GoodBerry

www.goodberry-eu.eu

Improving the stability of high-quality traits of berry in different environments and cultivation systems for the benefit of European farmers and consumers

GoodBerry Newsletter // Issue N° 3 // December 2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 679303.

In this issue:

Editorial

After almost four years, the GoodBerry project will come to an end. Over these years, a lot of research was done. Berry populations were planted and harvested in all different locations, data was evaluated and key results have been shared at conferences and events, within workshops and through scientific and applied publications.

Since a range of milestones have been achieved in the course of the project our third and last GoodBerry newsletter provides an overview of the work progress over the last 46 month and outlines the key project results again briefly.

As GoodBerry aims at having a major impact not only in the scientific community (with high impact scientific publications) but in the berry industry and growing community as well, a dedicated section for applied publications was created on the project website, which is described in greater detail in this issue.

To complement this summary, one member of the GoodBerry Scientific Advisory Board will share his perspectives on the project developments in a short interview and one participant of the RNAseq workshop will give an insiders account.

With this, the whole GoodBerry consortium wishes you all a good start to 2020.

Enjoy reading!

GoodBerry – Work Progress

The strategy of the GoodBerry project has been delivered through the activities of five Research and Technological Development work packages (WP1–WP5), with additional workpackages on dissemination (WP6) and management (WP7).

In WP1, our multidisciplinary consortium has applied the most recent technical advances in phenotyping overall plant performance of established cultivars of strawberry, raspberry and blackcurrant to be linked to flower initiation and dormancy studies. Concerning the analysis of fruit quality, the different partners involved in the analytical part have already analysed volatiles compounds and primary metabolites, as well as folate. The data is being evaluated to find biomarkers associated to fruit quality under climate change.

In WP2, we have optimized the integration of partner competences to develop new cultivation techniques to reduce inputs in berry production, extend plant adaptation to different and changing climatic conditions, expand production season and optimize berry quality. Also, new cultivars are being analysed to learn important floral initiation and dormancy characteristics before implementing these varieties in the practice cultivations spread over Europe. All different experiments have been conducted and important conclusions have been already published and disseminated through several practice abstracts published at the EIP-AGRI platform.

Over the project period, in WP3, the most updated techniques to evaluate, select and obtain new material with improved adaptability to cultivation conditions and systems, and exhibiting higher quality and nutritional quality value of the fruit, were applied.

The focus of WP4 was to develop a set of tools to analyse and select fruits with optimised quality (organoleptic, nutritional and bioactive components). A more extensive approach was developed on strawberry, raspberry and blackcurrrant. The improvement of fruit quality was achieved for the standard sensorial quality traits. State of the art high-throughput, metabolomic, gas chromatography (GC) and liquid chromatography – mass spectrometry (LC-MS) technologies was used to maximise analytical data collation while minimizing analysis time.

Within WP5 framework, a database for sustainable data collection, storage, and analysis has been set up based on an established LIFERAY technology platform. All raw RNAseq data has been uploaded, additionally QC as well as evaluated data and interactive visualizations for all completed sets (strawberry, raspberry) are available as well. Furthermore, additional phenotypic data has been uploaded and evaluated since the last report. Once the data will be validated and metadata corrected, it will be made openly available.

Scientific Publications

Even though the data generated in GoodBerry is still being produced and evaluated, the partners have already been committed to disseminating their results openly (OpenAccess) to the scientific community. Some examples are highlighted below.

Mapman4: a refined protein classification and annotation framework applicable to multi-omics data analysis

Genome sequences from over 200 plant species have already been published, with this number expected to increase rapidly due to advances in sequencing technologies. Once a new genome has been assembled and the genes identified, the functional annotation of their putative translational products, proteins, using ontologies is of key importance as it places the sequencing data in a biological context. Furthermore, to keep pace with rapid production of genome sequences, this functional annotation process must be fully automated. Here we present a redesigned and significantly enhanced MapMan4 framework, together with a revised version of the associated online Mercator annotation tool. Compared with the original MapMan, the new ontology has been expanded almost threefold and enforces stricter assignment rules. This framework was then incorporated into Mercator4, which has been upgraded to reflect current knowledge across the land plant group, providing protein annotations for all embryophytes with a comparably high quality. The annotation process has been optimized to allow a plant genome to be annotated in a matter of minutes. The output results continue to be compatible with the established MapMan desktop application. The full article is available in Molecular plant.

