insect lays 100 eggs and the infected psyllid lays 200, the following scenario can occur: with 60% of viable eggs in the healthy population, 60 adult psyllids can be generated at the end of the cycle. On the other hand, of the 200 eggs laid by an infected insect, 50% (100 eggs) may be viable to form a new generation. Although the percentage is lower for infected psyllids, the reproductive rate is higher," he explains. At every stage of the insect's life cycle, there is a certain mortality rate and when insects are infected, nymph mortality is higher. "However, as the number

of eggs is also much higher, the reproductive rate continues to be positive, between 12% and 14% higher compared to that of healthy psyllids," adds Volpe.

FLIGHT INITIATION

Another conclusion reached by the studies is that infected psyllids are more agitated when compared to healthy insects. In order to reach this conclusion, researchers placed adult insects from both groups on a platform. During the observations, the teams noticed that infected insects flew, on average, after 50 seconds from the beginning of the observation period; and the healthy subjects took around 150 seconds. "Knowing that the insect flies more often and starts flying earlier demonstrates agitation and altered behavior, increasing its ability to spread greening," clarifies Volpe.

DISPERSION AND DIET

The changes in psyllids infected with the bacteria are not limited to laying more eggs and having a higher reproduction rate; these psyllids perform more frequent dispersal flights. For instance, there are studies available which consider the number of take-off flights of insects in a given period. "Psyllids infected with the greening bacteria have a 45% higher rate of long flights when compared to healthy insects," explains Amaral. For this study, flights of at least 30 seconds were considered, which is enough time for the insects to go from one plant to another. In other words, the infected

IMPACTS OF GREENING BACTERIA ON PSYLLIDS

The bacterium *Candidatus Liberibacter asiaticus* is capable of promoting a series of changes in the insect upon contaminating it:

BEHAVIORAL CHANGES

10 to 100%
more eggs



Net reproduction
rate:
12 to 14%



Flight
dispersion:
45% longer



Flight
initiation:
3 times faster



Foraging:
greater need
to feed



Pheromone
response:
50 times less



BIOLOGICAL CHANGES

Susceptibility to
insecticides
20 to 313%



*considering susceptible insects

psyllid will fly longer distances and further spread the disease. Moreover, infected psyllids will also have a greater need to feed (foraging) on more shoots and, consequently, they will further disseminate the disease.

On the other hand, the susceptibility of infected insects to insecticides is greater than that of healthy insects. In other words, according to studies, psyllids infected with the greening bacteria require a 20% to 313% lower concentration of insecticides to achieve the same mortality rate of healthy insects. This happens because the bacteria interferes with the psyllid metabolism of these products, which hinders their detoxication process. Amaral, however, warns that this study should be interpreted correctly, especially when it comes to resistant psyllids. "We are talking about susceptible insects, whether healthy or infected with the disease. In the case of resistant psyllids, for example, to pyrethroids, there are no studies showing that healthy or infected insects would present different responses to the insecticide," he highlights.

Fundecitrus general manager, Juliano Ayres, reinforces the need for citrus growers to remain aware and reassured of the measures used to combat the disease in the field. "The more diseased plants in groves without appropriate psyllid control, the more contaminated insects there will be and, consequently, the faster the disease will spread. Therefore, it is essential to continue to eliminate diseased plants from groves and keep up strict control of the insect on these plants," he concludes. ●

PHEROMONE FORMULATION: A CHALLENGE

Published late last year, an important article written by Fundecitrus researchers in partnership with researcher Walter Leal, professor at the University of California (Davis/USA) and one of the world's leading names in chemical ecology, showed the results of the challenging work of producing at an industrial scale the psyllid pheromone, which was discovered by Professor Leal himself in 2017. The study concluded that infected psyllids need a 50-time higher dose of pheromone to be attracted when compared to healthy insects.

The conclusion was based on field analysis, using healthy psyllids in California

and infected psyllids in Brazil. "In California, the insects were all healthy, and we started considering the possible effects of the disease on the psyllid behavior in relation to the formulation we had developed, since part of the insect population was already infected in São Paulo," explains Leal. In the professor's opinion, this insect is very complex. "I can say that everything about this insect is difficult; with an experience of more than forty years working with pheromones, this is the most complicated insect I have ever worked with," he discloses. According to Fundecitrus researcher Haroldo Volpe, developing a high-dose commercial product to attract infected insects and another low-dose product to attract healthy males is unfeasible. "The dose that attracts infected insects does not attract healthy ones and vice versa. In practice, as the doses are incompatible between the two groups of psyllids, citrus growers would

