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Fort Myers, Florida, USA

www.conference.ifas.ufl.edu/pepper2018

Table of Contents

5 Welcome Letter

6 Planning Committee

7 Sponsor Recognition

9 Abstract Compilation

64 Notes

Welcome Letter

Greetings!

I would like to wish you a warm Florida welcome to the 24th International Pepper Conference in beautiful Fort Myers, FL!

It is appropriate that the conference has returned to Florida where it first had its origins. Dr. Ben Villalon and Dr. Tom Zitter first kicked around the idea of holding a meeting to draw together pepper researchers for the exchange of information and germplasm in 1972. The conference has come a long way since then and has emerged as the premier venue for the dissemination and exchange of information on *Capsicum*.

For the past 46 years, the International Pepper Conference has been held every other year in major pepper producing regions. The conference brings together pepper researchers, scientists, breeders, horticulturists, pathologists, entomologists, geneticists, physiologists, and virologists, in addition to extension agents, seed and chemical company representatives, major processors, growers, and chile aficionados from around the world providing a venue for the exchange of information and knowledge on *Capsicum* spp. In recent years, interest and demand for peppers has increased dramatically worldwide and peppers have achieved major economic significance in the global market.

The University of Florida is proud to host this event and welcome our colleagues from around the globe. We feel confident that we have been successful in putting together a program you will find informative, challenging and exciting. The diversity of papers and posters presented at this conference and the wide array of presenters will bring together the latest advances in the field from around the globe, and will undoubtedly provide something for everyone in attendance.

We know from past workshops that in addition to the exchange of information and ideas, the development of personal friendships and collaborative efforts between colleagues from around the world working on common issues is equally important. For this reason, you will note that we have included some down time between formal sessions so both new and old friends will have plenty of time to meet and mingle and trade ideas and innovations. Although some of the participants have been active with the pepper conference from the beginning, they remain willing to share and welcome new ideas and collaborators into their midst and we are sure you will want to meet and get to know them. We hope that you will find that this is a close and sharing community of friends with a common interest that unites us all.

In addition to the welcoming reception, we have planned group lunches, a Monday evening social and dinner and a Tuesday evening closing dinner banquet, which will give us all the opportunity to relax away from the structure of the meeting place and enjoy great food, drink and company. Monday will feature a full day of scientific presentations, while Tuesday will consist of an all-day tour of local industry research facilities and commercial pepper production South Florida style. The International Pepper Conference is not a formal association with voting members. By virtue of attending the conference, you are part of this informal organization and at our closing dinner banquet we will present Lifetime Achievement Awards and select the venue of the next International Pepper Conference in 2020.

We are grateful to all of our many and generous sponsors, who have joined in supporting this conference. I would also like to thank the committee members, speakers and poster presenters without whom there would be no conference. A sincere thanks is also due to Beth Miller-Tipton and her staff at the UF/IFAS Office of Conferences and Institutes as they have left no stone unturned in making sure that our conference is not only successful, but will be a fun time for everyone as well.

As you know, Florida is major tourist destination and we hope will find the time to visit the beaches and attractions like Disney, Universal Studios, and Sea World as well as see the “real” side of Florida and its great natural beauty. I am glad you were able to attend and hope you have an enjoyable and productive time together in this beautiful venue and return home with fresh ideas, strengthened collaborations and friendships, and renewed enthusiasm for all things *Capsicum*.

Sincerely,

Gene McAvoy, *Director*

Regional Vegetable Extension Agent IV
UF/IFAS Hendry County Cooperative Extension
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Planning Committee

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Conference Chair, UF/IFAS Regional Vegetable Extension Agent IV

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Abstract Compilation

Abstracts are alphabetical by presenting author's last name.
Presenting author names appear in **bold**.

