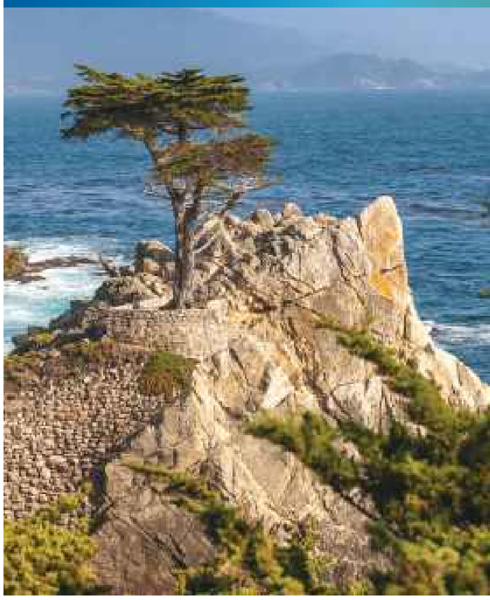
18th ISHS Symposium on Processing Tomato

Abstract Book

7 - 10 JUNE 2026

Monterey Bay | Monterey, California

We are pleased to welcome you to Monterey



We are pleased to welcome in **Monterey for the 18th ISHS Symposium on Processing Tomato**.

The Symposium is a unique forum that focuses on addressing key scientific questions and issues related to the entire tomato processing sector, from field (production for industrial purposes, applied ecophysiology, agronomy, biotic and abiotic stress resistance, genetics applied to industrial food system) to fork (organoleptic and nutritional food quality, smart quality control processes, healthy food, high quality cultivars).

Holding the symposium in parallel with the **16th World Processing Tomato Congress**, helps bring together academics, researchers and students with growers, processors and business professionals working in the processing tomato industry. This unique setup within the ISHS symposia has been a major success story ever since the first world processing tomato congress in Avignon (France) in 1989 and the creation of WPTC in 1998 at Pamplona (Spain).

Our call for papers attracted 60 abstract submissions from 13 different countries. This confirms the keen interest and enthusiasm the scientific community has for research in the fields of processing tomatoes. The ISHS symposium program has been arranged into 6 oral sessions, a poster session and a roundtable to encourage exchanges between researchers, growers and processors.

Full papers for the majority of the oral and poster presentations will be collated in a special issue of Acta Horticulturae which will be available directly from ISHS in a few months.

We would like to thank the presenters, session chairs and members of the Scientific and Organizing Committees and all sponsors for making this event possible and in particular **The Morning Star Company** and the **California Tomato Research Institute** for providing respectively three and one **Adopt a scientist** grants enabling young researchers to get the necessary funding to attend the event and present their work.

Our aim is to stimulate discussion and foster new collaborative ventures to ensure a bright future for the tomato processing industry. We hope that you will find the event both interesting and enjoyable.

The Symposium Convenors
Brenna Aegerter, Zach Bagley and Luca Sandei

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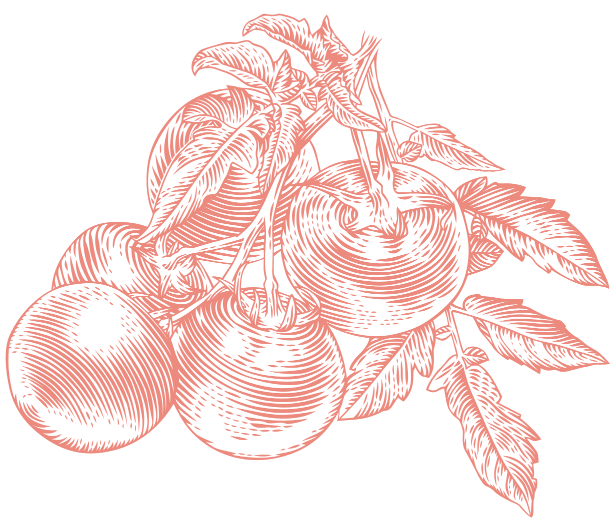

Symposium program

This program is correct at the time of printing but subject to minor changes, depending on speaker availability and unforeseen circumstances. Please refer to notice boards and oral announcements during the event for updated information.

MONDAY 8 JUNE

TIME	TITLE	ABSTRACT #
8:30 to 10:00	Joint with opening session with congress	
10:00	COFFEE BREAK	
10:30 to 12:30	**Session 1: Innovation in tomato processing and product quality** Moderators: Luca Sandei & Montaña Cámara	
30 mn	**Keynote: Assessment of nutritional and functional labels on tomato products according to international standards: WHO Nutrient Profile Model, FDA and EFSA nutrient claims** Presenter: Montaña Cámara	K1
15 mn	Tomato breeding to improve processing tomato nutritional quality Jessica Cooperstone	58
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TIME	TITLE	ABSTRACT #
1:30 to 3:30	**Session 2: Breeding the next generation of processing tomatoes** Moderators: David Francis & Patrick Smith	
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15 mn	Dissecting the genetic basis of forked inflorescence architecture in tomato Presenter: Shai Torgeman	20
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15 mn	Leveraging ethylene-modulated tolerance, Frl resistance gene traits, and endogenous resistance in wild germplasm to mitigate Fusarium stem rot and decline-associated losses in California processing tomato Presenter: Myles Collinson	35
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WEDNESDAY 10 JUNE

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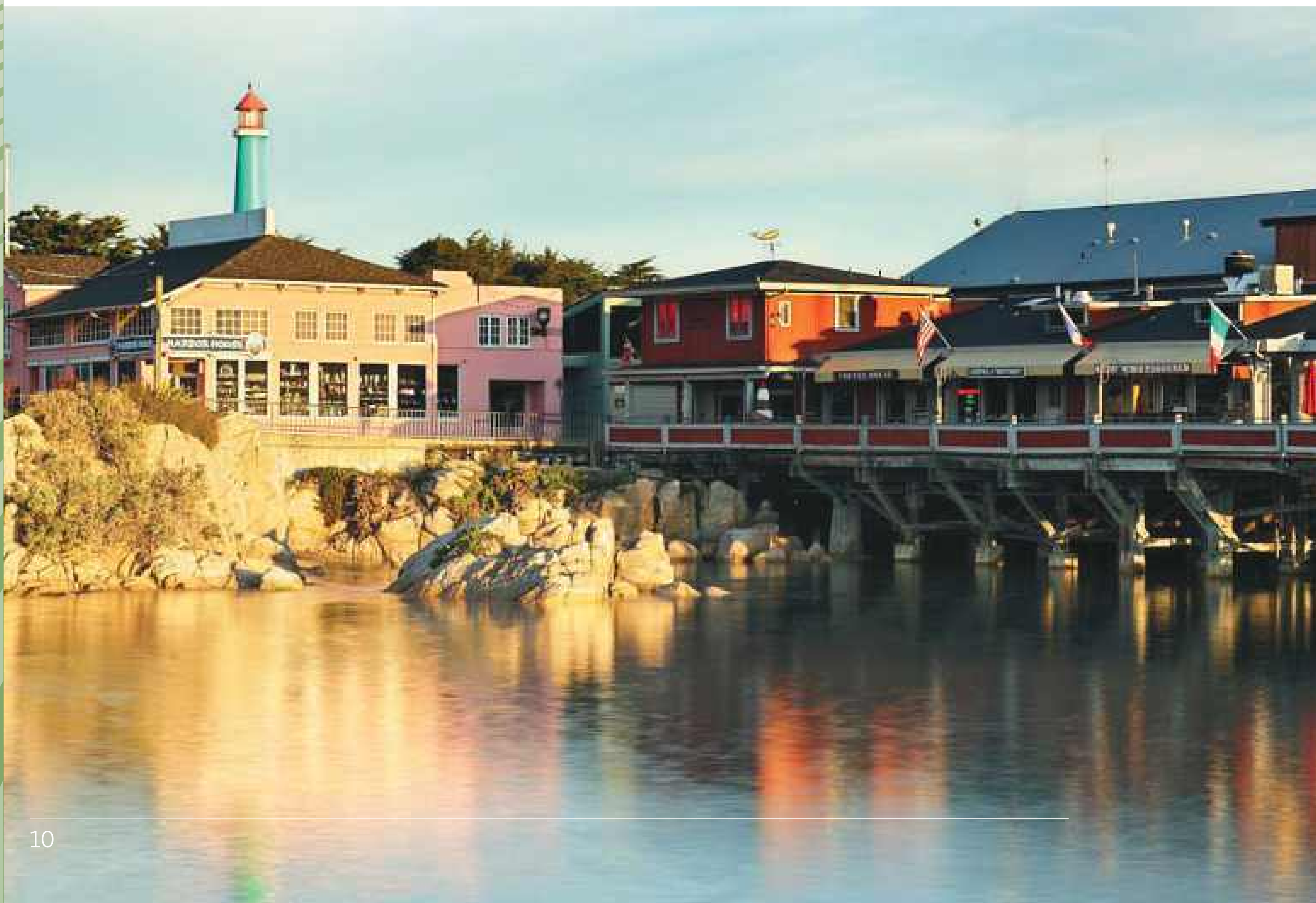
	Symposium conclusions & awards Business meeting of the ISHS Working Group Production of Vegetables for Processing
10:30 to 11:00	Joint closing ceremony
11:00	COFFEE & SNACKS



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Abstracts

K1

Oral

Assessment of nutritional and functional labels on tomato products according to international standards: WHO Nutrient Profile Model, FDA and EFSA nutrient claims

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The urgent need for healthy diets has raised public consciousness, shaping new consumer demands and creating a complex set of expectations. Tomato products offer a rich nutritional profile, including vitamins, minerals, fiber, and bioactive compounds, whose concentrations vary significantly with ripeness and processing. While fresh tomatoes are generally considered healthy, processing affects sensitive nutrients like vitamin C. However, beneficial compounds often persist or even become more bioavailable after processing.

In March 2023, the WHO Regional Office for Europe published its second version of the nutritional profile model (NPM), which sets out nutrient and promotional requirements across different food product categories. Although no category is directly excluded, limits are included for some components, such as sodium, total fats, saturated fats, sweeteners, and sugars (total and added). This report is being used internationally for the development of public policies such as the advertising of food and beverages aimed at children as well as often used for marketing restrictions or front-of-pack labelling. At the same time, current FDA and EU regulations allow nutrient content claims for protein, dietary fiber, vitamins, and minerals as long as they meet specific use conditions. There is a critical need to validate how these international standards reflect the actual nutritional quality of processed foods.

The objective of this work is to assess the nutritional and functional labelling of tomato products within different international standards: the Nutrient Profile Model of WHO in 2023, Nutriscore and others. These would include nutrients to limit (sugar, fat, sodium) versus nutrients and bioactive compounds to encourage (protein, fiber, vitamins, minerals, and carotenoids like lycopene). In addition, both FDA and EFSA nutrient claims will be reviewed in order to quantify the health potential of tomato products.

This work is intended to help tomato industry to develop healthy products and to respond to the consumer demand for food information shown in the front-of-packing to support well informed food choices.

Keywords: Tomato products, plant-based food, nutrient claims, public policies

K2

Oral

The history and future of public plant breeding in the world processing tomato industry

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Zach Bagley, California Tomato Research Institue, Woodland CA, United States of America; zach@tomatonet.org (co-author)

Crop improvement in the public sector, often abbreviated as "public breeding" is credited with 25 to 50 percent of increased crop yields in the past century and a half. International Agricultural Research Centers (IARCs) organized under the Consultative Group for International Agriculture (CGIAR) and North American Universities have played an outsized role in public breeding. In processing tomato, public breeders and engineers collaborated with the private sector to drive innovation leading to the wide-spread use of mechanical harvesting. This dramatic shift in the industry involved changing the architecture of the tomato to a highly branched, compact, and determinate plant favoring "once over" harvest. Changes in fruit shape from round to blocky or ellipsoid fruit with small stem scars both facilitated harvesting without damage and removed the need to hand-core tomatoes in processing facilities. These changes were the result of traits from wild crop relatives, most notably the wild current tomato Solanum pimpinellifolium. In the years since the dramatic human-driven change, yields and soluble solids have risen steadily, though incrementally. Today far more tomato breeding occurs in the private sector than in the public, with large scale agricultural commercialization, strengthened intellectual property laws, and declines in public investment driving the shift. There are four trends that have the potential to limit future progress: 1) world-wide, there are few public programs that evaluate and create new plant genetic resources for the processing tomato industry, leaving major biomes and environmental niches neglected; 2) support for public breeding declined as the role shifted from developer of finished varieties to pre-breeding and trait introgression; 3) private programs have consolidated and focused on short-term value; 4) a bottleneck to moving public discovery into private breeding is the lack of available commercially relevant genetic backgrounds. We argue that there remains a significant role for public breeding. Public breeding programs curate plant genetic resources, drive innovations, and lead to discovery. These innovations and discoveries span predictive selection strategies and encompass the introduction of nearly every disease resistance deployed in tomato. Historically public breeding has played an outsized role in the processing tomato industry. Drawing on our history, defining complimentary areas for collaboration may be the key to future progress. Breeding research coupled to agronomic, harvesting, and processing innovation will likely define the future. It is unlikely that the defining characteristics of public breeding including genetic resource curation, trait discovery, and introgression will be replaced by commercial entities. To accomplish a shared vision, discovery and pre-breeding in the public sector should be accessible to the commercial industry in the form of genetic backgrounds that meet contemporary standards.

K3

Oral

Collaborative research and outreach efforts to address the resurgence of broomrape in California processing tomato

Brad Hanson, Plant Sciences Dept, One Shields Ave, Davis CA 95616, United States of America; bhanson@ucdavis.edu (presenting author)

Branched broomrape (*Phelipanche ramosa*) has re-emerged as a significant threat to California processing tomato production, with detections beginning around 2017 following a decades-long absence. Addressing this highly regulated parasitic weed has required a coordinated response among university, industry, and regulatory partners, integrating outreach and education with the development of short- and long-term research solutions.