"WITH MORE THAN FORTY YEARS OF EXPERIENCE WORKING WITH PHEROMONES, THIS IS THE MOST COMPLICATED INSECT I HAVE EVER WORKED WITH"
Walter Leal



Collaborative studies on psyllid pheromones by the chemical ecology and insect behavior laboratory

need to decide between attracting healthy or infected psyllids. This is the reason why implementing this technology to monitor only part of the psyllid population in the field does not make sense," he explains. The study was developed by the team at the Fundecitrus Insect Ecology and Behavior Laboratory, where there are olfactometers to observe the insect behavior in reaction to the pheromone and a gas chromatograph coupled to a sequential triple-quadrupole mass spectrometry detector, used for the introduction of volatile organic compounds. The equipment acquired by Fapesp is multi-user and was essential for the completion of this work.

Walter Leal, professor at the University of California (Davis/USA)

Image: Sasha Bakhter / UC Davis

PES: 10 years of pioneer work and credibility

THE FORECAST CHANGED THE SCENARIO OF BRAZILIAN CITRICULTURE
BY GENERATING POSITIVE IMPACTS FOR THE CITRUS SECTOR



In 2014, a significant milestone was established in Brazilian agribusiness with the implementation of the Orange Crop Forecast (PES) in the citrus belt of São Paulo state and West-Southwest of Minas Gerais state. This work, which had been carried out by orange juice processors since 1988, became part of Fundecitrus attributions, which adopted a new method developed with the support of the consulting company Markestrat and professors from FEA-RP/USP (School of Economics, Administration and Accounting of the University of São Paulo) and Unesp/Jaboticabal (Jaboticabal Campus State University of São Paulo), consolidating the best practices used by these companies.

By taking on this responsibility, Fundecitrus promoted significant progress in the democratization

of information. Anyone interested in data on orange production, for instance, now has access to the same information, at the same time and with the same level of detail, following the model adopted by the United States Department of Agriculture (USDA) to disseminate data on orange production in Florida.

In its 10 years of operation, PES has played a fundamental role in the citrus industry. The benefits echoed throughout the entire production chain, facilitating the strategic planning of production and marketing not only of the fruit, but of all products that use oranges as a raw material. Furthermore, study opportunities have expanded in order to promote in-depth learning of production areas, including disease surveys and research projects that

evaluate the environmental contribution of citrus farming. This includes the quantification of areas destined for preservation, carbon stock studies and mapping of wildlife, bearing evidence of the commitment of citrus growers to environmental sustainability.

The President of Fundecitrus, Lourival Carmo Monaco, stated that PES is a landmark of the modernization of citrus farming in the states of São Paulo and Minas Gerais. "The crop forecast and the tree inventory were created to provide reliability to our agribusiness and these surveys contribute with information that enables the incorporation of good agricultural and commercial practices as well as of sustainability policies, living up to the expectations of increasingly demanding markets," he concludes.



In the photo, from left to right: Vinícius Trombin (Markestrat/PES coordinator), Cleber Albino, Alexandre Lino, Wladimir Pereira, Roseli Reina, Joferson Vermelho, Guilherme Barbosa, Marcos Barbosa and Fernando Delgado

Monaco recalls that before PES the crop season production was estimated using generic elements, which were replaced by a methodology developed by an institution maintained by citrus growers. "In addition to reliability, PES provides predictability about each region, based on their own history and culture. This combination strengthens the effective use of technical and scientific knowledge, and it also offers citrus growers better conditions to conduct the financial planning of their business," he asserts. "PES is always getting updated. The next steps involve advances in techniques, such as artificial intelligence, and the inclusion of new demands from the market and producers," he reinforces.

BENCHMARK

In the opinion of the general manager of Fundecitrus, Juliano Ayres, PES has become a reference for pioneer work and transpa-

rency. It is a concept that requires the contribution of all segments connected to citrus production in order to meet the demands of the sector involving the productivity and quality level required by the market. "Our mission is to contribute to strengthening citrus growing since it is a production chain that generates jobs and economic wealth for the country. PES greatly contributed to this purpose. In spite of the several challenges, we strive to make our Brazilian citrus industry increasingly vibrant, sustainable and at the top of the world," he affirms.

The executive director of the National Association of Citrus Juice Exporters - CitrusBR, Ibiapaba Netto, explains that the Orange Crop Forecast - PES is one of the most important and innovative projects in Brazilian citrus farming and that it has changed the operation of orange juice industries and citrus growers. "The crop forecast is a governance project for the citrus production chain that turned

out to be successful. It is a system that not only enables scientific reliability, but also provides reassurance to all links of the chain as it comprises numbers that are produced by the best statistical methodology available with the participation of large entities. Industries and citrus growers receive the same information with the same degree of precision, and this has enabled more assertive decision-making," he highlights.