INTERACTION BETWEEN *RHIZOCTONIA SOLANI* AND *MELOIDOGYNE INCOGNITA* ON *CAPSICUM ANNUUM* FROM SEQUENTIALLY INFESTED SOIL

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Meloidogyne incognita and *Rhizoctonia solani* have been isolated from chile fields in New Mexico. Our hypothesis investigated whether sequential inoculation of *R. solani* and *M. incognita* had a synergistic effect on chile injury in greenhouse experiments. *Meloidogyne incognita* was inoculated at a rate of 5,000 eggs per plant and *R. solani* was inoculated at a rate of five *R. solani* agar pellets (each 1-cm in diameter). Plant height, fruit number, and plant physiological measurements were recorded for chile two weeks before termination of each experiment. The frequency of recovery of *R. solani* and non-*Rhizoctonia* from tap roots and stem segments, *M. incognita* egg counts and reproduction factor and plant dry weight were measured for chile at the termination of each experiment. Generally, there were inconsistent effects of the interaction of *R. solani* and *M. incognita* for most measurements in the sequential inoculations. Higher frequencies of *R. solani* were observed when *R. solani* preceded *M. incognita* than when *M. incognita* preceded *R. solani* in one experiment. The effect of the sequential inoculation on several measured parameters was often significant. Consequently, results suggest that sequential inoculation of *R. solani* and *M. incognita* had a minor effect on chile growth and *R. solani*.

Presenter Bio: Dr. Al-Hammouri is an assistant professor in the department of land management and environment with more than 7 years of experience in teaching principles of plant production, principles of plant protection, and other courses. His research interest focuses on inhibiting soilborne fungal pathogens of vegetables in general by using biofumigation.

GENETIC DIVERSITY OF *CAPSICUM BACCATUM* FROM THE PRIMARY ORIGIN CENTER

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Crop diversity can be a basis for differentiated market products. The diversity of *Capsicum baccatum* remains under-researched as well as many traditional varieties with distinguished values that are of interest to breeders, growers and consumers.

Bolivia constitutes the primary center of cultivated *Capsicum* diversity. Bolivia also is one of America's wild pepper hotspots, where the fruits of several wild pepper species are consumed as food and used for medical purposes. *Capsicum baccatum* is a highly diverse species that offers abundant phenotypic variation, although its genetic diversity remains little studied. The goal of this study was to determine the genetic diversity of a collection of *C. baccatum* maintained by the Pairumani Center for Phytoecogenetic Research that consists of 205 accessions of landraces and wild peppers.

A morphological characterization of the samples was carried out using the Descriptors of *Capsicum* spp. of IPGRI, current Bioversity International. The characterization showed wide morphological variability including commercially valuable traits such as fruits color, shape and size. In the collection, they were accessions not classified taxonomically, the study allowed to identify them in *C. baccatum* var. *pendulum* or *C. baccatum* var. *baccatum*. Several accessions of supposedly wild *C. baccatum* var. *baccatum* locally called "arivivis" have been revealed to be, in fact, small-fruited landraces of the cultivated *C. baccatum* var. *pendulum*. Accessions with intermediate morphological characteristics between both varieties of *C. baccatum* were observed, they were confirmed in the molecular study constituting possible hybrids. *C. baccatum* var. *pendulum* is widely cultivated and processed for consumption, while *C. baccatum* var. *baccatum* is not cultivated but it's sold in local markets and harvested by extractive means. A subset of accessions of the collection was selected by biochemical characterization of fruits.

The genetic diversity and population structure were estimated using 18 microsatellites markers. High levels of polymorphism were found, with a total of 90 alleles identified and an average of 5 alleles per marker. This high degree of genetic diversity provides opportunities and challenges for plant breeders. However, no clear population structure was observed.

The genebank collection in the center of cultivated *Capsicum* diversity provides the necessary variation for selection. The information of this study will be used to develop strategies for conservation, domestication and breeding.

Presenter Bio: Mrs. Avila is a senior researcher with more than 20 years of experience in biotechnology and management and conservation of genetic resources.

HOT PEPPERS: XI. DEVELOPING A COLOUR STANDARDS FOR CARIBBEAN HOT PEPPERS (*CAPSICUM CHINENSIS* L.)