Branched broomrape, and to a lesser extent Egyptian broomrape (*Phelipanche aegyptiaca*), have been reported in several southern Sacramento Valley counties but not in the San Joaquin Valley. Accordingly, research and outreach efforts have focused on chemical and nonchemical interventions, along with sanitation programs to reduce the risk of introducing broomrape seed into new fields and regions. Collaborative research has emphasized identifying effective intervention points and translating findings into field-ready solutions.

Chemical control programs, particularly chemigation with rimsulfuron, have shown promise in suppressing broomrape development when applied at carefully timed intervals. Ongoing research aims to refine these programs to maximize efficacy while maintaining crop safety. Additional herbicides and germination stimulants have also demonstrated potential in early-stage evaluations.

Evaluation of current tomato cultivars has not identified meaningful differences in susceptibility to broomrape parasitism. However, screening of advanced breeding lines suggests longer-term opportunities for host tolerance or resistance. Field studies have also identified planting date as a key management factor; later transplanting dates often resulted in little or no parasitism compared to earlier plantings. Adjusting planting timing in infested versus non-infested fields represents a practical, immediately adoptable strategy. Research continues to better define broomrape seed dormancy and germination dynamics under California conditions.

Outreach and prevention efforts to limit seed movement between fields remain critical. Equipment sanitation guidelines, best management practices, and coordinated education efforts have increased awareness and promoted voluntary compliance. Collectively, these collaborative research and outreach efforts form the foundation of an integrated management framework for broomrape in California processing tomato.

Keywords: Branched broomrape, Egyptian broomrape, chemigation, sanitation, quarantine, cultural practice

1

Poster

Real-time photonic diagnostics for tomatoes: From nutrients and stress to fruit sugar

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Mr. Alaa Ben Fatma, Trav. des Brucs, 06560 Valbonne, France; alaa.benfatma@senseen.io (co-author)

Tomato production demands timely decisions, particularly for nutrient management, stress detection, and quality optimization. Yet growers often rely on delayed lab results or visual cues that appear too late to act. This results in inefficiencies, yield loss, and increased input costs, especially in high-value or resource-constrained systems.

Nutriscope™ is a handheld photonic scanner that enables real-time, in-field analysis of key plant and fruit parameters. It uses multispectral light (visible, UV, NIR) to assess redox potential, pH, electrical conductivity, macro- and micronutrients (e.g. N, P, K, Ca, Mg, S), and fruit sugar content (Brix). Measurements are processed through machine learning models calibrated with lab references. Nutriscope has been calibrated for tomato plant health since 2024. Nutrient models were developed during the 2025 field season, and Brix calibration in fruit is underway for release in Q1 2026. The nutrient module will be available to growers in time for early-stage tomato cultivation in protected systems (January–March). The tool integrates with a mobile app and online portal to support diagnostics and time-based tracking without lab dependency.

Nutriscope is already in active use across multiple crops and regions, with over 200 users and more than 500,000 field scans conducted to date. This broad base confirms the platform's usability and robustness in diverse real-world settings. While tomato-specific nutrient deployment begins in early 2026, the system has been calibrated for tomato plant health since 2024 and is already used by growers. Redox potential and the derived Stress Index offer early detection of physiological stress before symptoms appear, and the upcoming Brix and nutrient modules support more precise input decisions and harvest timing. By June 2026, Nutriscope will be fully operational for tomato systems. This contribution presents the platform's readiness and outlines how real-time, pocket-sized diagnostics can shift tomato production from reactive to predictive, enabling faster, science-based decisions in the field.

Keywords: Tomato diagnostics; In-field nutrient analysis; Plant stress detection; Brix measurement; Real-time crop monitoring; Decision support tools; Agroecology; Sustainable tomato production

4

Oral

Whole-genome sequencing of California's branched broomrape uncovers receptor targets and novel chemicals for parasitic weed control

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Parasitic plants in the Orobanchaceae family pose an increasing challenge to global food security, causing billions of dollars in annual crop losses, with millions of hectares infested worldwide. *Phelipanche ramosa* (Branched Broomrape), a devastating parasite of high-value crops, has recently re-emerged as a serious threat to California's processing tomato industry.

We present the first whole-genome sequence of California's Branched Broomrape, revealing dramatic evolutionary changes compared to European populations. American strains have undergone rapid expansion of strigolactone receptor gene families, acquiring 15 receptor copies compared to 4 in European strains. This receptor multiplication correlates directly with increased host range and agricultural virulence, suggesting ongoing adaptation to diverse cropping systems.

These genomic insights enabled development of a high-throughput chemical screening platform targeting the identified receptors. Screening of tens of thousands of small molecules identified novel inhibitors completely suppressing broomrape germination. Our work establishes the first molecular framework for precision control of California's Branched Broomrape, with applications for protecting tomato production and broader implications for sustainable parasitic weed management.

Keywords: *Phelipanche ramosa*, Branched broomrape, Parasitic weeds, Whole-genome sequencing, Chemical screening

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Poster

Overcoming Tomato production under harsh conditions: The case for pat-b parthenocarpy

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Parthenocarpy is a valuable trait for incorporation into tomato lines, allowing fruit set without pollination, thereby overcoming the narrow environmental window normally required for successful fertilization. Adverse environmental factors can include excessive heat, humidity, rain, drought, light, and other other plant-stressing conditions such as disease and insect pressure. This is especially true with increased temperatures associated with climate-change trends. For over a century, many resources have been allocated to improving or overcoming pollen-dependent fruiting. The research on pollen viability has been well-documented but has resulted in only modest production improvements with effective parthenocarpy eluding researchers. I will describe eleven years of tomato breeding efforts to improve the low-to-no fruit set associated with high temperatures during the summer months in the Southern United States. In a controlled greenhouse setting, I exposed generations of crosses to limited water and very high temperatures for extended periods and selected high-performing crosses. The result was a single plant with the pat-b mutation. Pat-b has been incorporated into numerous tomato types via traditional breeding including indeterminate, determinate, cherry, paste, slicer, and dwarf lines of all colors. The trait has been identified as new and several highly inbred lines have been developed, tested, and trialed over the past decade including against other pat-2 lines sourced from Oregon State University. The advantages are very clear in my trials--an increase in production up 80%, hybrid creation, seed cultivation, and seedlessness. It has none of the pleiotropic, negative effects literature has identified with other forms of parthenocarpy, including poor plant structure and fruit quality. Pat-b lines produce the same fruit, fertilized or not. Pat-b may provide a sound base for increased production in all environments, including improved fruit quality, improved processing, extended growing locations, enhanced disease resistance, greenhouse seedless culture, and cost savings.

Keywords: *Solanum lycopersicum* L.; production; parthenocarpy; seedless tomato

6

Poster

Evaluation of recent updates in rootstock technology for processing tomatoes

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For over ten years grafting scions with desirable industry qualities on rootstocks with disease resistance and increased vigor has been practiced commercially in processing tomato crops. The area planted with this technology has been mainly limited to farms known to have problems with difficult soil pathogens such as race three *Fusarium oxysporum lycopersici*. The main limitation for the expansion of this technology is the lack of compensation in yield for the high price of grafted plants. In past comparative field trials using rootstocks available at the time, the increase in yield was insufficient to cover the cost of grafting under normal healthy soil conditions. Recently developed rootstock technology including synthetic polyploid materials have shown much greater yield increases even at one half of the planting density of a normal processing tomato field, essentially changing the ROI equation. In previous studies the average commercial yield increase was around 29% whereas in recent studies the average yield increase was 54% with up to 92% increase in the 2024-2025 season. Furthermore, it was widely accepted that the use of grafts came at the cost of fruit quality sacrifice and an increase in crop cycle length as confirmed in trials conducted in La Consulta, Argentina through the seasons 2016-2020. The preliminary results of ongoing field studies in Argentina and Chile indicate that modern rootstock technology can pay for the added cost of grafting and produce greater profitability than a conventional non-grafted crop, beyond the traditionally sought disease resistance.

Keywords: Plant density; Disease resistance; *solanum lycopersicum*; yield increase; grafting

7

Oral

Advancing global processing tomato resilience through the Lark multiplex genome editing platform

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The global processing tomato industry faces escalating challenges, from aggressive parasitic weeds like broomrape (*Orobanche* spp.) to the logistical pressures of harvest synchronization. To address these threats, we present the Lark proprietary multiplex genome editing platform, a high-efficiency New Breeding Technology (NBT) designed to deliver rapid, precise solutions. This versatile system enables the simultaneous modification of multiple genetic targets, significantly reducing development costs and timelines. Furthermore, these transgene-free edits benefit from a streamlined path to market under recent USDA regulatory exemptions, allowing for the rapid deployment of "on-demand" genetics to ensure a resilient supply chain.

Our pipeline has already produced two breakthrough products with promising results in greenhouse and laboratory testing. The first is a "stealth" root system for broomrape resistance, which mutes the strigolactone chemical signals that the parasite relies on for detection. Without this "wake-up call," broomrape seeds remain dormant, unable to colonize the crop. The second is an Extended Field Holding (EFH) trait, engineered to maintain fruit integrity on the vine for longer periods. This provides growers and processors with a wider, more flexible harvest window, reducing waste and improving operational efficiency. Together, these innovations demonstrate the power of the Lark platform to provide scalable, high-quality solutions for the global tomato market.

Keywords: Multiplex Genome Editing, RNP mediated platform; broomrape resistance, extended field holding

8

Poster

Non-fumigant nematicides for the management of root-knot nematodes in tomatoes in California

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Root-knot nematodes (RKN), *Meloidogyne* spp., are the most important plant-parasitic nematodes affecting vegetable crop production in California. The root-knot nematodes cause characteristic galls on the roots, leading to root deformation. The galled roots are unable to sustain the water and nutrient needs of the plants, leading to yield reduction and predisposing the plants to other secondary pathogens. RKN in tomatoes are normally controlled by planting resistant varieties with Mi-1 gene resistance; however, there has been an increase in incidences of resistance breakdown in tomatoes with Mi gene resistance. Management has primarily relied on the use of pre-plant soil fumigants, such as Telone II (a.i. 1,3-dichloropropene) and metam sodium or metam potassium, which have raised environmental and regulatory concerns. In addition, the new fumigant regulations by the Department of Pesticide Regulations (DPR) have been put in place and due to these regulations, substantial parts of the field or the entire field may not be treated by fumigation because of buffer zone requirements. New nematicides with novel modes of action have emerged from major agricultural chemical companies in the last few years that have shown excellent performance in managing RKN. Fluazaindolizine (Corteva), fluensulfone (Adama), fluopyram (Bayer), and a new developmental Product have shown excellent nematicide properties in the field trials conducted in moderate to high RKN-infested soils. These new chemistries have effective new modes of action, lower mammalian toxicity, and lesser environmental impacts than previous generations of nematicides.

Keywords: Root-knot nematodes, Non-fumigated nematicides, Tomatoes

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Poster

Using seasonal thermal extremes in Ghana to simulate climate change: A field-based study of reproductive, physiological and yield responses in tomato

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Climate change poses a significant threat to open-field tomato production in the tropics, particularly in sub-Saharan Africa. This study used Ghana's dry season as a natural climate-change analogue to evaluate reproductive, physiological, and yield responses of five tomato varieties. The off-season environment, characterized by multiple concurrent stresses (high temperatures, low rainfall, high evapotranspiration rates), led to severe reductions in vegetative growth, biomass accumulation, flower retention, fruit set, and overall yield, with some commercial varieties experiencing near-total crop failure. Significant ($P < 0.05$) genotypic and seasonal differences were observed in pollen performance, highlighting its sensitivity to environmental stresses under field conditions. At the physiological level, carbohydrate dynamics in reproductive tissues were markedly disrupted. Flowers from plants grown under stressful conditions accumulated higher starch levels compared with those grown under non-stressful conditions, while sucrose and glucose concentrations were substantially reduced, leading to sugar limitation. The concurrent increase in starch accumulation and decline in soluble sugars suggests a disruption of normal carbohydrate turnover in reproductive organs. This pattern indicates that specific stress components (most notably high temperatures and heat-induced osmotic stress) may have impaired starch degradation and sugar production, although the individual contributions of co-occurring stresses could not be clearly distinguished under field conditions. Overall, these findings highlight the value of field-based screening for identifying tomato varieties resilient to harsh production environments and provide insight into the physiological mechanisms underlying stress-induced reproductive failure.

Keywords: on-field, tomato, high temperature, sugars, starch, pollen

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Oral

Impact of farming practices on nutrient density of processing tomatoes HM 58841 in northern California

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Understanding how farming practices influence processing tomato nutrient density is critical for improving crop quality, supporting sustainable production, and informing nutrition labeling. In 2024, we established a foundational dataset for Northern California processing tomatoes by evaluating an intermediate processing variety (HM 58841) grown under different sustainable practices (e.g., applied organic matter, cover crops, or combined practices) and conventional farming systems across 18 farms. Quality and nutritional parameters included physicochemical properties (Brix, pH, color, total solids, moisture, and titratable acidity) and key nutrients (total phenol content [TPC], total flavonoid content [TFC], lycopene, ß-carotene, and potassium). Field survey data captured soil organic matter, irrigation method, tillage, crop rotation, and fertilizer to aid interpretation of quality outcomes.

Correlation analysis revealed strong relationships between moisture and total solids ($r = -0.99$), highlighting dilution effects influenced by irrigation management. Lycopene and ß-carotene were positively correlated ($r = 0.63$), consistent with shared biosynthetic regulation responsive to light exposure and plant stress. TPC and TFC showed a moderate correlation ($r = 0.56$), indicating differential regulation of phenolic subclasses associated with soil fertility and nitrogen management. Potassium exhibited a moderate association with total solids ($r = 0.43$), supporting its role in sugar transport and quality development.

Univariate and multivariate analyses (ANOVA, PCA, and PLS-DA) demonstrated that combined cover crops and organic matter management resulted in significantly higher TPC, while applied organic matter alone was associated with higher TFC, potassium, ß-carotene, and total solids. Irrigation, tillage, crop rotation, and fertilizer application further influenced solids, carotenoids, and yield, indicating management-dependent nutrient responses.

Building on these findings, the 2025 harvest focuses on the same variety grown under consistent farming practices across multiple Northern California regions to improve prediction of processing-relevant quality outcomes. This work supports the development of a multi-year, industry-relevant tomato quality database linking farming practices to finished product potential.