Schwacke, R, Ponce-Soto, GY, Krause, K, Arsova, B, Hallab, A, Bolger, AM, Gruden, K, Stitt, M, Bolger, ME, Usadel, B, "Mapman4: a refined protein classification and annotation framework applicable to multi-omics data analysis." Molecular plant 12.6 (2019): 879-892. https://doi.org/10.1016/j.molp.2019.01.003

Scientific Publications

Computational aspects underlying genome to phenome analysis in plants

Recent advances in genomics technologies have greatly accelerated the progress in both fundamental plant science and applied breeding research. Concurrently, high-throughput plant phenotyping is becoming widely adopted in the plant community, promising to alleviate the phenotypic bottleneck. While these technological breakthroughs are significantly accelerating quantitative trait locus (QTL) and causal gene identification, challenges to enable even more sophisticated analyses remain. In particular, care needs to be taken to standardize, describe and conduct experiments robustly while relying on plant physiology expertise. In this article, we review the state of the art regarding genome assembly and the future potential of pangenomics in plant research. We also describe the necessity of standardizing and describing phenotypic studies using the Minimum Information About a Plant Phenotyping Experiment (MIAPPE) standard to enable the reuse and integration of phenotypic data. In addition, we show how deep phenotypic data might yield novel trait–trait correlations and review how to link phenotypic data to genomic data. Finally, we provide perspectives on the golden future of machine learning and their potential in linking phenotypes to genomic features. The full article is available in The Plant Journal.

Bolger AM, Poorter H, Dumschott K, Bolger ME, Arend D , Osorio S,Gundlach H, Mayer KFX, Lange M, Scholz U, Usadel B, "Computational aspects underlying genome to phenome analysis in plants." The Plant Journal 97.1 (2019): 182-198. doi: 10.1111/tpj.14179

Genetic diversity of strawberry germplasm using metabolomic biomarkers

SCIENTIFIC REPORTS

High-throughput metabolomics technologies can provide the quantification of metabolites levels across various biological processes in different tissues, organs and species, allowing the identification of genes underpinning these complex traits. Information about changes of metabolites during strawberry development and ripening processes is key to aiding the development of new approaches to improve fruit attributes. We used network-based methods and multivariate statistical approaches to characterize and investigate variation in the primary and secondary metabolism of seven domesticated and seven wild strawberry fruit accessions at three different fruit development and ripening stages. Our results demonstrated that Fragaria sub-species can be identified solely based on the gathered metabolic profiles. We also showed that domesticated accessions displayed highly similar metabolic changes due to shared domestication history. Differences between domesticated and wild accessions were detected at the level of metabolite associations which served to rank metabolites whose regulation was mostly altered in the process of domestication. The discovery of comprehensive metabolic variation among strawberry accessions offers opportunities to probe into the genetic basis of variation, providing insights into the pathways to relate metabolic variation with important traits. To view the full article please follow this Link.

José G Vallarino, Francisco de Abreu e Lima, Carmen Soria, Hao Tong, Delphine M. Pott, Lothar Willmitzer, Alisdair R Fernie, Zoran Nikoloski, Sonia Osorio, "Genetic diversity of strawberry germplasm using metabolomic biomarkers." Scientific reports 8.1 (2018): 14386. doi: 10.1038/s41598-018-32212-9.