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The Caribbean is the producer of some of the most pungent red-hot peppers (*Capsicum chinensis* L.), but its physio-chemical quality parameters such as colour stability and pungency in particular are unsubstantiated. A Caribbean hot pepper visual colour standard and the relative pungency of the fresh and processed products has been developed and validated, based on the standards set by ASTA for red colour pigmentation and pungency. The Caribbean has two very hot peppers with very high capsaicinoids viz: Trinidad Scorpion (2.08mg) and Carvalho (1.07mg), which also exhibits equally high heat based on the Scoville test (31,200,000 and 16,000,000 SHU, respectively). The ASTA value for the processed pepper (377 ASTA units) and the fresh mature hot fruit (366 ASTA units) were also computed. The study found Carvalho hot peppers can be used for industrial processing as mash, flakes, or powder without loss of colour or pungency compared to all the other tested cultivars. A color chart and a table of pungency is now available to producers and processors.

Presenter Bio: Puran Bridgemohan is a Crop Scientist. He is an Associate professor in agriculture and engineering systems at University of Trinidad and Tobago, former Director of Research and Principal Scientist of the Caroni Research Station and published over 12 peppers in pepper agronomy and post-harvest. Dr. Puran has 1 book chapter in pepper phyto - chemistry and is part of team which worked on the Trinidad Scorpion and Carvalho peppers chemistry. His current interest includes product development and post-harvest processing.

HOT PEPPERS: XII. TOWARDS A QUALITY ASSURANCE MODEL FOR CARIBBEAN HOT PEPPER (*CAPSICUM CHINENSIS* L.) FRESH FRUITS AND PROCESSED PRODUCTS

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The sustainable cultivation and international marketing of Caribbean hot pepper fruits and processed products needs to maintain consistency for pungency, color and fruit characteristics. This will allow them to be more viable and competitive and also to maintain the unique Geo-brand of the different island peppers. This paper proposed a Quality Assurance model [$Q_A = F_C + F_M + R_p$] which is predicated on the sum relationship of fruit colour [F_C], Fruit morphology [F_M] and Relative pungency [F_M]. The model further ascribed for each main factor, the qualitative [F_Q] and quantitative [F_D] sub-factors that contributed to it. The a model used colorimetric testing, microbial evaluation, and HPLC analysis for colour, fruit morphological characteristics, capsaicin content and risk of spoilage for both fresh and processed products. The standard for Caribbean fresh hot peppers was validated it on both fresh and processed products, and now ready for commercial evaluation.

Presenter Bio: Puran Bridgemohan is a Crop Scientist. He is an Associate professor in agriculture and engineering systems at University of Trinidad and Tobago, former Director of Research and Principal Scientist of the Caroni Research Station and published over 12 peppers in pepper agronomy and post-harvest. Dr. Puran has 1 book chapter in pepper phyto -chemistry and is part of team which worked on the Trinidad Scorpion and Carvalho peppers chemistry. His current interest includes product development and post-harvest processing.

***IN VITRO* GERMINATION OF ORNAMENTAL PEPPER (*CAPSICUM CHINENSE* L.)**

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The *in vitro* seed recalcitrance in *Capsicum* species is high when compared with other Solanaceae species as tobacco, tomato and potato. This work aimed to evaluate *in vitro* and *in vivo* seed germination of *Capsicum chinense* (UFPB 128). All seeds were disinfested and placed to germinate in Petri dishes on a filter paper moistened with distilled, deionized and autoclaved water, five seeds per plate. After 4 days 150 seeds were decoated by transversely cutting at the opposite side of the radicle and placed on ½ MS medium. The experiment was conducted in a completely randomized design. After inoculation, the flasks with the seeds were kept in the growth room at a temperature. Evaluation of germination was made daily. Another 150 intact seeds were sown in polystyrene trays (Stryrofoam) containing commercial substrate (Plantmax) and placed for germination in a greenhouse. The seeds sown in trays did not germinate. The dissected seeds showed 60.6% infected, 27.4% have not developed and 12.0% reaching adulthood. *In vitro* culture enabled germination percentage.