Keywords: processing tomato, nutrient density, sustainable farming practices

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Poster

Evaluation of a biodegradable superabsorbent polymer to improve water use efficiency while maintaining yield in California processing tomato production

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Limited water availability and stricter irrigation conditions are major challenges in processing tomato production in California. This study evaluated the effects of a biodegradable superabsorbent polymer (commercial product: EF Polymer) on soil moisture, plant growth, yield, and fruit quality. Field trials were conducted in multiple commercial processing tomato fields, comparing plots with polymer application and untreated control plots. Polymer-treated plots showed improved soil moisture in the root zone. In several fields, yields in polymer-treated plots were equal to or higher than those in control plots, even under reduced irrigation. No significant differences in fruit quality were observed between treatments. These results indicate that biodegradable superabsorbent polymers may be a useful technology to improve water use efficiency while maintaining yield under limited water availability. Further field trials will be conducted for better understanding of the technical and economic benefits.

Keywords: processing tomato, water use efficiency, superabsorbent polymer, irrigation management, soil moisture

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Oral

Controlling in-row weeds with mechanical cultivation and pre-emergent herbicides in processing tomatoes

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A standard herbicide program for processing tomatoes in California is trifluralin or pendimethalin + metolachlor pre-plant incorporated followed by rimsulfuron applied 7 and 14 days after transplanting. Grass specific herbicides are used post emergence as needed. While the preemergent herbicides can be very effective, they require mechanical or sprinkler incorporation. Incorporation before planting is efficient, but often transplanting moves the soil and herbicides, resulting in reduced weed control in the plant row. The result is that hand weeding is often required. Alternatives include automated or robotic cultivators and finger weeders. Trials were conducted to determine if automated weeders or finger weeders improved in-row weed control in processing tomatoes. Robotic cultivators (Kult, Robovator, Farmwise) and a Steketee finger weeder were evaluated in multiple trial locations and planting dates in 2020 - 2025. Pre-emergent herbicides included rimsulfuron, pendimethalin, napropamide, and metribuzin, applied at maximum label rates two weeks after transplanting and then incorporated with the finger weeder. Comparison treatments included standard cultivation with post-plant herbicides and untreated controls. A randomized block design with four reps was used for each trial. Main weed species differed by location, but were dominated by annual broadleaf weeds, including nightshades (*Solanum nigrum, Physalis wrightii*), puncture vine (*Tribulus terrestris*), pigweeds (*Amaranthus sp.*), and lambsquarters (*Chenopodium berlandieri*). The use of robotic cultivators significantly ($p < 0.05$) reduced weed pressure and hand weeding time 30% to 64% compared to untreated controls but were slow as compared to the less expensive finger weeder. Cost savings ranged from $14 - $96 per acre. Post plant applications of rimsulfuron provided 61% - 75% broadleaf weed control at 4 weeks after transplanting, whereas the finger weeder without herbicides provided 15% to 75% control (average 61%). Combining herbicides with the finger weeder generally improved weed control to 84% - 94%. Robotic cultivators reduced plant stand in some trials, however, crop injury from the herbicide sprays or crop damage from the finger weeder was minimal at all locations and not significantly different from the untreated control.

Keywords: automated weeders, robotic weeders, finger weeders, pre-emergent herbicides, herbicide incorporation, rimsulfuron, processing tomatoes

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Oral

A site-specific nitrogen fertilization calculator for drip-irrigated processing tomatoes

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Subsurface drip irrigation has been widely adopted for processing tomato production in California. A project was initiated to develop and validate a nitrogen (N) fertilization budget with site-specific input for fertigated and drip-irrigated processing tomatoes. Nitrogen partitioning in the aboveground biomass was determined in commercial fields. At harvest, the N concentration in the fruit averaged 1.5 g N kg-1, which accounted for 64% of the total N in the aboveground biomass. An N budget, which considered residual soil mineral N, nitrate in the irrigation water and N mineralized from soil organic matter, was calculated and validated in replicated fields trial with three N application rates ranging from 152 to 306 kg ha-1. Yields averaged 135 Mg ha-1 across the two growing seasons of the trials. Nitrogen application rates had no significant effect on yield. However, across both years the total N in the aboveground biomass increased significantly by 0.875 kg kg-1 of additional N, suggesting luxury consumption at higher rates.

The results of this study were incorporated into a simple crop N calculator, which is freely available online at http://geisseler.ucdavis.edu/Crop_N_Calculator.html. The calculator is easy to use and requires few readily available input variables. However, such a simple tool cannot capture all the factors that affect growth and yield of a crop in individual fields. While the assumptions used to calculate the budget provide a margin of safety for commercial producers, it is crucial to monitor the fields during the growing season. Soil nitrate testing and leaf analyses are valuable tools to determine N availability and N status of the crop and allow for in-season adjustments if needed. The results of this study and the calculator allow processing tomato growers in California make informed decisions on site-specific N application rates and optimal time of application.

Keywords: fertigation, online calculator, nitrogen budget

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Oral

Environmentally friendly tomato peeling using ultrasound water bath with citric acid pretreatment: Effects on lycopene yield and peeling efficiency

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Conventional industrial tomato peeling typically utilizes lye (sodium hydroxide) treatments, which present significant environmental concerns due to the generation of high pH wastewater and potential chemical handling hazards. This study investigates an innovative, sustainable alternative by integrating citric acid (CA) pretreatment with ultrasonic water bath technology. The primary objective was to evaluate the synergistic effects of organic acid concentration, temperature, and ultrasonic parameters on peeling efficiency and the preservation of critical bioactive compounds.

Materials and methods involved subjecting fresh tomatoes to varying CA concentrations (0%, 2%, and 4%) within water bath environments maintained at 70°C and 90°C. Subsequent to this pretreatment, samples were processed in an ultrasonic water bath across multiple power levels (40, 60, and 80 W) and frequencies (37 and 80 kHz) for durations of 60, 90, and 120 seconds. The effectiveness of these combined treatments was quantified by measuring peeling yield (percentage of skin removed), lycopene retention through spectrophotometric analysis, and color quality using the a*/b* ratio.

Key results demonstrated that a 2% CA pretreatment at 90°C, followed by specific ultrasonic application, significantly enhanced peeling efficiency compared to standalone ultrasonic or thermal treatments. Optimal processing conditions were identified as 80 kHz frequency at 60 W ultrasonic power for a duration of 90 seconds. Under these precise parameters, the methodology achieved maximum peeling efficiency while maintaining superior color preservation and high lycopene stability. This combined approach offers a safer, more eco-friendly alternative to caustic lye peeling, showcasing substantial potential for integration into large-scale industrial tomato processing lines where sustainable practices are increasingly prioritized.

Keywords: tomato peeling, ultrasound, citric acid, lycopene, sustainability, emerging technologies

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Oral

Using plant smells to detect hidden broomrape in tomato fields

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Branched and Egyptian broomrape (*Phelipanche ramosa* and *P. aegyptiaca*) are highly destructive parasitic weeds in tomato production, remaining largely undetectable belowground until flowering, when irreversible crop damage and widespread seed dispersal occur. Recent detections have been reported in the northern San Joaquin and Sacramento Valleys. To prevent widespread damage to tomato crops, early, field-scale detection methods are urgently needed.

Here, we report results from a two-year investigation using gold-standard laboratory gas chromatography-mass spectrometry (GC-MS) to characterize how tomato volatile organic compound (VOC) emissions change following broomrape parasitization, with the goal of enabling odor-based "sniffer" sensor technologies that can be deployed in production fields for pest screening.

Across controlled greenhouse experiments conducted over two growing seasons, we monitored tomato VOC emissions throughout the course of broomrape infection. While direct detection of broomrape emissions proved impractical due to low parasite biomass, we identified reproducible shifts in the tomato VOC profile induced by parasitization. Multivariate and machine-learning analyses revealed a distinct VOC signature associated with infected plants, detectable as early as three weeks after underground attachment—well before broomrape emergence aboveground. By five weeks post-exposure, classification performance improved substantially, demonstrating strong discrimination between infected and uninfected plants based solely on odor profiles.

These findings establish a temporal framework for early, non-destructive detection of cryptic broomrape infections and provide the chemical foundation necessary for translating laboratory insights into deployable sensing technologies. Building on prior demonstrations of differential mobility spectrometry (DMS)-based sensors for citrus greening disease, this work lays the groundwork for adapting a portable, AI-enabled odor "sniffing" platform to screen tomato fields for broomrape. More broadly, this approach has potential applications for monitoring other tomato pests and diseases, including deployment at points of entry, inspection stations, within-field surveys by growers and regulatory agencies, or for monitoring tomato quality during storage and processing.

Keywords: broomrape, pests, sensors, early warning

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Oral

Bio-based approach for sustainable control of root-knot nematodes

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Plant-infesting nematodes are a major cause of agricultural losses, with current management practices relying heavily on soil fumigants that have substantial ecological and health impacts. Non-fumigant alternatives like Velum Prime (fluopyram) and Vydate L (oxamyl) have shown limited efficacy after transplanting, and nematode resistance is emerging as a challenge. To address these issues, sustainable solutions that actively control plant-infesting nematodes, such as root-knot nematodes, are critical.

This study explores the development of a bio-based delivery system using heat-inactivated yeast as biocarriers for pyrethrum extract. The yeast biocarriers demonstrated a three-fold higher affinity for root-knot nematodes in agar gel diffusion assays. A plant extract was encapsulated in yeast cells using a patented negative pressure-assisted infusion method, with an infusion yield of 24 mg/g and an infusion efficiency of 27%. Bioassays in both water and soil showed that the yeast-encapsulated plant extract exhibited significantly higher nematocidal activity compared to the free extract, primarily due to enhanced stability of the extract and the nematode's affinity for the yeast cells. Additionally, the bio-based composition significantly reduced the number of nematode eggs in the tomato plant roots, with lower phytotoxicity than Vydate.

Furthermore, encapsulating allyl isothiocyanate, a volatile plant-derived extract, in yeast biocarriers reduced phytotoxicity and allowed higher dosages due to controlled release. This research demonstrates the potential of yeast-based biocarriers to overcome the limitations of plant-derived nematocidal extracts, offering a promising approach for developing sustainable pest control solutions in tomato plants.

These findings highlight the ability of bio-based compositions to enhance the efficacy and safety of nematocidal formulations, paving the way for their commercial application in sustainable agriculture.

Keywords: Nematodes, bio-based carriers, plant extract, phytotoxicity, sustainable agriculture

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Poster

Development of a sustainable antifungal system using a synergistic treatment of aqueous olive pomace extract (OPE) and sunlight to control Alternaria infection on tomato plants

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Agricultural byproducts, such as olive pomace, have the potential to develop sustainable and low-cost sources of photoactive antifungal agents that can exert strong synergistic antifungal activity upon exposure to sunlight.

This study was conducted to evaluate the antifungal potential of the crude olive pomace extract (OPE) with sunlight to inhibit Alternaria infection on tomato skins and leaves.

The aqueous OPE was obtained from dried olive pomace using water-based, ultrasound-assisted extraction (UAE; 100W, 42 kHz, 20 min). The minimal inhibitory concentration (MIC) of OPE against Alternaria alternata was determined using a germination tube assay. The synergistic antifungal activity of OPE with sunlight was evaluated on tomato skins and leaves using a plate count assay. An in vivo test was conducted to evaluate the synergistic activities of OPE and sunlight in inhibiting the A. alternata infection on tomato leaves. The spread of the infection on tomato leaves was monitored during 10 days of storage after the combined treatment.

The OPE obtained using water-based UAE exerted strong antifungal potential against *A. alternata* (MIC: 2.0 mg GAE/mL). The combined treatment of OPE and sunlight exerted strong synergisms on tomato skins and leaves and achieved ca. 2.73 and 2.21 log reductions of *A. alternata conidia* within 30 min, respectively. The combined treatment of OPE and sunlight exhibited strong synergism in inhibiting the spread of *A. alternata* infection on tomato leaves. The infected tomato leaves exposed to the combined treatment showed about a 2.4-fold increase in the size of the infection area during 10 days of storage, whereas those treated solely with DW, OPE, or sunlight showed about 18, 21, or 8-fold increases after the storage.

These findings will illustrate the novel application of ag-by products to develop sustainable antifungal agents and synergistic enhancement in their activity upon exposure to sunlight to control plant fungal pathogens.

Keywords: Olive byproduct, plant extract, photodynamic inactivation, antifungal treatment, Alternariosis, tomato plant

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Poster

Microbe-immobilized biochar enhances productivity and stress resilience in climate-smart processing tomato systems

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Biochar adoption in climate-smart agriculture is constrained by variable field performance, frequent increases in soil pH and salinity, and inconsistent microbial responses. We evaluate microbe-immobilized biochar (MIB), in which diverse microbial consortia are pre-established within biochar matrices. We hypothesize that early colonization at the amendment–soil interface can retain biochar's physicochemical benefits while moderating soil chemistry and supporting functional microbial networks.

Across contrasting pedoclimatic zones and two feedstocks (almond-shell, softwood), multi-site trials were used to examine agronomic feasibility. In a replicated processing-tomato field trial on sandy loam (Lodi, California), we compared conventional fertilization (control), biochar alone (5% v/v), and a compost+MIB blend (5% v/v; N-equivalent). During a season with pronounced heat-wave-associated reproductive stress, marketable yield under MIB was 279% higher than the control and 73% higher than biochar alone. Relative to biochar alone, MIB attenuated typical increases in soil pH and electrical conductivity, while improving water-holding capacity, soil organic matter, and cation exchange capacity. Soil properties were measured alongside 16S rRNA gene amplicon sequencing.

Biochar alone reduced bacterial alpha-diversity, whereas MIB increased diversity and shifted community structure, enriching Planctomycetota, Chloroflexi, and Bacteroidota. Functional prediction suggested increased potential for nitrification, carbon degradation, phosphorus cycling, osmoprotectant biosynthesis, and reactive-oxygen-species detoxification, consistent with plausible pathways supporting stress resilience.