Vitamin C content in fruits: Biosynthesis and regulation

Throughout evolution, a number of animals including humans have lost the ability to synthesize ascorbic acid (ascorbate, vitamin C), an essential molecule in the physiology of animals and plants. In addition to its main role as an antioxidant and cofactor in redox reactions, recent reports have shown an important role of ascorbate in the activation of epigenetic mechanisms controlling cell differentiation, dysregulation of which can lead to the development of certain types of cancer. Although fruits and vegetables constitute the main source of ascorbate in the human diet, rising its content has not been a major breeding goal, despite the large inter- and intraspecific variation in ascorbate content in fruit crops. Nowadays, there is an increasing interest to boost ascorbate content, not only to improve fruit quality but also to generate crops with elevated stress tolerance. Several attempts to increase ascorbate in fruits have achieved fairly good results but, in some cases, detrimental effects in fruit development also occur, likely due to the interaction between the biosynthesis of ascorbate and components of the cell wall. Plants synthesize ascorbate de novo mainly through the Smirnoff-Wheeler pathway, the dominant pathway in photosynthetic tissues. Two intermediates of the Smirnoff-Wheeler pathway, GDP-D-mannose and GDP-L-galactose, are also precursors of the non-cellulosic components of the plant cell wall. Therefore, a better understanding of ascorbate biosynthesis and regulation is essential for generation of improved fruits without developmental side effects. This is likely to involve a yet unknown tight regulation enabling plant growth and development, without impairing the cell redox state modulated by ascorbate pool. In certain fruits and developmental conditions, an alternative pathway from D-galacturonate might be also relevant. We here review the regulation of ascorbate synthesis, its close connection with the cell wall, as well as different strategies to increase its content in plants, with a special focus on fruits. The article is available in Frontiers in plant science.

Mario Fenech, Iraida Amaya, Victoriano Valpuesta and Miguel A. Botella, "Vitamin C content in fruits: Biosynthesis and regulation." (2018). doi: 10.3389/fpls.2018.02006

Physiological response and susceptibility of strawberry cultivars to the charcoal rot caused by Macrophomina phaseolina under drought stress conditions