Presenter Bio: Dr. Riselane is professor of Seed Science at Universidade Federal da Paraíba and she has extensive experience with the seed physiology.

RESPONSE MECHANISMS IN THE INTERACTION BETWEEN *CAPSICUM CHINENSE* JACQ. AND THE OOMYCETE *PYTHIUM ULTIMUM*

Yahaira Cab-Guillén¹, Julissa Ek-Ramos², J. Armando Muñoz-Sanchez¹, and S. M. Teresa Hernández-Sotomayor¹

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Chili habanero (*Capsicum chinense* Jacq.) is an important product from Mexico that is exported. In our country, Yucatan is considered as a center of production for this crop, due to its economic importance not only for the regional gastronomy but also for its use in the elaboration of drugs, cosmetics, paints and tear gas. However, all crops are susceptible to several environmental factors resulting in critical disease; as a consequence, they present reduction in the production and the quality of the fruit. Specifically, *C. chinense* shows susceptibility to the infection with the oomycete *Pythium ultimum*. This pathogen is an inducer of roots damping-off and wilting in the seedling stage or in adult plants, causing production losses in approximately 80% in Mexico. The studies on the specific response of *C. chinense* cells infected with *P. ultimum* are still scarce. Therefore, we are interested in the signal transduction pathway described in the response produced during the infection with *P. ultimum*. In this work, an *in vitro* infection system of cellular suspensions of *C. chinense* was developed. The infection was determined through the cell viability and by the morphological changes in the cells using microscopy. In addition, we present evidence that *P. ultimum* can induce the accumulation of salicylic acid (SA) in the cellular suspensions of *C. chinense* Jacq., also to the induction of genes expression related to pathogenesis (*PR1*) in the different periods after infection was observed. These results suggest the possibility that a defense response is being triggered where SA participates as a signal molecule in response to *P. ultimum*.

Presenter Bio: MSc Yahaira Cab-Guillén is a student from the program of Biochemistry and Molecular Biology. She has extensive experience with *in vitro* culture of *Capsicum chinense*, and stress factors in plant tissue culture.

CONTROL OF BROAD MITE, WHITEFLY AND SPIDER MITES IN OPEN FIELD PEPPER AND EGGPLANT WITH PREDACEOUS MITES

Philip A. Stansly and José A. Castillo

Department of Entomology and Nematology, University of Florida/IFAS, Immokalee, FL, USA

The broad mite *P. latus*, the spider mites *Tetranychus urticae* and *T. evansi*, and the whitefly, *B. tabaci*, are serious pests of pepper and eggplant in Florida and elsewhere. Biological control of these and other pests using predaceous mites is commonly practiced in greenhouse vegetable production. *Amblyseis cucumeris* is used for broad mite and thrips control, *A. swirskii* for broad mite, whitefly and thrips and *A. californicus* for broad mites and spider mites. However, little has been reported regarding the effectiveness of these Phytoseiid mites in open field pepper and eggplant production. We evaluated *A. cucumeris* and *A. swirskii* in ‘Serrano’ pepper and eggplant in experimental plots in southwest Florida and assessed control of broadmite in ‘bell’ pepper on a commercial farm in the same region. Both mites provided significant levels of control of broad mite on both crops, although *A. swirskii* required fewer releases and provided better control when both predaceous mites were compared directly. In addition, *A. swirskii* controlled *B. tabaci* which is an especially important pest of eggplant in this region. Both pepper and eggplant receiving *A. swirskii* yielded significantly more fruit than untreated plants or even eggplants receiving two acaricide sprays. However, *A. swirskii* did not provide adequate control of the spider mites *Tetranychus spp*, important pests of this crop in south Florida. Therefore, a mixture of *A. swirskii* and *A. californicus* was tested in eggplant. Final data indicated persistence of both mites well into the crop cycle when released at planting with consequent suppression of all three pests.