At Five Points (clay loam), softwood MIB increased yield by 6% and coincided with elevated nitrification/N-fixation signatures. In Dixon (sandy loam), almond-shell MIB+compost increased hand-harvested yield by 9% over compost alone and by 21% relative to the control. Responses were site-dependent, but the direction of yield and microbiome shifts was broadly consistent across soils and feedstocks. Collectively, these findings support MIB as a scalable climate-smart practice that can stabilize soil chemistry, steer beneficial microbiomes, and improve productivity in processing-tomato systems.

Keywords: Biochar, Microbes, Regenerative Agriculture, Microbial diversity

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Oral

Dissecting the genetic basis of forked inflorescence architecture in tomato

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Wild tomato species represent an underutilized reservoir of allelic diversity for crop improvement. Improving yield remains a central breeding goal, with inflorescence architecture particularly branching and flower number per rachis being a major yield-determining trait. Inflorescence structure in tomato is highly dynamic, varying along the plant axis: while lower nodes often exhibit regular, unbranched inflorescences, later sympodial units may develop forked or compound types. This architectural diversity reflects complex genetic and developmental control of floral meristem maturation.

To explore the genetic basis of forked inflorescences, we developed and analyzed large, recombination-rich backcross inbred line (BIL) populations derived from the green-fruited wild species *Solanum pennellii* accession LA5240, known as the "Lost Accession." This accession displays forked inflorescences that influence flower number and yield potential. It was crossed with two cultivated tomato inbreds differing in growth habit: LEA (a determinate processing background) and TOP (an indeterminate fresh-market, large-fruited background). The LEA and TOP BILs, at the BC2F8 generations, consist of approximately 1,400 and 500 lines, respectively, and were genotyped with ~8,000 SPET markers, enabling high-resolution mapping analysis. In addition, an F2 population was developed from a self-cross of the commercial processing hybrid NB169, one parent of which exhibits an "ultra-forked" inflorescence type. These combined resources provide a unique opportunity to investigate how alleles controlling inflorescence branching persist and function across wild and cultivated genetic backgrounds.

QTL mapping in the LEA BILs revealed a major locus controlling the forked inflorescence phenotype on chromosome 3. Two adjacent MADS-box candidate genes identified within this interval, FRUITFUL2 (FUL2) and ENHANCER OF JOINTLESS2 (EJ2), are both implicated in regulating floral meristem determinacy. Validation using PCR-based genotyping in a segregating F2 population derived from a self-cross of a BIL hybrid carrying the chromosome 3 introgression, along with screening of recombinant BILs within the QTL interval, confirmed that EJ2 shows the strongest association with the forked phenotype, explaining up to 31% of the phenotypic variation. Additional QTLs on chromosomes 4 (TOP BILs) and 8 (processing tomato hybrid NB169) highlight the genetic background-dependent expression of the trait.

Phenotypically, forked inflorescences increased flower number across all populations; however, yield outcomes varied by genetic background. In the LEA BILs, the wild-derived allele caused flower abortion and yield loss, likely due to linkage drag, whereas in the NB169 background, forked plants produced up to 30% higher yield without compromising fruit size or quality.

Together, these findings establish EJ2 as a major regulator of inflorescence branching derived from S. pennellii and reveal additional loci in cultivated tomato that promote branching without causing reproductive abortion. This work highlights the persistence of the forked inflorescence trait across tomato domestication and its potential to enhance yield through targeted breeding in both wild and elite genetic pools. We believe that this genetic resource provides a solid foundation for collaborative research within the Solanaceae community, particularly for investigating the genetic basis of complex and epistatic traits in tomato.

Keywords: Processing tomato; Plant breeding; *Solanum pennellii*; Fork inflorescence; Yield

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Poster

Introducing Fusarium stem rot and decline: A newly described, highly damaging disease of processing tomato caused by *F. noneumartii* and *F. martii*, present in California and Japan

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A recent etiologically ambiguous vine decline outbreak driving major yield losses in California processing tomatoes prompted in-depth analyses of Fusarium solani species complex (FSSC) pathogens of tomatoes. Standard FSSC sequence markers (tef1a, rDNA, rpb2) resolved at least four closely related species causing tomato diseases globally: *F. noneumartii, F. martii, F. falciforme* and *F. solani-melongenae*. Somatic compatibility (SCG) and single nucleotide polymorphism (SNP) analyses connected single *F. noneumartii* (SCG FN-1) and *F. martii* (SCG FM-1) clones, and five *F. falciforme* clones (SCG FF-1 to 5), with vine decline and stem rot symptoms in California. In greenhouse studies, *F. noneumartii* and *F. martii* produced stem lesions (6-162 mm) in 92-100% of plants and canopy decline in 8-94% of plants ($P < 0.05$ vs. mock). *F. falciforme* did not cause vine decline and produced small (≤ 6mm) or no stem lesions, with greater stem rot incidence than the mock for only one (/6) isolates ($P < 0.05$). In full-season field studies, *F. noneumartii and F. martii* both caused canopy collapse (73-93% of plants) and reduced total fruit biomass by 60% compared to negative controls ($P < 0.05$). *F. falciforme* did not cause vine decline and had similar fruit biomass to the control. tef1a sequence comparisons indicate that this is the first report of *F. martii* as a tomato pathogen and connect 2010 foot rot isolates from Japan to FN-1. California *F. falciforme* isolates are conspecific with an isolate putatively representing the foot rot pathogen first described in Australia, which is distinct from clonal *F. falciforme* isolates in Mexico. We propose that the name Fusarium foot rot be used for the minor *F. falciforme*-driven disease and the new name Fusarium stem rot and decline (FRD) be used for the disease caused by *F. noneumartii* and *F. martii*, driving outbreak-level losses in California processing tomatoes.

Keywords: Fusarium foot rot, *F. solani* f. sp. *eumartii*, Fusarium solani species complex, *Solanum lycopersicum*

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Poster

Pre-transplant night chilling impairs shoot growth but promotes root elongation and physiological recovery in tomato seedlings

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In California's Central Valley, early-season chilling stress limits tomato (*Solanum lycopersicum* L.) establishment and yield, as transplanting in early spring often exposes seedlings to cold soils and low night temperatures. This study aimed to evaluate the immediate chilling-induced changes and post-stress recovery response in 35-day-old tomato seedlings exposed to nighttime chilling. Processing tomato seedlings (cv. HM3287) were grown under optimal conditions (23/18 °C, day/night) in a climate-controlled chamber and subjected to 10 consecutive nights of chilling at 5 °C and 12 °C, with non-chilled plants serving as the control (18 °C). Morphological and physiological metrics were assessed immediately after chilling and after 10 days under optimum conditions to evaluate recovery and lasting effects. Chilling led to a significant reduction in leaf area and biomass accumulation. The Dickson Quality Index (DQI) was reduced by 27–39% compared to the control. Chlorophyll levels dropped by 15–20%, which means that the pigment was unstable at lower temperatures, while photosystem II efficiency (Fv/Fm) and leaf relative water content were not significantly affected. After 10 days, seedlings showed partial recovery in growth, but values remained substantially lower than those of the control. Interestingly, chilled seedlings developed longer roots during recovery, indicating altered biomass allocation. The DQI of chilled plantlets improved after 10 days, but it didn't approach control values. Overall, moderate chilling (12 °C) caused less biomass reduction and elicited adaptive responses compared to 5 °C, indicating its potential as a preconditioning strategy to improve transplant quality under early-season conditions. Further research is needed to integrate molecular and biochemical markers and to examine chilling responses at different seedling ages in order to inform when tomato transplants may be most resilient to nighttime cold exposure.

Keywords: tomato, growth, chilling tolerance, seedling quality, stress physiology

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Oral

Genetic dissection and marker-assisted introgression of resistance to resistance-breaking tomato spotted wilt virus in processing tomatoes

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The emergence of resistance-breaking variants of tomato spotted wilt virus (RB-TSWV) has compromised the durability of resistance mediated by the Sw-5b gene in major tomato-producing regions, creating an urgent need for new sources of genetic resistance. In this study, we identified a new source of resistance to RB-TSWV variants in the North Carolina State University tomato breeding program and employed integrated genomic and marker-assisted strategies to transfer this resistance into elite tomato lines with processing-type backgrounds. Using whole-genome resequencing of the resistant line TSW-07 and comparative analysis with 60 tomato accessions, we identified two clusters of unique genetic variants and developed associated DNA markers (NC-TSW10, NC-TSW11). Field evaluation of 21 F4 genotypes in Fresno County, CA, revealed NC-TSW10 as the marker most strongly associated with RB-TSWV resistance. Further haplotype analysis indicated a large TSW-07 introgression linked to NC-TSW10, prompting the development of additional flanking markers to capture the full resistance-associated region. Marker-assisted backcrossing successfully transferred this introgression into processing-type tomato lines carrying Sw-5b/Sw-7 loci, several of which exhibit desirable horticultural traits, including elongated fruit, jointless pedicels, and crimson interior coloration. While greenhouse assays for resistance have been difficult to reproduce, replicated field trials consistently validate the robustness of RB-TSWV resistance derived from the TSW-07 line. These results establish NC-TSW10 and its associated genomic region as valuable breeding targets and demonstrate a viable path toward developing tomato cultivars with stacked, durable resistance to RB-TSWV.

Keywords: RB-TSWV, Marker-Assisted Selection, Processing tomatoes, and integrated genomic

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Oral

Progress and challenges in developing farm equipment phytosanitation methods using quaternary ammonium compounds to prevent the spread of branched broomrape and other pathogens in California processing tomatoes

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The parasitic weed branched broomrape (BB, *Phelipanche ramosa*) is a recently reemerged quarantine pest in California. Validated equipment sanitation programs are being developed to mitigate spread of BB seed within and among tomato production regions; these practices aim to serve the dual purpose of dispersal management for other important soil borne pathogens. Quaternary ammonium compounds (QACs) were known to reduce BB seed viability. We aimed to evaluate QAC efficacy under conditions relevant to tomato farm equipment phytosanitation (exposure durations, commercial formulations, and debris on machines). We established that two of three QACs could completely inhibit BB germination with exposure durations of 1 min at concentrations down to 0.2% w/v. Commercial formulations of mixed QACs at the recommended rate (1% v/v) and 1 min exposure completely inhibited germination of BB, *F. oxysporum* f. sp. *lycopersici* (Fol) spores (Fusarium wilt pathogen), and *Clavibacter michaganensis* cells (bacterial canker pathogen). However, sclerotia of *Athelia rolfsii* (southern blight pathogen) were not affected, even at twice the label concentration. Problematically, in the presence of a 10% w/v soil solution, QAC (Mg4 quat) efficacy was almost entirely lost against BBand 60% reduced against Fol. Low levels of vegetative plant tissue (4% w/v) also reduced QAC efficacy against Fol and BB to 60% or less; fruit had variable inhibition (48-90% against Fol and BB). Mixed soil-dominant and tomato tissue-dominant field debris on trailers had similar effects and required QAC concentrations as high as 8% w/v to recover efficacy for BB. In-situ studies are underway to address these challenges using higher QAC concentrations, increased volume, and delivery via aqueous foam. These results are being used to develop the first science-based phytosanitation methodology to mitigate soil borne pathogen spread in California processing tomato.

Keywords: branched broomrape, Fusarium wilt, bacterial canker, equipment, machine, vehicle, cleaning, sanitation, quaternary ammonium compounds (QACs)

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Oral

Green technology extraction of glycoalkaloids and polyphenols from unripe green tomatoes "industrial wastes"

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In the last years, the extraction of natural bioactive molecules coming from the agri-food wastes has been the goal of many research groups worldwide, both from scientific and economic reasons. In particular, tomato industry has been considered very interesting for this enormous potential, as it produces a massive number of organic wastes at all the stages of the process: from the mechanical harvest of fresh tomatoes in the field, until processing by-product selection in the process, with a negative impact on sustainability in both environmental and economic terms. This study focused on the specific "waste" made by unripe green tomatoes, which are, nevertheless, rich in essential nutrients, including vitamins C, K and B, and rich also in bioactive molecules such as glycoalkaloids and polyphenols. The scientific literature on the extraction of the bioactive compounds involves several conventional solvent extractions together with the latest "green" extraction techniques. Despite the promising potential of some of the proposed methods, waste recovery of the unripe green tomatoes is still limited to lab scale studies.

Our research has been conducted using innovative and eco-sustainable bio-based technologies using exclusively physical treatments, operating at rational temperatures and with the exclusive use of "green solvents" like ethanol. By means of a patented prototype Ultrasound UAE* at semi-industrial pilot plant scale juice extractor, paired with a pilot scale ASE-Extreva** extractor, in a "cascade application", several trials have been conducted in order to identify the best processing settings for extracting the principal bioactive molecules of interest (glycoalkaloids and polyphenols).

The optimal conditions studied include ultrasonic treatments lasting 20 minutes at a temperature of 55 °C, then regarding the accelerated solvent extraction, best condition has been obtained with 15 minutes at 55 °C with EtOH: H_2O mixtures, 50:50 for polyphenols and 70:30 at pH 3.2 for glycoalkaloids extraction. The final complex extraction powder obtained can be used as a substrate to create natural bio-pesticides (exploiting the antimicrobial capacity of the extracted natural glycoalkaloids). Furthermore, these extracted and concentrated molecules can be reused as natural bioactive constituents, used directly as functional food ingredients, as animal feed, and finally, as innovative biomolecules for the pharmaceutical and nutraceutical-functional markets.