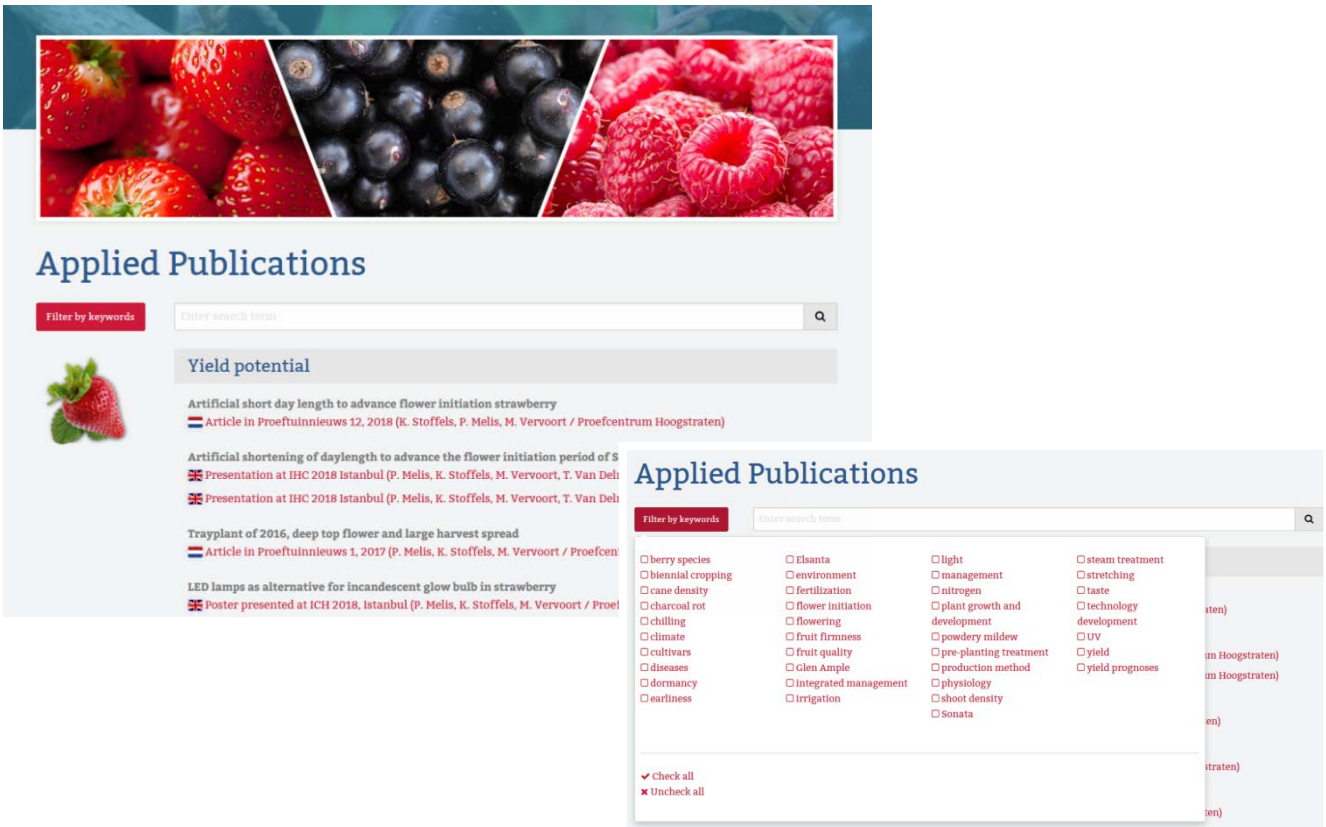
Charcoal rot of strawberry (Macrophomina phaseolina) is an emerging disease difficult to manage, a desirable alternative is the use of resistant cultivars. However, little is known regarding the reaction of cultivars to the pathogen under water stress conditions. The aims of this work were to study the effect of water stress on the physiology of four strawberry cultivars during the infection, and to determine the relationship between water stress and cultivar susceptibility. Healthy and inoculated plants of 'Monterey', 'Albion', 'Camarosa' and 'Sabrina' were maintained under no irrigation and full irrigation regimes, in greenhouse conditions. Stem water potential (SWP) and stomatal conductance (gs) were evaluated. The disease severity was recorded weekly for seven weeks. The disease detrimentally affected the water relations in 'Sabrina', 'Albion' and 'Monterey'. A significant correlation was detected between the evaluated parameters and the disease severity. The disease severity increases in plants with no irrigation, regardless of cultivar. Our results show that the infection caused by M. phaseolina increases the negative effects of water stress, depending on the genotype, and that the cultivars that were able to maintain more stable water relations respond better to the disease. The article is available here.

Sánchez S., Grez J., Contreras E., Gil P.M. and Gambardella M, "Physiological response and susceptibility of strawberry cultivars to the charcoal rot caused by Macrophomina phaseolina under drought stress conditions" (2018). Journal of Berry Research Preprint: 1–13, doi: 10.3233/JBR-180329

All applied results at one sight on the GoodBerry project website!

GoodBerry aims at having a major impact not only in the scientific community (with high impact scientific publications) but in the berry industry as well. In this regard numerous activities are performed to drive the results to the growing community. These include the publication in dedicated magazines and online resources, i.e. Erdbeer & Spargel, Obstbau (Germany) or Réussir-Fruits-et-Légumes (France), the participation in dedicated conferences, meetings and workshops, i.e. Fruit Logistica, Frukt og bærseminar (Norway), and the organization of field visits and demonstrations.

As can be seen, the results from GoodBerry are not only of scientific value, on the contrary the work performed (in GoodBerry) generates learnings and results that are very relevant for direct application in the field. Therefore we wanted to have a kind of central "repository", where the berry industry could easily find all relevant GoodBerry results. The idea of a dedicated section for Applied publications was born.



In this section on the GoodBerry project website short articles and presentations relevant for the berry industry (breeders, growers …), i.e. articles in growers magazines, presentations, posters or practice abstracts (also available on the EIP AGRI platform), are available in various different languages. The articles are classified by berry (Strawberry, Raspberry or Blackcurrant), as well as by output (fruit quality, yield potential, pathogen resistance, plant physiology). Another feature of the user-friendly design are flag icons, that help to easily spot the articles in the language of your choice. Additionally users can get even quicker to their topic of interest via a search tool and the possibility to filter by keywords.