CARBON AND WILDLIFE

An example that depicts the influence that citrus farming plays on agriculture is based on the fact that last year PES produced unprecedented data from a scientific investigation that measured carbon stock levels in production areas and areas destined to preserve native vegetation on rural properties in the citrus belt. The work concluded that, in a territory of approximately 600,000 hectares in the citrus belt, the carbon stock level



is approximately 36 million tons.

This year, in addition to the 2024-2025 crop forecast, PES will provide data from a survey that quantifies the wildlife in the citrus belt, an important indicator of environmental quality. Moreover, it will also provide recommendations to producers on how to create environments that are favorable to wildlife. These data reinforce the relevance of citrus farming to benefit the environment and the importance of encouraging this kind of work on citrus properties. The survey is carried out by a partnership project between Fundecitrus and Embrapa, with financing from *Innocent Drinks*.

INDISPENSABLE TOOL

The citrus grower at Fazenda Bom Jardim (Monte Azul Paulista/SP state) and member of the Montecitrus Group, Fernando Vianna Arroyo, believes that PES has become a work tool and an

instrument for decision-making. "With the contribution made possible by PES, we have managed to showcase how sustainable and efficient Brazilian citrus farming has become. It is a carefully crafted, reliable and precise project. The survey has become essential in the commercial decisions we make, and it guides us towards our next steps. In addition to improving each year, the forecast gave visibility to important data from the citrus belt related to environmental preservation," he reinforces.

The activities performed by the PES team are monitored by a technical committee made up of representatives of orange juice companies, citrus growers, researchers and Fundecitrus supervisors. The committee monitors the performance of field activities and proposes solutions for operational improvements.

The coordinator of the Orange Crop Forecast, Vinícius Trombin, highlights the crucial role that PES has played over a decade. "Du-

PES IS A MILESTONE IN THE MODERNIZATION OF CITRUS FARMING IN SÃO PAULO AND MINAS, THANKS TO THE SUPPORT OF THE PRODUCERS

ring this period of progress and discoveries, we have not accomplished this journey alone. The research is only viable thanks to the full support of producers. We rely on exceptional partners who enrich our work with knowledge. The technical committee, for example, has been instrumental in providing valuable insights and proposing solutions to enhance our methodology. Professor José Carlos Barbosa also deserves our acknowledgment for his exceptional competence in Statistics, as well as Professor Marcos Fava Neves, for his in-depth knowledge of the citrus chain," he explains. "The partnership with Embrapa Digital Agriculture took another



step in improving the counting of green fruits on trees using neural networks. Furthermore, with the precise support of Embrapa Territorial, we were able to size environmental preservation areas, estimate the carbon stock and map the rich wildlife on citrus properties," he emphasizes.

Trombin also explains that in view of the large amount of information already delivered by PES, the work goes beyond simply forecasting the next crop. "It is about identifying opportunities that will shape the future of the sector. We hope that the information provided by PES may guide this journey between the present and the future, enabling producers to act now

towards a tomorrow they would like to build," he concludes.

Annually, around 100 professionals are hired temporarily to carry out the forecast surveys. After the release of the forecast, the team is reduced to nine Fundecitrus technicians who continue working throughout the crop season to update the initially projected data. 🍊

TEAM WORK



More than
400,000 km
covered in surveys from January to April



100 professionals
involved to
forecast the crop

Towards mechanization and good practices



COLHE+ PROJECT
ADVANCING
TOWARDS INNOVATIVE
SOLUTIONS, BRINGING
EFFICIENCY AND
PROFITABILITY GAINS
TO THE FIELD

With the high demand for orange juice overseas, citrus farming is one of the agribusiness sectors with the highest employment rate in rural areas of the country. Therefore, one of the main challenges facing citrus farming around the world has been the shortage of labor to harvest fruits. Producers and companies are seeking to promote a new citrus industry, with equipment capable of harvesting fruits in a semi- or fully-mechanized way, and with better practices for harvesting workers.

Considering these limitations and challenges, Fundecitrus crea-

ted the Colhe+ project, an initiative that aims to drive the development of citrus harvesting, seeking alternatives to improve the manual process, as well as creating solutions that enable the mechanization process. The project was born from a partnership between Fundecitrus, Agricef and Move Agro, and it also has the support and participation of eight companies of the citrus sector.