Keywords: Green extraction technology; Glycoalkaloids; Polyphenols; unripe green tomatoes

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Poster

Assessing a low-complexity precision irrigation strategy to increase the water productivity of processing tomato crop

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Increasing water scarcity and climate-driven rainfall variability make irrigation scheduling a key practice to sustain yield and quality in spring–summer crops such as processing tomato (*Solanum lycopersicum* L.). While precision agriculture (PA) and Decision Support Systems (DSS) offer solutions to optimize water productivity (WP), their adoption remains limited due to complexity perceived by farmers. An on-farm trial was conducted in 2024 on 'Vulspot' processing tomato cultivar in the Volturno plain (Mondragone, Caserta, Italy). The 3-ha field was initially mapped through Synthetic Soil Image (SYSI) index and later divided into two management systems to compare the farmer's business-as-usual irrigation management (T1) with a sensor- and DSS-guided approach based on digital soil mapping (T2). Transplantation was performed on April 23, after which a weather station and soil-moisture probes were installed to provide weekly irrigation bulletins to the farmer. The crop status was monitored using high-resolution satellite imagery until harvesting (August 6). During a growing season characterized by very limited seasonal rainfall (68 mm) and frequent heat peaks, T2 strategy reduced seasonal irrigation volumes by 10% compared to T1. Remarkably, irrigation and economic WP increased from 50.9 to 60.8 kg m^{-3} and from 6.8 to 8.0 EUR m^{-3}, respectively, under T2, indicating improved efficiency without penalties on total yield (~ 111–119 t ha–1) or yield components compared to T1. Fruit technological quality remained similar (pH ~ 4.5; titratable acidity ~ 0.32 g% citric acid; soluble solids ~ 5.62–5.71 °Brix; dry matter ~ 6.56–6.71 g%). The application of the PA- and DSS-based approach proved environmentally and economically sustainable, amply offsetting the technology costs (< 250 EUR ha–1) which still represent a barrier to adoption by Italian farmers. These results support the on-farm transferability of low-complexity DSS-based precision irrigation strategies in Mediterranean processing tomato cultivation.

Keywords: *Solanum lycopersicum* L., Decision support system, Water saving, Sustainability, Management zones

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Oral

Biostimulant strategies can enhance processing tomato performance

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Processing tomato cultivation is increasingly exposed to the effects of climate change, particularly abiotic stresses such as heat and water stress, which negatively affect yield, quality, and production sustainability. In this context, biostimulants represent an innovative tool to improve resource use efficiency and enhance crop physiological responses. This study evaluated the effectiveness of two commercial biostimulant strategies applied to processing tomato (*Solanum lycopersicum* L.) in a commercial farm located in the Sele Plain (Eboli, Southern Italy) during the 2025 growing season, which was characterized by high temperatures and limited rainfall. The experimental design compared an untreated control with two treatments based on biostimulants containing humified organic matter, rhizosphere microorganisms, plant extracts, and seaweed-derived compounds. Biostimulants were applied through seedling dipping before transplanting, fertigation, and foliar spraying. During the growing season and at harvest, physiological, agronomic, and qualitative parameters were assessed using precision instruments, in order to evaluate the effects of the treatments on plant growth, nutrient use efficiency, and crop productivity. The results highlighted significant differences among treatments. The most effective strategy resulted in an increase in marketable yield of up to +55% compared with the untreated control and an increase in total yield of +48%. The number of fruits per plant increased by +28%, while nitrogen agronomic efficiency (NAE) and fruit water productivity (FWP) increased by +46% and +56%, respectively. The strategy promoted a more balanced vegetative development, with a significant increase in stem diameter and root length (up to +68% compared with the control). Fruit quality parameters (°Brix, pH, color, and pericarp thickness) did not show statistically significant differences among treatments, confirming the stability of technological quality. Overall, the study demonstrates that the targeted application of biostimulants can significantly enhance productivity and resource use efficiency in processing tomato under climate stress conditions.

Keywords: Climate change, Digital Agriculture, Sustainability, Tomato, Innovative fertilizers

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Oral

Geospatial assessment of production potential and optimal seeding windows for processing tomatoes in the Mississippi Delta

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The Mississippi Delta provides favorable conditions for crop production due to its long growing season, typically extending from early March through mid-November; however, high summer temperatures and heat stress can negatively affect tomato flowering and fruit set. The southeastern United States has a long tradition of tomato production, and tomatoes are the most widely grown vegetable crop in Mississippi based on the number of farms. The Mississippi Delta, characterized by fertile alluvial soils, established row-crop infrastructure, and reliable water availability from the Mississippi River Valley alluvial aquifer, represents a promising but underexplored region for specialty crop production.

This study applies a geospatial, data-driven framework to evaluate potential suitability for processing tomato production across the Mississippi Delta by integrating satellite-derived climate indicators, Natural Resources Conservation Service soil survey data, and biodiversity occurrence records from the Global Biodiversity Information Facility Database. Early analyses indicate that spring planting windows may provide favorable thermal conditions for processing tomato establishment and early reproductive development, while potentially reducing exposure to peak pest pressure. Major pests such as tomato fruitworm (*Helicoverpa zea*)—identified as a priority arthropod in the southern region, including Bt-resistant populations—typically reach peak abundance in late summer to early fall, suggesting comparatively lower risk during early-season production windows.

Establishing specialty crop production in a region without an existing processing tomato industry represents a high-risk decision due to uncertainty in climate suitability, soil constraints, and seasonal pest pressure. Geospatial decision-support tools that integrate climate, soil, and biodiversity data can reduce this uncertainty by narrowing site options and identifying planting windows that minimize heat and pest risk prior to field investment. This framework can be extended using machine learning or other predictive modeling approaches to synthesize multi-source spatial data, identify patterns associated with favorable production conditions, and support risk-based planning.

Keywords: Mississippi Delta, risk-based planning, tomato fruitworm, processing tomatoes, climate, geospatial assessment, alluvial soils

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Poster

Solar steam generation with a Fresnel collector for pilot-scale tomato paste production in CTAEX, Spain

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The processing tomato industry is highly heat-intensive, and steam demand for evaporation is a major driver of energy use and associated greenhouse-gas emissions. Solar process heat can partially replace conventional boilers, but industrial deployment is often limited by the need to deliver process-grade steam at stable pressure and flow under variable irradiance.

This work reports the design, integration and pilot testing of a solar steam generation system based on a linear Fresnel collector at CTAEX (National Agri-food Technology Center "Extremadura", Badajoz, Spain). The solar field has 157 m² aperture area and 75 kWth nominal thermal capacity. It was coupled to a Rossi & Catelli pilot tomato concentration plant with a throughput of 500 kg/h of fresh tomatoes. Integration was implemented at the steam header feeding the steam network, enabling solar steam injection without modifications to downstream unit operations. The system was configured to supply steam at 3 bar, 133.5 °C and a target mass flow of 40 kg/h. A test campaign was conducted in August 2025, including continuous monitoring of direct normal irradiance and key steam parameters (pressure, temperature and mass flow) at the header to support performance assessment and energy balance calculations.

Key results demonstrate the technical feasibility of integrating a Fresnel-based solar system into a steam network serving tomato processing operations: during suitable irradiation periods, the system generated and injected steam at the defined setpoints into the header, confirming operational compatibility with pilot-scale tomato concentration activities. The acquired dataset provides the basis to quantify solar fraction, thermal savings relative to conventional steam generation and avoided CO_2 emissions, supporting scale-up and techno-environmental evaluation of solar steam supply as an emerging resource-efficient technology for tomato processing in high-irradiance regions.

Keywords: solar process heat; linear Fresnel; steam generation; tomato processing; evaporation; energy efficiency; decarbonization

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Poster

Influence of the sample preparation method on instrumental color measurement in crushed tomato of the same variety

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Instrumental color measurement in crushed tomato is a commonly used tool to assess the quality and uniformity of raw materials. However, the results may depend significantly on the sample preparation method, especially when variables such as temperature, deaeration, particle size, or the presence of solid fractions (skins and seeds) are modified. The objective of this study was to quantify the effect of two preparation methodologies on color parameters (L*, a*, b*) in tomatoes of the same variety, in order to estimate the comparability of results between pilot plant and laboratory measurements.

Two procedures were evaluated. In Method 1 (pilot plant), the sample was subjected to controlled heating, followed by crushing and separation of skins and seeds; it was then cooled, deaerated, and the color was measured. In Method 2 (laboratory), the sample was crushed directly and color was measured immediately, without heating or separation or deaeration steps. For each sample, L*, a*, and b* values were recorded, and the a*/b* ratio was additionally calculated as a descriptor of relative redness. Differences between methods were analyzed using paired comparisons, considering the same origin and variety, and interpreting the magnitude of variation in both statistical terms and practical relevance.

Keywords: Color measurement, Sample preparation methods, Method comparison, Repeatability and reproducibility, Quality control

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Poster

In-field prediction of optimal harvest time in processing tomato using portable NIR spectroscopy

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Harvest timing is a critical factor determining quality and industrial performance of processing tomato. This study presents the development and validation of a portable near-infrared spectroscopy (NIRS) approach for non-destructive, real-time assessment of tomato quality directly in the field. Tomatoes were sampled from three commercial plots, collecting fruits from 20 plants per plot at different maturity stages. NIR spectra (950–1700 nm) were correlated with reference measurements of soluble solids (°Brix), titratable acidity, lycopene content and firmness. Multivariate regression models showed good predictive performance for °Brix, lycopene and firmness, with cross-validation coefficients (1–VR) above 0.70 and RER values higher than 10, indicating their suitability for quantitative screening purposes. Temporal monitoring revealed a progressive increase in lycopene content and a marked decrease in firmness during ripening, identifying both parameters as robust indicators of optimal harvest time. The proposed methodology enables dynamic quality profiling of the crop and supports objective harvest decision-making, potentially improving processing efficiency and could contribute to reducing energy consumption during tomato paste production.

Keywords: portable NIRS; processing tomato; harvest optimization; non-destructive analysis; lycopene; firmness; precision agriculture

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Poster

Proof of concept for decarbonization of the tomato concentrate industry

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There is major concern regarding the energy transition in the tomato concentrate process in Extremadura, Spain. Hitherto, this industry has been using natural gas as a primary energy source, and consequently the high amount of CO2 emissions and the inherent cost associated are notable drawbacks. In that sense, StomSun project endeavors to propose a solution, concluding in previous results that the integration in the process of Solar Fresnel with latent heat energy storage with Phase Change Materials (PCMs) was the most promising alternative. While the installation of the Solar Fresnel has been completed, the addition of the PCM storage tank in the system was still a challenge. This work brings the detailed integration scheme of the PCM storage tank, describing the industrial processes for charging and discharging operations. For the correct design, it has been crucial to meet the tomato concentrate process conditions, the Solar Fresnel output, and most importantly, the PCM thermo-physical properties. The PCM selected, adipic acid, has shown excellent behavior for long-term utilization and it is characterized by having a phase transition at 151 °C and a storage capacity of 254 kJ kg-1. The main idea behind the integration is to use the storage tank as both a heat exchanger and a steam generator. Consequently, the PCM inside the tank will absorb or release heat to the steam during charging and discharging respectively, thereby extending the use of renewable energy. This study is a further step towards maximizing solar energy, enabling its use during the night and reducing fossil fuel consumption in tomato concentrate production even further.

Keywords: thermal energy storage, Phase Change Materials PCMs, solar collector system, tomato evaporation

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Poster

Using unmanned aerial systems (UAS) to evaluate drought stress tolerance in tomatoes

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With warmer temperatures and more extreme weather events, traditional tomato production areas are experiencing increased heat and drought stress throughout the growing season. A USDA Specialty Crop Research Initiative on breeding tomatoes with improved biotic and abiotic stress now supports efforts by a group of public tomato breeders. For this project, we grew a tomato diversity panel of 106 accessions at the OSU Vegetable Research Farm in 2025 with the objective of identifying germplasm with drought stress tolerance. The diversity panel included wild species (*Solanum pimpinellifolium*, *S. galapagense*), semi-domesticated accessions (*S. lycopersicum* var. *cerasiforme*), and domesticated tomatoes (*S. lycopersicum* var. *lycopersicum*). The panel was grown under dry farm conditions with a second set grown with supplemental irrigation. From May to September, 61 mm of precipitation fell, while evapotranspiration accounted for 988 mm. Observational data was collected on growth habit, plant architecture, first ripe date, and fruit characteristics. A UAS was used to collect multispectral, thermal, and LiDAR data 99 days after transplanting. Multispectral data was used to calculate normalized difference vegetation index (NDVI). Based on NDVI, stress levels were moderate (> 0.60) in the dry farm plots, but accessions showed significant differences for NDVI among irrigation treatments. Leaf temperatures from thermal data also showed significant differences both within and among treatments and were strongly correlated with NDVI data. Some accessions, mainly S. pimpinellifolium and S. l. cerasiforme species, showed relatively little stress in the dry farm treatment and had relatively slight differences in response between treatments, indicating a high degree of tolerance to drought stress. A subset of the diversity panel appears promising to breed for drought tolerance. The subset includes 11 cultivated tomato cultivars as well as 29 S. l. cerasiforme accessions. UAS acquired data provided a quantitative, rapid throughput method to evaluate drought stress in this tomato diversity panel.

Keywords: unmanned aerial vehicle (UAV), abiotic stress tolerance, drought stress, NDVI

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Oral

Proof of concept for decarbonization of the tomato concentrate industry

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Fusarium Stem Rot and Decline (FRD) is an emerging crown/stem rot and canopy decline disease caused by two closely related species, *Fusarium noneumartii* and *F. martii*; the decline component prematurely exposes fruit to sun, leading to high levels of degradation and yield loss. Under FRD pressure, commercial cultivars vary in normalized yield (e.g. H1776: 1.26, HM58841: 1.05) and canopy decline (e.g. H1776 0.96, HM58841: 1.04). Annual screenings of this variation are used to provide cultivar-based management recommendations. Identification of traits associated with improved performance could refine screenings; this combined with identification of resistant wild germplasm could also inform breeding efforts. Two commercially available traits were studied in replicated field trials with *F. noneumartii*: (1) ethylene-modulating extended field holding (EFH) which slows fruit ripening, and (2) single-gene resistance to the closely related crown rot pathogen, *F. oxysporum* f. sp. *radicis lycopersici* (Frl gene; FR cultivars). EFH cultivars had 0.22-fold greater marketable fruit incidence ($P < 0.001$) and 1.62-fold greater total fruit biomass ($P = 0.028$) compared to non-EFH cultivars with similar vine decline levels ($P > 0.05$). FR plants had 42% less stem rot than non-FR plants ($P = 0.031$), although vine decline and fruit impacts were not different ($P = 0.607$-0.872). Wild germplasm screenings have identified seven accessions that putatively appear completely resistant to F. noneumartii (no stem rot or vine decline; $P > 0.934$ vs. non-inoculated controls), including four Solanum habrochaites accessions (LA0361, LA160, LA1721, LA1223). Studies are underway to expand germplasm screening, and to extend cultivar-based management tools to *F. martii*. These studies indicate that ethylene-modulated tolerance and the Frl gene are components of quantitative resistance / tolerance to FRD, which are important to include in screening / breeding efforts. Wild accession studies indicate opportunity to develop cultivars with complete resistance to FRD in the longer term.