Applied Publications

Some examples of applied publications available on the GoodBerry website are highlighted and summarized below.

Artificial short day length to advance flower initiation strawberry (in Dutch)

Flower initiation of mid-late short day cultivars is limited to 15 Sep–15 Nov in Belgium. Therefore, planting date cannot be sooner than 25 Dec., and first harvesting cannot be advanced earlier than 25 Mar. The goal was to manipulate flowering in the short day cultivar Sonata by shading the plants in summer, and thereby advance flower initiation and realize earlier planting and harvest. Results showed that flower initiation started 21 days earlier, planting date was in November, 35 days earlier, and the harvest started in February, 42 days earlier than without shading. The yield was 6.6 and 7.0 kg/m2, with 72% and 67% large fruits, for the shaded and non-shaded control plants, respectively.

K. Stoffels, P. Melis & M. Vervoort, Proefcentrum Hoogstraten, Belgium
Article in Proeftuinnieuws 12, 2018

Reduction of nitrogen and water supply in strawberry cultivation (in English and Italian)

Drought is recently becoming more widespread and frequent, leading to an increased demand of water resources. An experimental was conducted in Italy to identify and select the most adaptable strawberry cultivars, under reduced hydric and nutritional restitution conditions. The cultivars 'Cristina', 'Romina' and 'Sibilla' where given three different irrigation programs (100%, 80% and 60% of hydric restitution) and three different doses of nitrogen restitution (100%, 80% and 60%) from start of growth until fruit ripening. 'Cristina' and 'Romina' were able to maintain regular plant development, yield and fruit quality at 80% of water restitution. At further reduction (60%), reduced yield and increased fruit quality were observed. Regarding reduces nitrogen application, 'Romina' and 'Sibilla' seems not to be influenced by a lower amount of nitrogen regarding vegetative growth and yield. For 'Cristina', yield was negatively affected at 60% of nitrogen restitution, but still reached the best fruit quality.

B. Mezzetti & L. Mazzoni, Università Politecnica delle Marche, Italy
Abstract on EIP AGRI platform

Should we fertilize the black currant bushes in autumn? (in Norwegian)

Field fertilization experiments in black currants have given inconsistent results. Therefore, we used controlled nutrient feeding of single-stemmed pot plants and fertilized by controlled trickle fertigation during both the period of flower formation in autumn and during berry development to study fertilization effects. Continuation of nutrient supply until mid September, or a one-week

pulse of generous supply in early September delayed growth cessation and floral initiation, and increased total flowering and berry yield in the following season. Such autumn fertilization did not adversely affect plant winter survival and growth vigour in the spring. Berry yield and fruit size also increased with increasing nutrient supply during fruit development in cultivars 'Ben Tron' and 'Narve Viking', while they were unaffected in 'Hedda' and decreased with increasing supply in the high-arctic 'Imandra'. However, berry dry matter and the concentration of soluble solids decreased with increasing nutrient supply in all cultivars. We conclude that black currants should preferentially be fertilized in early autumn, immediately after berry harvest, as this will enhance flower formation and subsequent berry yield.

A Sønsteby, U. M. Roos & O. M. Heide, Norwegian Institute of Bioeconomy Research, Norway
In Norsk Frukt & Bær

Experiences with autumn fertilization in berry crops (in English)

The effect of controlled nutrient feeding during the period of short day (SD) induction of flowering has been studied in three SD berry crops. An experimental system with standardized plant material grown with trickle fertigation in controlled environments was used. In strawberry, flowering was advanced and increased when an additional N pulse was given 1–2 weeks after commencement of a 4-week SD induction period, while the opposite resulted when the treatment was applied 2 weeks before start of SD. In blackcurrant, the highest flowering and yield were obtained when fertilization was applied shortly after the natural photoperiod had declined to the inductive length in September. While generous nutrient supply during spring and summer reduced berry soluble solids in blackcurrant, this was not observed with autumn fertilization. Autumn fertilization did not adversely affect plant winter survival or growth vigour in spring. Withdrawal of fertilization prior to, or at various stages during floral induction, did not significantly affect flowering and yield in raspberry, but marginally advanced flowering and fruit ripening.