Additional Information: First author Philip A. Stansly passed away September 12, 2018.

IS CAPSAICIN TOXIC FOR INSECTS?

Yosra Chabaane, and Betty Benrey

Laboratory of Evolutionary Entomology – University of Neuchâtel; Switzerland

The role of secondary metabolites in plant defense is widely recognized. In chili peppers, one of the main compounds associated with defense is capsaicin also responsible for the pungency trait. There is ample evidence that capsaicin protects plants against pathogens and fungi. However, a thorough review of the literature failed to reveal rigorous studies on the toxic effect of capsaicin for insect herbivores.

In this study, we determined the effect of capsaicin on the performance of two generalist herbivores, *Spodoptora latifascia* and *Spodoptora exigua* that have been shown to feed on leaves and fruits of chili peppers. Larvae were reared on three artificial diet treatments: control (without capsaicin), low-capsaicin (20 ppm) and high-capsaicin diet (200 ppm). These concentrations mimic those naturally present in the sweet bell pepper, mild poblano variety and in the pungent cayenne variety.

We found that the level of capsaicin significantly affected the performance of both herbivore species. Survival, pupation rate and adult emergence were 40 to 20 % lower on the high capsaicin diet compared to the low-capsaicin and control, respectively. However, performance on the low capsaicin diet was 20% higher than in the control. These results suggest that at low levels, capsaicin might enhance insect performance by acting as a feeding stimulant. Yet, this idea still needs to be examined experimentally.

Currently, we are conducting experiments with the natural chili fruits and following the same procedure used with the artificial diet. The results of our study are expected to increase our understanding on the role of capsaicin in plant defense against insect herbivores and its potential implications for pest control.

Presenter Bio: Ms. Chabaane is a first year PhD student in the laboratory of Evolutionary Entomology at the University of Neuchâtel. Originally from Tunisia, she obtained her Master of Science degree at the University of Neuchatel in 2013. After that, she worked as a research assistant at CABI (Switzerland), as an Intern and Consultant at FAO (Italy) and Product Manager at nextProtein in Tunisia. Her PhD research focuses on the consequences of domestication of chili pepper on plant-insect interactions.

USE OF BIOPESTICIDES FOR MANAGEMENT OF CERTAIN DISEASE AND INSECT PESTS OF PEPPER

Vijay Kumar Choppakatla

BioSafe Systems; East Hartford, CT, USA

Biopesticides can be a key component in integrated pest management in Peppers for their safe and non-residual characteristics. There is a growing interest in adopting biopesticides for management of certain important insect pests and diseases of Pepper such as Green Peach Aphid (GPA), Pepper Weevil (PW), European Corn Borer (ECB) and Phytophthora Blight. Field and lab bioassays with mycoinsecticide based on *Beauveria bassiana* strain ANT-03 show potential for control of above mentioned insect pests (GPA, PW, ECB). Similarly, use of Activated Peroxide based products (Hydrogen Peroxide + Peracetic Acid) as a pre and post-transplant soil treatment in conjunction with *Bacillus* based soil inoculants and other bio-fungicides can be an option for Phytophthora Blight management. The objective of this paper is to discuss these active ingredients, associated studies in Peppers and other crops and their potential to be part of integrated pest management in conventional and organic Pepper production.

Presenter Bio: Vijay Kumar Choppakatla currently serves as Plant Pathologist/R&D Director for BioSafe Systems, based in East Hartford, CT. Vijay holds a Ph.D in Plant Pathology from Oklahoma State University and has over ten years of field and lab experience in plant diseases and conventional/biological crop protection. As the head of BioSafe Systems research and development wing, Vijay works closely with university and industry experts in developing new product applications for plant protection in field, green houses, nurseries, hydroponics etc. He also runs plant, soil and irrigation water diagnostic lab at BioSafe Systems headquarters and is a source of technical information about BioSafe's products and technologies for sales/distributor personnel and grower clients.