Keywords: Fusarium, Processing Tomato, Cultivars, Breeding, Wild germplasm

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Poster

California annual crop susceptibility and rotation risk of *Fusarium noneumartii*—driver of the emergent disease of processing tomatoes, Fusarium stem rot and decline

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Fusarium noneumartii (FN), specifically the clone SCG FN-1 causes Fusarium Stem Rot and Decline (FRD), is an emerging major yield loss-driver of California processing tomatoes. FN-1 also causes canopy decline and tuber rot of potato, and stem rot of hemp, sometimes with severe yield impacts; beyond this, FN-1 host range and impacts on non-tomato crops are not well characterized. Tomato growers need to know which crops can be rotated with tomato without building FN-1 inoculum or incurring losses in rotated crops. In initial greenhouse-based host range studies, FN-1 had the greatest impact on carrots (severe tap root rot 78% of plants), cilantro, potato, and sunflower (stem rot and canopy decline in 80-100% of plants), with up to a 50% reduction in canopy biomass (cilantro; $P < 0.03$ vs. controls). Cryptic hosts that developed stem rot (55-100% of plants) but not canopy symptoms ($P > 0.05$) included garbanzo, hemp, pepper, pumpkin, safflower, and spinach. Potential non-host crops included alfalfa, broccoli, barley, corn, cotton, fava, garlic, melon, onion, parsley, and wheat (no symptoms). In subsequent trials conducted in FN-infested fields all putative hosts evaluated in the warm season (pepper, safflower, sunflower) developed stem rot (30-70% of plants) but symptoms did not develop in any putative host crops evaluated in the cool season (carrot, cilantro); subsequent trials are underway evaluating host status of a wider range of crops over the warm season. These studies, together with tomato-focused crop rotation trials, are being used to develop FN-1 crop rotation guidelines to mitigate losses in California annual cropping systems.

Keywords: Fusarium, Processing tomato, Rotation, Host range, Cover cropping, Cryptic hosts, Plant disease, IPM

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Poster

Multi-trait selection integrating yield components, nutritional quality, and virus response in tomato under tropical field conditions using MGIDI

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Tomato is an important horticultural crop valued for its nutritional compounds, yet breeding programs in tropical environments are challenged by the need to simultaneously improve yield, fruit quality, and resistance to viral diseases. This study evaluated phenotypic diversity among 36 tropical tomato genotypes to identify materials with balanced performance across yield components, nutritional traits, and virus severity. Fruit morphology and virus severity were assessed using an augmented design, while biochemical traits were evaluated in a randomized complete block design with three replications. Multi-trait selection was conducted using the Multi-trait Genotype–Ideotype Distance Index (MGIDI). Principal component analysis explained75.27% of the total variation and, together with factor analysis, organized 11 traits into four biological domains: fruit morphology and yield components (FA1), carotenoid-related quality (FA2), virus severity and physiological response (FA3), and antioxidant metabolism (FA4). MGIDI values ranged from4.50 to 7.96, clearly differentiating genotypes. Eleven genotypes were selected under a 30% selection intensity. Genotype TO026 showed the lowest MGIDI value, combining superior fruit morphology with reduced virus severity. TO025 also exhibited favorable agronomic performance, while TO037, a purple-fruited genotype, contributed strong carotenoid and flavonoid attributes. Integrating yield, nutritional quality, and virus response within an ideotype-based framework effectively identified balanced genotypes adapted to tropical conditions. These materials represent promising parental resources for breeding resilient, nutrient-rich tomato cultivars.

Keywords: carotenoids, factor analysis, MGDI index, plant breeding, virus response

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Poster

Effect of insecticides on incidence of curly top disease caused by beet curly top virus vectored by the Beet leafhopper (*Circulifer tenellus*)

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Beet curly top virus (BCTV) infects tomato plants annually in Central California and can cause substantial economic loss. Beet leafhopper transmits BCTV after minutes of feeding and retains the virus for life. In 2025, the effect of insecticides/insecticide programs on curly top disease (CTD) were evaluated in two studies at University of California West Side Research Extension Center. On 5 Jun, transplants (H1996) were planted. The design was a four-replication randomized complete block with single-bed x 22-m plots. In the efficacy study, two consecutive foliar applications of acetamiprid, afidopyropen, cyantraniliprole, fenpyroximate, flonicamid, sulfoxaflor, zeta-cypermethrin at high label rates made 5- and 7-weeks post-transplant were compared to an untreated control and a transplant treatment cyantraniliprole 197 g/ha with and without a drip injection of thiamethoxam 97 g/ha three-weeks post-transplant. In the insecticide program study, the untreated control, cyantraniliprole transplant treatment with and without the thiamethoxam application were compared to programs including applications made 5- and 7-weeks post-transplanting. At weeks 4, 6 and 8, counts of CTD plants were recorded, and BCTV was confirmed in 9 representative samples by qPCR in Dr. Robert Gilbertson's laboratory. Percentage CTD was calculated, ANOVA performed and Student's t was used for mean separation. In the efficacy study, the cyantraniliprole transplant/thiamethoxam drip-treatment had the lowest CTD incidence numerically. In the insecticide program study, all treatments receiving the cyantraniliprole transplant treatment had statistically similar CTD incidence regardless of the foliar- or drip-applied insecticides that followed. Only treatments receiving cyantraniliprole transplant applications had significantly lower levels of CTD than the untreated control. Eight weeks post-plant, 12% of the untreated plants had CTD with 2% developing by week 4, and 11% by week 6. Under conditions of relatively early CTD-development, cyantraniliprole applied to transplants at the equivalent of 197 g/ha had the lowest disease incidence.

Keywords: virus management, Beet leafhopper (*Circulifer tenellus*), Beet curly top virus (Geminiviridae family, Curtovirus genus), insecticide, processing tomato

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Oral

Exploring causal factors for the yield gap in California processing tomato

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California processing tomato yields have stagnated for nearly a decade. However, consistently high yields are observed on fields planted to tomato for the first time. The causes for this yield gap between tomatoes grown on 'new' and 'old' ground, if known, could provide management targets for increasing tomato yields and input use efficiency. A paired-field approach was used to identify factors consistently differing between "old" fields (in an annual rotation including tomato for more than a decade) and "new" fields (previously in walnut). Three matched field pairs were monitored in Yolo County, California through the 2025 season. All 'new' fields over yielded their paired 'old' field by 10-27%. Chemical, biological, and physical factors were identified which differed consistently between 'old' and 'new' fields. Across sites, 'new' fields had significantly higher potassium (K) than paired 'old' fields, in both soil and leaf samples. Fruit and foliar K deficiency symptoms were evident on two of the 'old' fields. Pathogens present differed among fields, and were dominated by Fusarium diseases and southern blight (*Athelia rolfsii*). Disease pressure was greater in the 'old' fields than in the 'new', but was also present in two of the 'new' fields. A tendency to higher bulk density in the 12-18" depth in the 'old' fields suggested structural degradation around the drip tape (buried 12" deep in the centers of 60" beds). This suggestion was reinforced by soil pits, in which a massive soil structure was observed towards the bed center in 'old' but not 'new' fields, accompanied by a visual suggestion of altered root architecture. Our results suggest that common stresses of growing processing tomato – namely, export of fruit K exceeding import, disease buildup over short rotation times, and structural degradation around the subsurface drip tape—interact with site-specific factors to reduce yields in "old" fields.

Keywords: Yield, nutrition, disease, compaction, tomato

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Poster

Evaluation of integrated management of Fusarium diseases in the Central Valley of California

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Fusarium stem rot and decline (FRD, caused by the pathogens *F. martii* and *F. noneumartii*) is a widespread disease affecting California processing tomatoes. Although cultivars differ in their susceptibility, no true resistance is available and many widely grown cultivars are very susceptible. Given this, there was interest in whether chemical, biological, or nutritional approaches had utility as part of an integrated disease management approach. Multiple field trials were conducted in commercial fields between 2019 and 2025. Pre-plant treatments included a fumigant applied via injection into a sub-surface drip irrigation system and shallowly incorporated poultry manure. In-season treatments applied at planting and during the early season included fungicides, biofungicides, biostimulants, and supplemental potassium (K). Materials evaluated included the fumigant metam potassium (metam-K), fungicides pydiflumetofen and flutriafol, biofungicides containing the beneficial microbes *Trichoderma harzianum* and *Streptomyces*, a biostimulant containing N-fixing microbes *Azotobacter* and *Clostridium*, and biostimulants with active ingredients including thyme oil and potassium phosphite. Not all trials included all materials. During the season, we measured disease incidence and severity with an emphasis on vine decline as the primary disease metric. We measured NDVI, machine-harvested yield, cull rate and fruit quality (soluble solids, pH and color). Efficacy varied by trial and the magnitude of the effect was not always related to the level of disease pressure. Biofungicide and biostimulant products had no effect. The treatments which most consistently resulted in yield improvements were fumigation (significant effect in 7 of 10 trials, with a mean yield increase of 22 Mg/ha) and manure addition (significant yield effect in 2 of 2 trials, with a mean yield increase of 14.6 Mg/ha). Adding manure after fumigation, which was only done in one trial, gave a yield increase of 32 Mg/ha, higher than either treatment separately.

Keywords: Fusarium stem rot and decline, processing tomato, fumigation

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Oral

Activated tomato pomace: Enhancing the by-product valorisation through potential incorporation as a techno-functional food ingredient

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The tomato processing industry generates significant amounts of by-products, particularly tomato pomace. This side stream product is rich in bioactive compounds, although most often being treated as a waste, possessing an environmental risk and economic burden. Direct application of dried tomato pomace is limited due to its low fibre solubility, leading to an incompatibility with the food matrix compounds. The present study demonstrates the pilot-plant production of tomato pomace powder using different pre-treatments – subcritical water treatment, high-pressure homogenization or their combination. Techno-functional properties of the powders such as water-binding and swelling capacities, oil absorption capacity and emulsion stability were determined to evaluate the powders for potential food applications. In addition to dietary fibre composition, microstructural changes were monitored using scanning electron microscopy. Moreover, (poly)phenolic composition was characterized by HPLC-DAD-ESI-MSn. The combined pre-treatment showed both improved techno-functional properties and an enhanced content of naringenin content, being among the major flavonoids of the activated tomato pomace.

Keywords: Tomato pomace; Subcritical water treatment, High-pressure homogenization, Techno-functional properties, (Poly)phenols, Naringenin

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Poster

Effect of spatial variability on yield, soil moisture content and nitrogen balance in a commercial plot of processing tomato

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Spatial variability within agricultural fields influences final crop yield depending on the management practices applied. Information derived from precision agriculture techniques can play a key role in decision-making processes and in adapting irrigation strategies to field heterogeneity. The objective of this study was to analyse the effect of spatial variability in two commercial processing tomato fields on nitrogen balance, soil hydraulic properties, and their impact on final yield and fruit quality. The study was conducted in two commercial fields located at Aldea del Conde farm, in the municipality of Talavera la Real (Badajoz, Spain). Spatial characterization was performed using historical yield maps, soil texture analysis, apparent soil electrical conductivity (ECa), initial and final measurements of selected physicochemical soil properties, soil hydraulic measurements, and spectral index maps (NDVI). To assess spatial variability, soil sampling was conducted at 63 georeferenced points, where initial and final soil nitrogen levels were determined for the growing season. Final yield results (t ha^{-1}) obtained in each management zone were consistent with the delineated zoning and the differentiated treatments applied. The nitrogen balance analysis across the different zones revealed negative nitrogen requirements in several areas and values not exceeding 25 kg ha^{-1} in zones with the highest demand. Initial soil nitrogen levels prior to basal fertilization indicated that approximately 50% of total crop nitrogen uptake (estimated according to Prieto et al., 2014) was already available in a large portion of the field. Crop nitrogen uptake was estimated using NDVI imagery from previous seasons to approximate vegetative development. At the end of the season, soil analyses showed that nearly 20% of total nitrogen inputs remained unused by the crop. Overall, the analysis of spatial variability proved to be a valuable tool for designing site-specific irrigation and fertilization strategies aligned with crop requirements and existing soil nitrogen balance. This work was supported by the ET4DROUGHT project (PID2021-127345OR-C33), funded by the Ministry of Science and Innovation / State Research Agency (10.13039/501100011033) and co-funded by ERDF funds, and by the DigiSPAC project (TED2021-131237B-C22), funded by the Ministry of Science and Innovation / State Research Agency (10.13039/501100011033) and the European Union – Next Generation EU / Recovery, Transformation and Resilience Plan for Spain.

Keywords: Precision agriculture; Apparent electrical conductivity of soil; NVDI; fertilisation.

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Oral

Development of a platform as a tool for automating life cycle analysis supported by low-cost sensors

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Accurate inventory data are essential for conducting reliable Life Cycle Assessments (LCA) in crops such as processing tomatoes; however, farmers and particularly LCA practitioners often encounter difficulties in accurately quantifying several key parameters required to properly account for the different environmental impacts generated by each agricultural operation. Within the TID4AGRO project, Task 4.2 aims to apply digital innovation to obtain the parameters necessary for calculating the life cycle assessment of agricultural products. To achieve this objective, an extensive survey process was carried out, identifying significant data gaps in water consumption, fertilizer use in fertigation systems, and labor time associated with field operations. To address these limitations, three low-cost LoRaWAN-based sensors were developed to enable remote and continuous quantification of these parameters: a water flow meter, a liquid fertilizer volume sensor, and a machinery operating time sensor with implement detection. To improve data acquisition whether manually entered by the producer or automatically recorded by field-installed sensors a digital platform was developed to integrate sensor data directly into the LCA workflow, automatically generating the inventory files required by LCA software. This automation streamlines the data processing required for software input, which would otherwise rely on more exhaustive survey procedures. The system allows users to link each sensor through a unique identification code, enabling automatic data retrieval and updating. This approach enhances the accuracy, traceability, and automation of agricultural LCA inventories, facilitating the integration of digital technologies into environmental assessment frameworks. The system is accessible through a web-based platform (https://acv.dtagro.es/) and enables users to automatically generate impact assessment reports for their fields, along with recommendations for environmental performance improvement.