T. L. Woznicki, O. M. Heide & A. Sønsteby, Norwegian Institute of Bioeconomy Research, Norway
In Acta Hortic. 1217. ISHS 2018. DOI 10.17660/ActaHortic.2018.1217.57 Proc. VIII International Symposium on Mineral Nutrition of Fruit Crops Eds.: T. Mimmo, Y. Pii and F. Scandellari

Aerated steam by the 'Plant Sauna' eradicates powdery mildew from strawberry transplants (in English)

A closed container with even distribution of aerated steam at a set temperature was tested. The 'Plant Sauna' was originally developed in Norway to disinfest greenhouse equipment. Adapted to treat strawberry plants against diseases and pests. Eliminates or significantly reduces important diseases. Standard treatment with aerated steam developed in Florida: 1-h pre-treatment at 37°C to increase heat tolerance of the plants, then 1 h at 20–25°C (no steam), followed by 4 h at 44°C. Here, we tested effects of aerated steam against powdery mildew (Podosphaera aphanis) on strawberry transplants. The results showed that aerated steam at 40 to 44°C for 2 to 4 h effectively kills strawberry powdery mildew. Treatments at the highest temperature may reduce growth in plug plants; no negative plant and yield effects were found in experiments with cold-stored bare root plants. Further experiments will include studies with insects and mites. An up-scaling of the treatment capacity of the 'Plant Sauna' is currently taking place, led by the companies Marten BarelBV (The Netherlands) and Myhrene AS (Norway).

C. Dias Da Silva Jr., V. Hong Le, B. Asalf, C. Grieu, N. Y. Wang, N. A. Peres, W. W. Turechek, A. Stensvand
Poster presented at APS 2019, USA

Interviews with SAB members

The Scientific Advisory Board (SAB) provides additional advice to help ensure that the GoodBerry consortium can successfully disseminate and exploit project findings. With that it is an essential part of the extended project team, giving valuable scientific input for strategic decisions.

The GoodBerry SAB consists of representatives from international institutions in the field of horticulture. With that Dr Pedro Nogueira Brás de Oliveira (Instituto Nacional de Investigação Agrária e Veterinária, Portugal), Prof. Yves Desjardins (Horticultural Research Center/NAF, Laval University, Canada), and Richard Harnden (Director of Research, Berry Gardens Limited, UK) are bringing different expertise to the project.

Providing an insight into his experiences and feelings about GoodBerry, we sat down with Richard Harnden for a short interview:

1. In your opinion, what is unique about Goodberry's approach?
GoodBerry is a very large and ambitious project covering multiple topics and work packages, from phenotyping and genetics through investigating production practices to improving shelf life and postharvest quality, being undertaken by a large group of experienced research partners from across the European Union, drawing on their strengths and competencies and all contributing in a coordinated manner to deliver, in total, a staggering quantity of scientific outputs, which will be of great benefit to breeders and growers. The enormous breadth and depth to the GoodBerry project makes it, in my opinion, in a class of its own and clearly unique for the sector.

2. What is the main impact of Goodberry for the berry community and which main need is addressed?
As noted above, in a project of GoodBerry's size and scale there is a considerable body of research being undertaken that will produce numerous outputs; many of which will have significant impact. If my memory serves me correctly, at the last GoodBerry project review meeting there had been about 65 scientific papers and applied publications already published from the research. Obviously some of the outputs will only have impact in the medium to longer term, for example those arising from the breeding and marker assisted selection research, and others have an impact that growers can use within their businesses almost immediately. As an external advisor to the project, one of my parting comments to the consortium partners at the last meeting was to be very thorough in identifying all the outputs from the project and making sure that they were captured in all the papers, reports and articles published. I am especially keen that any outputs, which could have an impact on growers' businesses, are separated out and presented in a form that is easily disseminated and understood by all growers within the European Community.