The general manager of Fundecitrus, Juliano Ayres, explains that Colhe+ is an innovative project whose purpose is promoting efficiency and sustainability in the field. "Thinking about the concept of the new citriculture focused on improving the working

conditions for harvesters, Fundecitrus seeks innovative alternatives that aim to increase workers' safety and promote the advancement of the harvesting process. The new scenario requires changes and adaptation, and we need to thrust towards a modern and efficient citrus industry," declares Ayres.



IMPROVING THE MANUAL HARVESTING PROCESS

With the support of companies of the sector, multidisciplinary teams were created with the participation of experts, Fundecitrus researchers and other market professionals, who held meetings and shared flexible and collaborative approaches to characterize and detail the different harvesting processes used on properties, facilitating the dissemination of knowledge on the benefits of activities performed in the field.

The teams also met with the aim of identifying the causes of

decreased harvesting yield and evaluating improvement proposals. The greatest challenges identified during the analyzes are related to the early stage of harvesting, such as the distribution of workers in the field, the availability of required materials to perform the services (big bag, ladders and logistics, for example), and difficulties posed by the characteristics of groves, bearing in mind the safety of harvesters.

With the definition of best practices for the process of manual harvesting, Fundecitrus, with the support of partners, held a project launch event in each of the participating companies in order to present the best practices to the harvesting leaders and supervisors. According to the project coordinator, Efraim Albrecht Neto, the idea is that the knowledge conveyed during the training sessions is shared with the teams and transformed into good practices. "We monitored the inauguration and implementation of the project in the eight companies as well as the work of some leaders. We noticed good progress, but opportunities were identified to further improve the harvesting process. Now, based on these findings, we will replicate this experience to the teams of the other companies involved in the project. It is a constant learning process," he explains. In total, more than 200 rural workers have already participated in the training program.

**MECHANIZED
HARVESTING OFFERS
A SAFER OPERATION,
FACILITATING THE WORK
OF HARVESTERS IN THE
ENTIRE CITRUS INDUSTRY**

IMPLEMENTATION OF MECHANIZATION

The exchange of experience with other agribusiness sectors that use mechanized harvesting processes, as well as the use of platforms and concepts already adopted, enable the project to create more effective and safe working conditions for harvesters. "In the last crop season, for instance, tests were carried out with some semi-mechanized equipment. It was a very interesting and promising experience. During the initial activities of the next crop season, more tests are to be made, including equipment used in other crops and national and international supplier platforms," he discloses.

In the case of fully mechanized harvesting, considering the challenges of dealing with an innovative approach in Brazil and the fact that it will foster social and economic development, the Colhe+ project team has sought to establish partnerships with companies, research institutes, startups and universities in Brazil and in other countries in order to support open innovation initiatives that enhance the sector ecosystem.



Efraim Albrecht Neto, coordinator of Colhe+ Project, during the presentation of the project at the International Symposium "The New Citriculture"



Colhe+ has already established, for example, a cooperation agreement with the multinational company CNH Industrial to carry out tests and monitor a harvesting machine which should operate in the next crop season. Furthermore, other partnerships with companies and research institutions are in the final validation phase. "This will allow for the use of other equipment, including robotic mechanisms for harvesting," he says.

After all evaluations and tests, the project will gather information to establish a practical and efficient concept in order to enable citrus growers to start implementing the mechanized harvesting process. "Fundecitrus believes that citrus growers need to modernize. Even in the face of challenges, such as mechanized harvesting, we seek to foster

innovation so that all companies, farms and workers can be engaged in this ecosystem and leverage the potential to deliver the best results in the field by using the technologies that are compatible with each property," he concludes.

A HORIZON OF OPPORTUNITIES

In search for a mechanized solution, Fundecitrus has participated in international events that provided knowledge and updates on this practice. In January this year, Juliana Ayres and Efraim Albrecht attended the Democitrus event in Spain, which featured the presentation of different machines and tools aimed at mechanizing citrus management as well as the latest technologies for the sector.

In addition to equipment and

concepts developed for the management of groves, the project will soon offer a specialized course, which will be made available on our online course platform, Fundecitrus Digital, so that professionals can be prepared and further enhance their performance. The module will cover the entire harvesting methodology as well as training and techniques carried out in the field.

"Citrus farming has several challenges to be tackled before implementing the modern and optimized solution of mechanized harvesting. Citrus growers who choose this option will have to change their groves, as the technique requires smaller plants, tree density, irrigation, pruning and advanced greening management. These innovations can trigger productivity gains with reduced costs and increased crop yield," concludes Ayres. 🍊