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Keywords: Life Cycle Assessment (LCA); Precision agriculture, LoRaWAN sensors; Environmental impact assessment; Digitalisation in agriculture

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Poster

Evaluation of alternative chemical approaches to management of Consperse stink bug (*Euschistus conspersus*)

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Extremely high population densities of Consperse stink bug occurred in areas within important tomato production areas in 2024 and 2025 and caused considerable yield loss. To address this issue, trials were initiated at the University of California West Side Research and Extension Center for insecticide efficacy comparisons. Transplants (HM8237) were planted on 2 Jun. An untreated control and commercial standard foliar (dimethoate 467 g/ha, fenpropathrin 241 g, acetamiprid 71 g, lambda cyhalothrin 35 g) were compared to Celite (diatomaceous earth) dust 162 kg/ha, dinotefuron 294 g/ha drip injected, sulfoxaflor 378 g/ha foliar, and isocycloseram 60 g/ha. Foliar materials were tank mixed in the equivalent of 374 L/ha with DyneAmic 0.25 % v/v and were applied on 21 Aug and 5 Sep, except sulfoxaflor, which was only applied on 21 Aug. The experimental design was a four-replication randomized complete block with 23 m x single bed plots. On 28 Aug and 22 Sep, the canopy was shaken and pushed to the side and stink bug densities on one side of the bed x 1.2 m were recorded. On 17 Oct, 2 m of bed were hand-harvested, and a 10 to 12 kg sub-sample was hand sorted into red, green, sunburn, severe rot, and stink bug rot categories and weighed. Percentages of each category were calculated. Untreated plots averaged 21 stink bugs per 1.2 m on 22 Sep and at harvest, 45 % of the fruit in untreated plots had stink bug damage. Analysis of Variance was performed on and Student's t was used for mean separation. All treatments had significantly lower population densities than the untreated control. Plots treated with isocycloseram had the lowest densities (1.8). At harvest, isocycloseram treatment had less stink bug damage (9.8%) than other treatments but was similar the commercial standard (15.4 %).

Keywords: Consperse stink bug (*Euschistus conspersus*), fruit rot, insecticide, processing tomato

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Oral

Toward a high-anthocyanin purple processing tomato

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Anthocyanins are naturally occurring polyphenols associated with protection against cardiovascular disease, certain cancers, and age-related degenerative conditions. Although tomato contains the complete biosynthetic pathway for anthocyanin product, conventional cultivars accumulate negligible levels of anthocyanins in their fruit. In 2008, Butelli et al. reported the generation of transgenic tomatoes with substantially elevated anthocyanin levels in both peel and flesh by co-expressing two transcription factors from snapdragon (Antirrhinum majus)—Delila (Del), encoding a basic helix-loop-helix (bHLH) protein, and Rosea1 (Ros1), encoding an R2R3 MYB protein—each under the control of the fruit-specific E8 promoter (Nature Biotechnol. 26: 1301; doi.org/10.1038/nbt.1506). The Del/Ros1-N event, generated by Agrobacterium-mediated transformation of the cherry tomato cultivar MicroTom, accumulated predominantly delphinidin- and petunidin-based anthocyanins acylated with hydroxycinnamic acids at concentrations averaging 2.83 mg/g fresh weight—comparable to levels found in other purple fruits—while anthocyanins were virtually undetectable in wild-type fruit. The purple trait was expressed uniformly through both peel and flesh in all introgressed lines, distinguishing these varieties from conventionally bred purple tomatoes (e.g. Indigo Rose, Cherokee Purple), in which anthocyanin accumulation is limited to the fruit skin. Molecular characterization across breeding generations confirmed stable inheritance of the single T-DNA insert and consistent expression of the purple fruit phenotype in all genetic backgrounds. Compositional analyses conducted per OECD guidelines demonstrated substantial equivalence to conventional counterparts for proximates, vitamins, minerals, and carotenoids, with the intended exception of elevated anthocyanins and chlorogenic acid. The Del/Ros1-N event has now received regulatory clearances for environmental release food use in the United States (USDA 2022; FDA 2023), Canada (Health Canada and CFIA 2025), and Australia (OGTR and FSANZ 2025). Norfolk Plant Sciences, and its commercial subsidiary, Norfolk Healthy Produce (NHP), have since developed and commercialized fresh market varieties of The Purple Tomato™. To extend the trait into the processing sector, NHP has partnered with Orsetti Seed Company to express the trait in elite processing backgrounds. These lines are currently under field evaluation in California. This work demonstrates the pathway from proof of concept to a commercially viable high-anthocyanin processing tomato, offering consumers a novel dietary source of anthocyanins through one of the world's most widely consumed crops.

Keywords: Anthocyanins, breeding, health

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Poster

Life cycle assessment of processing tomato production in Extremadura-Alentejo

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Life Cycle Assessment (LCA) is an environmental assessment methodology standardised under the ISO 14040 series of standards. ISO 14040 defines LCA as “a technique for assessing the environmental aspects and potential impacts associated with a product, by compiling an inventory of relevant inputs and outputs of a system, evaluating the potential environmental impacts associated with those inputs and outputs, and interpreting the results of the inventory and impact assessment phases in relation to the objectives of the study.” ISO 14044 further specifies the requirements and guidelines for conducting an LCA. The objective of this study is to develop a reliable and validated tool to objectively assess the environmental impact of improvements implemented in industrial tomato farms, particularly from the perspective of greenhouse gas balance. The life cycle assessment was conducted using SimaPro software (version 9.6), incorporating the different processes that constitute the crop production cycle, including the irrigation system, fertilisers, plant protection products, crop management practices, and permanent structures. These processes were modelled based on data collected through surveys conducted with selected processing tomato producers in Extremadura (Spain) and Alentejo (Portugal) regions. The results of the LCA indicate that fertilisers represent the largest contribution across most of the calculated impact categories, except for land and water use, where crop management accounts for nearly all impacts, and freshwater ecotoxicity, where pesticides contribute the highest share. Regarding the carbon footprint, the value obtained is relatively low compared with other LCA studies of tomatoes grown in both greenhouse and open-field systems reported in the literature. Fertilisers account for 73% of total emissions within this impact category, while crop management contributes 17%. The remaining contributions arise from the irrigation system and plant protection products, with polyethene use and pesticides being the primary emission sources within those components, respectively.

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Keywords: LCA, digitisation, Agricultural sustainability, TID4AGRO; Greenhouse gas emissions; Fertilizer emissions

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Poster

Assessment of stability of tomato lines

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Six tomato (*Solanum lycopersicum* L.) genotypes, consisting of five industrial inbred lines and a standard variety (Heinz 1015), were tested for several fruit morphological traits (average fruit weight, pH, total soluble solids and dry matter content) in a multienvironment experiment in three environments – Pazardzhik (Bulgaria), Požega (Serbia) and Smederevska Palanka (Serbia). The aim was to evaluate the performance of each genotype at different locations and determine the contributions to phenotypic variation and the degree of genotype×environment interaction, as well as significant differences from the standard variety and between the tested inbred lines, test the correlation coefficients between the observed traits and select the best genotype for further breeding studies. All observed trait values differed significantly among the tested genotypes. The highest average fruit weight and dry matter content were measured in the Pazardžik area, while the highest content of total soluble matter was measured in the Smederevska Palanka and Požega areas. A significant negative correlation (r = -0.82) was found between dry matter content and pH value. Two of the tested genotypes were recommended for inclusion in future breeding studies. Of all the observed genotypes, genotype G5 had significantly higher weight compared to standard cultivar, Heinz 1015 while biochemical properties of this cultivar's fruits shown no significant difference to standard cultivar. Production results which genotype G5 achieved on different environments show a degree of variation, so further assessment of genotype G5's stability would be recommended for further studies. If proven stable, this genotype could be registered as a new cultivar. Apart from G5, genotypes G3 and G4 shown nonsignificant differences to standard cultivar in its biochemical fruit properties, so it would be recommended to also include this genotype in further studies.

Keywords: Breeding, sustainability, industrial tomato, multi-environmental trial

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Poster

Evaluation of marketable quality and bioactive characteristics of six processing tomato cultivars organically grown up in northern Italy district area. The “BioTomQual” SSICA Project

Evaluation of marketable quality and bioactive characteristics of six processing tomato cultivars organically grown up in northern Italy district area. The “BioTomQual” SSICA Project

Processing Tomato (*Solanum lycopersicum* L.) represents one of the most important agricultural materials in Italy and an important dietary source of bioactive compounds with recognized health benefits. Certainly, increasingly consumer awareness regarding the strict correlation between nutrition and health, and environmental sustainability, has been stimulating growing interest in the research on organically processed tomato cultivars. This study has been aimed to characterize organic processed tomatoes in order to verify quality parameters and bioactive compound content, with particular attention to the mains: lycopene, total polyphenols and ascorbic acid. A three-year's experimental trial (2022–2024) has been conducted on six organic tomato cultivars, supplied by some Italian producer's associations and processed with semi-industrial scale SSICA plants. Fresh tomatoes have been showed wide variability among cultivars and years, with soluble solids ranging from approximately 4.5 to 7.5 °Brix, pH values between 4.2 and 4.6, and marked differences in sugar–acid balance and colour parameters, all of which are critical for processing suitability. Processing led to standardized pH and soluble solids values compliant with Italian regulations for tomato products. In order to assess the values of bioactive compounds for each cultivar, statistical analysis has been performed using non-parametric Kruskal–Wallis test, followed by post hoc tests to identify significant differences ($p < 0.05$). The content of bioactive compounds in fresh tomatoes and in tomato puree has been valued by averaging all measurements collected over three years for each individual cultivar. Based on this approach, significant differences have been found in the average lycopene content among the raw cultivar, while no significant differences have been observed in ascorbic acid and total polyphenol content over the three years of experimentation. In tomato puree, instead, significant differences among the cultivar have been observed in both the average lycopene and ascorbic acid content, whereas no significant differences detected in the average total polyphenol content over the three years of experimentation. Overall, the results have been demonstrated that cultivar selection influence the nutritional profile of fresh organic tomatoes and of tomato puree, supporting its role as a valuable processed product within sustainable and health-oriented food systems.

Keywords: Organic farming, processing tomato cultivars, bioactive molecules, quality

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Oral

Yield performance of processing tomato cultivars in fields with a history of Fusarium stem rot and decline

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In 2024, we collaborated with a California seed dealer to place processing tomato cultivar trials in grower fields with a history of Fusarium stem rot and decline (FRD) caused by *Fusarium noneumartii* and/or *Fusarium martii* (Fusarium solani species complex). Cultivars selected for this study were either widely planted or promising early commercial cultivars and included a highly tolerant cultivar and highly susceptible cultivar identified from previous trials. Fields were in the southern Sacramento Valley and northern San Joaquin Valley. At each field location, the same group of 24 cultivars were planted using standard grower practices (mechanical transplanting, sub-surface drip irrigation and typical fertilization and pest management practices). Plots were a single plant row on 1.5-m centered beds and measured 21 to 26 m in length, with three replicate blocks. During the season, diseased plants were sampled to determine which soilborne diseases were present. In trials where disease developed, we determined the pathogens present and evaluated the number of plants in each plot that exhibited advanced decline (dead or nearly dead) in the weeks leading up to harvest. Plots were machine-harvested using the growers' harvesters and crew. Data on advanced vine decline and yield were analyzed using analysis of variance and correlation analysis. Trials without disease or with abiotic-induced vine decline were excluded from analysis; six trials had FRD-associated vine decline and were included. Many of the trials also had other soil-borne diseases, most commonly southern blight (*Sclerotium rolfsii*) for which we believe there is no resistance or tolerance in current commercial cultivars. FRD-associated vine decline incidence varied between trials with trial mean rates of advanced vine decline ranging from 4 to 32 percent. Trial mean yields ranged from 82 to 152 tons per hectare. Cultivar means (averaged across all six trials) ranged from 98 to 135 tons per hectare. There was a significant statistical interaction ($P = 0.0075$) between location and cultivar (cultivar performance rankings shifted slightly with location), precluding a combined analysis of all locations. At five of the six locations, vine decline and yield varied significantly between cultivars ($P < 0.05$). We will show the association between vine decline and yield, and how the degree of association varies with the level of disease pressure from FRD at each location.

Keywords: Disease resistance; disease tolerance

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Oral

Systems-wide approaches to improve processing quality and nutritional value of open-field tomatoes

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Tomato (*Solanum lycopersicum* L.) processing performance depends on fruit composition, enzymatic activity, and cultivar-specific traits that determine yield, viscosity, color stability, nutrient retention, and shelf life in sauces, pastes, and packaged products. Critical parameters, such as soluble solids, titratable acidity, lycopene concentration, and structural integrity, govern extraction efficiency, thermal stability, and final product quality. Effective optimization, therefore, requires coordinated management of genetic, physiological, and postharvest factors for both open-field and greenhouse-grown tomatoes.

Our interdisciplinary research integrates genomics-assisted breeding, physiological evaluation, and processing-oriented enzyme characterization to develop germplasm combining heat tolerance and improved water-use efficiency with superior quality retention. Our past studies critically focused on controlling enzymatic degradation during fresh-cut handling and industrial processing of both open-field and greenhouse-grown tomatoes. Polyphenol oxidase (PPO) and peroxidase (POD) were identified as primary drivers of browning and oxidative quality loss. Thermal inactivation kinetics revealed that POD is significantly more heat-resistant than PPO, indicating that conventional pasteurization may not fully inactivate oxidative enzymes. These results highlighted the need for optimized thermal regimes and complementary non-thermal strategies customized to enzyme-specific stability. Cultivar-based mitigation strategies were also examined. Varieties enriched in endogenous volatiles such as ß-damascenone and d-limonene reduced PPO activity by approximately 50%, demonstrating the feasibility of clean-label metabolic approaches to preserve color and limit browning.