3. For you personally, what is the most exciting result of Goodberry?
It's quite hard to single out just one result arising from the GoodBerry project but, as I'm being pressed, I think that the benefits of applying ultra-violet light to strawberry crops at night, in order to control powdery mildew, other fungal pathogens and mites, is very significant as it benefits so many areas and has multiple impacts. Although the technology requires investment, it can be brought in and used by growers very quickly, thereby providing almost immediate benefit to their business. When deployed correctly, as the GoodBerry project research has shown, it supports integrated pest and disease management control strategies, reducing the need for many applications of plant protection products and enabling sustainable production, as well as providing a consumer benefit by allowing them to purchase fruit with fewer pesticide residues, and a more reliable product with longer shelf life. If carried out correctly, the use of UV-C light is a great example of a win-win-win all round.

RNAseq Workshop

by Dr Bastienne Brauksiepe

The workshop which took place at RWTH Aachen after the 3rd GoodBerry progress meeting was an excellent opportunity for interested members of the GoodBerry consortium to dive into the theory of transcriptome sequencing, also called RNA-seq. This one and a half day RNA-seq workshop was organized by Prof. Dr. Björn Usadel who specializes in bioinformatics, data management and visualization. Within the GoodBerry project he is the leader of the work package "Data management and analysis" (WP5).

RNA-seq uses high-throughput next generation sequencing (NGS) technology to comprehensively reveal the transcriptome of a biological sample at a specific time point. It is the method of choice for transcriptome profiling. In the frame of the GoodBerry project RNA-seq is used to reveal differentially expressed genes functionally associated with biological processes like flower induction, dormancy induction and dormancy release in strawberry, raspberry and black currant. As the generation of NGS data has become much more affordable over the last years the method is now increasingly used in research projects. However, the computational analysis and the interpretation of these data are challenging. It is a fundamental task to transform the huge amount of data obtained by NGS into useful biological information. For many researchers the analysis of RNA-seq data is still the major bottleneck.

Therefore, the aim of this workshop was to familiarize researchers with RNA-seq data and to initiate them in the analysis providing practical exercises. The course layout was adapted to the needs of beginners in the field of bioinformatics and allowed scientists with little background to get first hands-on experience.

Björn Usadel was an excellent lecturer to impart knowledge in Linux and command line based file and data management. He also taught the participants how to use bioinformatics tools for handling RNA-seq data like read quality control of obtained data and provided information about read mapping theory and data analysis theory so that the auditorium gained insight into the workflow of data processing. After the workshop in Aachen attendees were enabled to perform important first tasks of NGS data analysis themselves.

Overview Past & Upcoming Berry Events*

2019

JANUARY

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FEBRUARY

Fruit Logistica 2019 in Berlin

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MARCH

3rd GoodBerry Progress Meeting in Aachen

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APRIL

2nd Plant Genomics & Gene editing Congress in Rotterdam

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JUNE

5th International Conference on Plant Genomics in Berlin

2nd GoodBerry Progress Meeting in Brussels

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XXII Open Day at Experimental Orchard in Dabrowice