Preharvest production systems further influenced downstream processing. Net-house vs open-field cultivation produced genotype-dependent differences in enzyme activity, carotenoid and phenolic retention, dietary fiber composition, and functional properties. Spectral light management (blue and UV-B) enhanced firmness, antioxidant accumulation, and carotenoid profiles; blue light increased the cis-to-trans lycopene ratio, improving bioavailability and color stability. Collectively, this processing-informed framework improves thermal stability, reduces oxidative losses, enhances nutrient retention, and strengthens supply chain resilience.

This research was partially supported by USDA-NIFA-2024-51181-43464 and USDA-NIFA-AFRI 2023-67013-39616 through the Vegetable and Fruit Improvement Center and the Institute for Advancing Health Through Agriculture at Texas A&M University.

Keywords: Pre- and post-harvest management; Phytochemical stability; Quality retention; Enzymatic control; Thermal and non-thermal interventions, Open-field and Greenhouse

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Poster

Effect of transplanting window on *tuta absoluta* infestation dynamics, yield, and soluble solids in commercial dry-season processing tomato production in northern Nigeria

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Dry-season processing tomato production in tropical regions is increasingly constrained by climatic variability and outbreaks of the invasive pest *Tuta absoluta*. While chemical control remains the dominant management strategy, regulatory pressures and resistance development necessitate agronomic approaches that reduce crop vulnerability. This study evaluated the influence of transplanting windows on infestation timing, yield, and fruit soluble solids under commercial production conditions in northern Nigeria.

Field data were collected during the 2024–2025 dry season across multiple commercial blocks. Three transplanting windows were defined: early (5–21 November), mid (23 November–7 December), and late (9–19 December). Marketable yield (MT ha^{-1}) and average fruit soluble solids (°Brix) were recorded at harvest. *Tuta absoluta* infestation timing was categorized according to crop phenological stage (bloom, fruit set, or post-first red fruit). Data were analyzed using analysis of variance to assess differences among transplanting windows and infestation categories.

Transplanting windows significantly affected yield ($p < 0.001$). Early transplanting achieved the highest mean yield (42.8 MT ha^{-1}), while late transplanting resulted in severe reductions (7.5 MT ha^{-1}). Infestation occurring at bloom was associated with the greatest yield losses (12.6 MT ha^{-1}), whereas infestations after first red fruit had limited impact (45.2 MT ha^{-1}). Soluble solids (°Brix) were comparatively stable across transplanting windows but showed moderate variation associated with genotype and stress exposure. Spatial observations indicated earlier infestation onset and reduced yield in field-edge zones.

These findings demonstrate that transplanting window functions as a practical agronomic lever influencing pest exposure and yield stability. Adjusting planting schedules to avoid peak pest pressure represents a climate-adaptive management strategy for processing tomato systems facing increasing biotic stress.

Keywords: Processing tomato; *Tuta absoluta*; transplanting window; pest dynamics; yield stability; soluble solids; agronomic management; dry-season production

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Poster

Research activities developed by CTAEX with Producer Organisations (OPFH) through Operational Programmes to improve sustainability in the processing tomato sector

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The processing tomato sector in Extremadura (Spain) is strongly structured around Fruit and Vegetable Producer Organisations (OPFH), which implement operational programmes within the framework of the Common Agricultural Policy to improve the competitiveness and sustainability of agricultural production. Within these programmes, research and innovation activities play a key role in supporting farmers in the adoption of more efficient and environmentally sustainable production practices.

In this context, the National Agrifood Technology Centre of Extremadura (CTAEX) has collaborated with several OPFH to design and implement applied research activities focused on improving the sustainability of processing tomato production systems. These initiatives include soil characterization, foliar analysis, fruit quality assessment and agronomic data processing using diagnostic tools and precision agriculture approaches. The integration of these methodologies enables the generation of tailored fertilization recommendations and improved management strategies for growers.

The results obtained show that the use of agronomic diagnostic tools allows the identification of nutritional imbalances and the optimization of fertilizer management, contributing to reduced input use, lower environmental impact and improved crop performance. Moreover, the collaboration between producer organisations and research centres enhances knowledge transfer to farmers and facilitates the implementation of innovative practices in the sector.

This cooperative model demonstrates the relevance of operational programmes as a mechanism to promote applied research and technological transfer, strengthening the sustainability and competitiveness of the processing tomato sector.

Keywords: Processing tomato, Nutrient management, Agronomic diagnostics, Producer Organisations (OPFH), Sustainable agriculture

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Poster

Characterization of transcriptomic response of branched broomrape infection and engineering resistance to branched broomrape in tomato

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Broomrapes are parasitic plants in the Orobanchaceae family which attach to the roots of host plants and siphon the host's resources for survival. *Phelipanche ramosa* (branched broomrape)is a major agricultural weed, reducing crop yields worldwide. With reported yield losses up to 70% in tomato, *P. ramosa* is a critical threat to California's tomato industry, which produces 95% of processing tomatoes in the USA. P. ramosa is difficult to control through management techniques due to a primarily underground and rapid life cycle and seed persistence in the soil. Therefore, developing host resistance to broomrape infection is critical. The broomrape life cycle begins with seed germination upon the detection of host root exudates. Upon contact with the host root, the broomrape seedling penetrates the root and forms a vascular connection to acquire nutrients and water from the host. While resistance mechanisms that prevent host detection by *P. ramosa* have been reported, resistance mechanisms after host detection and attachment are unknown. We identified a core group of genes that are transcriptionally up-regulated in multiple processing tomato varieties in response to P. ramosa infection and hypothesized that some may be susceptibility genes involved in facilitating P. ramosa infection. To test whether the loss of function of these genes could block attachment, we designed a CRISPR/Cas9 screen editing 100 candidate genes and tested these for resistance in tomato using "hairy root" Rhizobium rhizogenes transformation. Thus far in this project, we have identified mutations in multiple genes that cause increased resistance relative to the GFP reporter control.

Keywords: Broomrape, Parasitic plant, Tomato, Roots, Gene editing, Pathogen resistance

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Oral

Tomato breeding to improve processing tomato nutritional quality

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Epidemiological studies have noted an association between tomato consumption and decreased risk for a variety of chronic conditions, including cardiovascular disease and cancers. This relationship has held up in clinical trials, where tomato product interventions have been shown to reduce low-density lipoprotein (i.e., the "bad" cholesterol) oxidation, positively impact markers of oxidative stress/damage, inflammation, and endothelial function. Considerable attention regarding the health benefits of tomato has been paid to lycopene (the pigment providing their red color), though studies have found tomato interventions to be more efficacious than lycopene alone, suggesting other phytochemicals within the fruit also play a role. Here, we will present a body of work investigating tomato steroidal alkaloids as a putative bioactive compound from tomato. We have developed methods to enable steroidal alkaloid analysis via liquid chromatography, mass spectrometry, and screened large populations of wild and cultivated tomatoes to understand natural variation. We have conducted genome wide association studies and identified quantitative trait loci responsible for steroidal alkaloid accumulation. Tomato breeding has also been used to develop near isogenic tomatoes high in steroidal alkaloids, which are being administered in both animal studies testing bioactivity and sensory studies to understand taste implications. A goal of our work is to develop tomatoes with enhanced nutritional qualities that have well founded scientific studies to back justification for impact.

Keywords: tomato, nutrition, breeding, health, steroidal alkaloids, lycopene

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Poster

Unlocking shelf stability in tomato products: Metabolomic drivers of quality and resistance to spoilage

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Tomato (*Solanum lycopersicum*) is one of the most widely consumed and economically important crops worldwide. Although fresh consumption is encouraged, nearly 85%–90% of U.S. tomato production is directed toward processing. Although processed tomato products generally have an extended shelf life, spoilage can still occur, with canned products having the longest shelf life, followed by products packaged in oxygen-permeable cartons, and not-from-concentrate products having the shortest shelf life. Spoilage is primarily associated with the growth of heat-resistant and acid-tolerant microorganisms, including *Bacillus coagulans*, *Clostridium* spp., and *Zygosaccharomyces bailii*, as well as molds such as *Botrytis cinerea*. The proliferation of these spoilage organisms can be significantly suppressed at lower pH (<4.2) and by anti-spoilage compounds. Tomatoes are naturally rich in organic acids (e.g., malic and citric acids), amino acids (glutamic and aspartic acids), polyphenols (including chlorogenic, caffeic, and p-coumaric acids), volatile organic compounds (VOCs), and other bioactive secondary metabolites. These include constitutive phytoanticipins such as α-tomatine and inducible phytoalexins, such as rishitin, lubimin, solavetivone, and phytuberin, all of which contribute to fruit quality and antimicrobial defense. Importantly, the accumulation of these metabolites is highly influenced by environmental stressors and varies significantly among genotypes. Therefore, our study focused on quantifying tomato compounds that are important for maintaining pH stability and providing anti-spoilage activity in newly developed tomato processing varieties from our ongoing USDA-SCRI project. This was achieved using liquid chromatography (LC), LC–mass spectrometry (LC–MS), gas chromatography–mass spectrometry (GC–MS), and two-dimensional GC–MS. Interestingly, the VOCs in our developed tomato breeding lines, including aldehydes such as hexanal and (E)-2-hexenal, alcohols such as 1-hexanol and (Z)-3-hexen-1-ol, terpenoids including linalool and ß-caryophyllene, and ketones such as 6-methyl-5-hepten-2-one, exhibit antimicrobial activity against spoilage microorganisms, and are vital for consumer acceptance. In addition, the higher levels of polyphenols and key amino acids, including glutamate and branched-chain amino acids essential for volatile synthesis, along with estimated α-tomatine and rishitin, could be instrumental in improving storability and reducing spoilage concerns. The outcomes of this detailed metabolic analysis are being integrated into marker-assisted breeding programs, ultimately enhancing both the nutritional quality and inherent antimicrobial properties of tomato fruits destined for processed products. Such improvements are expected to increase the stability of processed tomato products, thereby reducing spoilage and ensuring higher quality for consumers. This work was primarily supported by USDA-NIFA-2024-51181-43464 and partially supported by USDA-NIFA-AFRI 2023-67013-39616 through the Vegetable and Fruit Improvement Center and the Institute for Advancing Health Through Agriculture of Texas A&M University.

Keywords: Anti-spoilage compounds, Extended shelf-life, Strengthen natural defense, Phytoalexins, Phyto-anticipins

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Oral

Variation in health-promoting compounds in tomato products: Implications for processing, packaging, and pricing strategies

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Commercially available processed tomato-based foods are widely marketed as natural and nutritious products. However, these products differ in their processing intensity, packaging format, pricing, and nutritional claims, which in turn shape consumer perceptions. The differences in processing and packaging influence overall quality, bioactive composition, and potential health benefits. Therefore, the present study focused on comprehensively evaluating the bioactive abundances in commercially available tomato products across major retail categories, including processing intensity (processed and ultra-processed), concentration status (from concentrate, FC, and NFC, and different packaging formats (glass containers, plastic bottles, cans, and cartons). The study further related product composition and overall quality to market-based attributes, such as price and nutritional claims. The study targeted seven metabolite classes, including free amino acids, polyphenols, carotenoids, ascorbic acid, organic acids, sugars, and volatile organic compounds (VOCs). The results indicated that the amino-acid profile was remarkably influenced by processing intensity, since ultra-processed juices had significantly ($p<0.05$) lower free amino acids compared to minimally processed tomato juice. Specifically, glutamic acid, γ-aminobutyric acid (GABA), and phenylalanine were identified as the predominant amino acids. FC juices had a lower concentration of volatile compounds as compared to NFC juices, possibly due to processing-related loss of VOC abundance. The heat and light-sensitive compounds, such as ascorbic acid and carotenoids, were also significantly ($p<0.05$) affected by processing category and packaging format. This integrated study improves our understanding of the relationship between processing intensity, packaging system, product claims, price, and nutritional quality and identifies how market positioning and processing conditions may influence the retention of health-promoting compounds and overall product quality. This work was partially supported by USDA-NIFA-2024-51181-43464, USDA-NIFA-AFRI 2023-67013-39616 through the Vegetable and Fruit Improvement Centre and the Institute for Advancing Health Through Agriculture of Texas A&M University.

Keywords: Commercial tomato juices, Price, Nutritional claims, Packaging, Processing, Bioactive compounds

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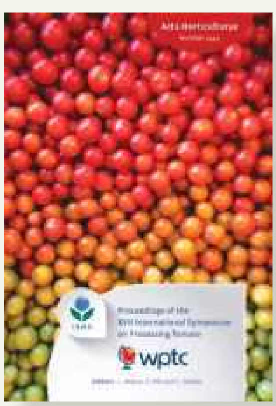
- **Acta Horticulturae:** a series of scientific technical publications, mainly the proceedings of ISHS Symposia and the ISHS International Horticultural Congress. All articles (over 42,000) are available online on a paid basis. The entire Acta Horticulturae library is available online and services the needs of thousands of researchers worldwide who use the www.actahort.org site.
- **Chronica Horticulturae:** a quarterly publication sent to ISHS members and other subscribers. Unlike a scientific journal, it contains horticultural articles of interest to a broad audience of ISHS members and other professionals in science and industry. The full text of all issues is available for free download online.
- **Scripta Horticulturae:** a series of works devoted to specific horticultural issues such as position papers, crop or technology monographs, and special workshops or conferences. The full text of all articles since 1961 is available online on a paid basis.

ISHS membership is open to all interested researchers, educators, students and horticultural industry professionals.



Proceedings of the 17th International Symposium on Processing Tomato

The proceedings of the 17th International Symposium on Processing Tomato held in Budapest in June 2024 can be purchased at https://ishs.org/ishs-book/1445/

The full articles of the research presented during the **18th International Symposium on Processing Tomato** will be published in a special issue of Acta Horticulturae, available in a few months from ISHS.

ISHS 18th ISHS Symposium on Processing Tomato

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