ISHS XII Rubus & Ribes Symposium 2019 in Zurich

JULY

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PERIFEL 2019 in Douville

NOVEMBER

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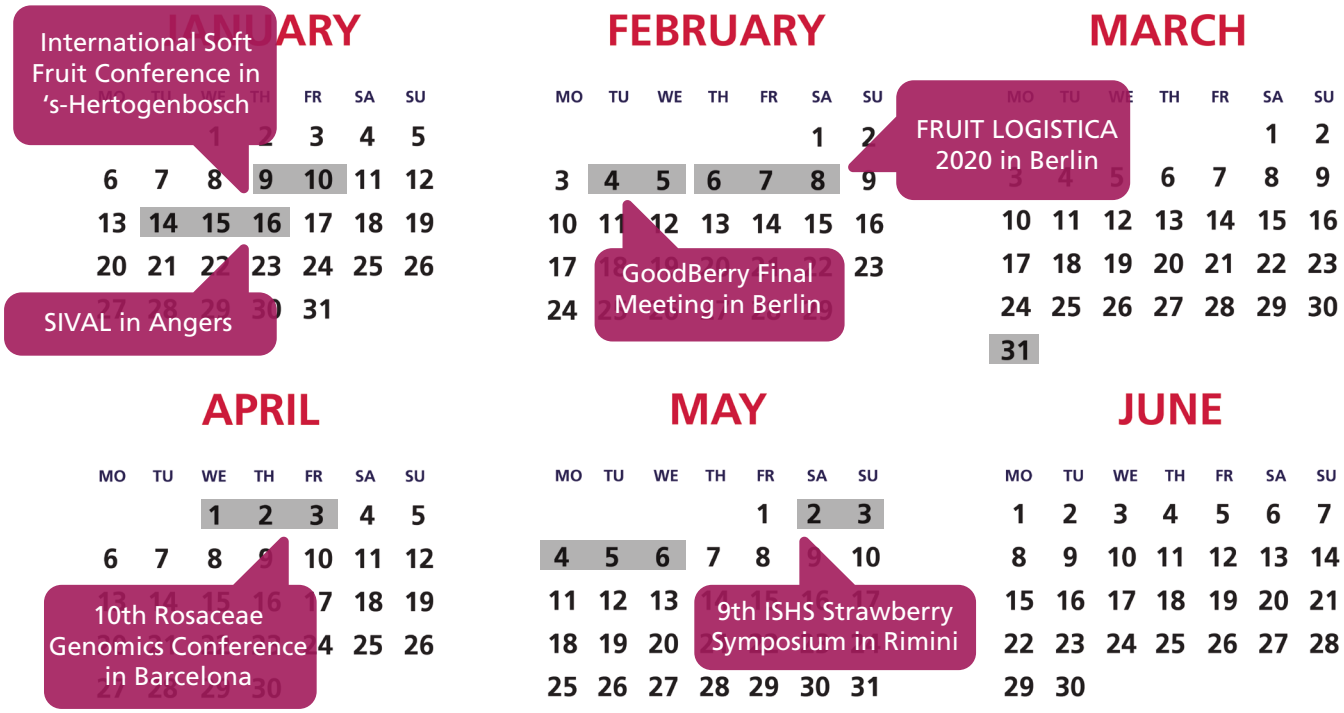
Strawberry Annual Conference in China

*Please find more details about the events under: goodberry-eu.eu

2020



Upcoming Berry Events in 2020

Save the date!

9th International Strawberry Symposium

May 2–May 6, 2020, Rimini, Italy

GoodBerry consortium partner Polytechnic University of Marche and the Council for Agricultural Research and Economics (CREA), in conjunction with the ISHS are delighted to invite you at the 9th ISHS Strawberry Symposium (ISHS-ISS2020) that will take place in Rimini, May 2–6, 2020.

After the 2016 International Strawberry Symposium held in Quebec, this edition will follow the new ISHS2.0 approach, aiming to bridge the gap between academia and strawberry industries, involving everyone interested in strawberry, from research, production, industries, market and consumers.

The ISHS-ISS2020 will be accessible to experts in the world, in particular from developing countries where the strawberry production is expanding not only as an industry but also as an opportunity of rural development and improvement of quality life.

Four GoodBerry partners, Anita Sønsteby, Sonia Osorio, Beatrice Denoyes and Peter Melis, are invited speakers and will have the opportunity to present the results of the GoodBerry project and meet colleagues for further scientific and technical exchange.
Also, ISHS-ISS2020 is not only Rimini. Guided Pre- and Post-tours to Southern and Northern production areas as well as another Berry School, will let you learn about the highly diversified Italian Strawberry production system. Young scientists and technical experts will be trained on strawberry breeding and cultivation systems.
We would be glad to meet you at ISHS- ISS2020 next May 2–6, 2020 in Rimini!
For further information visit the ISHS Strawberry Symposium Website: https://www.iss2020.com

Register at: https://www.iss2020.com/registration/

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www.goodberry-eu.eu

Disclaimer

The GoodBerry project is funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 679303.

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