BREEDING (PEPPERS) FROM A FARMER'S PERSPECTIVE

Edward Curry

Curry Farms, Pearce, Arizona, USA

Our journey in practical breeding began some 40 plus years ago. It was the early part of the 1970s, the green chile industry was well on its way in the southwestern United States. A young, handsome, intelligent, common sense type pepper breeder by the name of Phillip Villa moved from Peto Seed Company to Heublien Corporation in Oxnard, California where he was asked to improve yields, flavor, and disease resistance in Anaheim type chile.

At the same time, two other young men with similar passions for this fruit called chile were taking similar journeys just in slightly different segments of a young and developing industry of "chile".

Dr. Ben Villalon, who spent and dedicated much time to developing a sweet jalapeno, and a mechanical harvest system, both agronomic, and genetic as well as mechanical. Mr. Evertt Wood, who at the same time, was completing what would be one class short of a doctorate in genetics, and was working hard to improve paprika for the then young dehydration industry.

All three men were working towards a common goal of improving their particular part of this group of young industries developing around this FRUIT called "chile". Each one carried similar passions, work ethic and drive to improve the genetic base of their unique pepper of choice. Each used Gregor Mendel's basic methods with, with each of them adding new ideas and flares of their own making as well, and each contributing very distinct gene improvement's to their specific parts of this very unique industry of *Capsicum annuus*. All three used very deliberate methods of practical crossing of chiles with distinct parental differences to recombine gene packages from which improvements could be selected.

Because of my mother and father's love and dedication to this crop called "chile", they surrounded themselves with these men. Therein lies the beginning of my love for improvement of chile. I was 13 years old and following Evertt Wood and Phil Villa in the field - listening, learning and realizing the importance of selecting specific plants for growing out the following season to continue a very base method of improving a gene pool. Today, some 40 years later due to help of each of these men and Dr. we continue to use "PRACTICAL BREEDING SKILLS" to furnish our industry with the best yields, flavor and improvements in green chile, paprikas, cayenne and many more. Not to exclude Arizona 20 and Arizona 1904, of which consecutively became the standard of the green Chile industry, with several new types being tested as this is penned.

Presenter Bio: Ed's love for chiles began at a very early age when his parents planted their first chile crop in 1957. He essentially grew up in the chile fields. His passion for chiles continued to grow into what eventually became a lifelong interest in chile genetics. For 25+ years, he worked closely with his partner, Phil Villa, a well-known chile breeder, in developing new and improved hybrids that can be produced with uniform quality, flavor and heat. Careful plant breeding also resulted in improving certain strains of chiles that are now producing nearly double their average yield. The seed from these hybrid chiles come with pedigrees and with care and feeding guidelines to ensure that growers using Curry's seeds earn the best yield possible. Ed Curry continues to work extensively in chile genetics. In the farming industry, it is said that the genetic origins for 80 – 90 percent of the chiles grown commercially in the U.S. can be traced back to Curry's farm in Arizona. The Curry Seed & Chile Company supplies chile seed to growers in the Southwestern U.S. and in several states in Mexico.

PEPPERHUB, A PEPPER INFORMATICS HUB FOR THE CHILI PEPPER RESEARCH COMMUNITY

Feng Liu^{1,3}, Huiyang Yu^{2,3}, **Yingtian Deng**^{2,3}, Jingyuan Zheng¹, Minglei Liu², Lijun Ou¹, Bozhi Yang¹, Xiongze Dai¹, Yanqing Ma¹, Shengyu Feng², Shuang He², Xuefeng Li¹, Zhuqing Zhang¹, Wenchao Chen¹, Shudong Zhou¹, Rong Chen², Minmin Liu², Sha Yang¹, Ruimin Wei¹, Huadong Li², Feng Li^{2*}, Bo Ouyang^{2*} and Xuexiao Zou^{1*}

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Pepper is among the most widely cultivated and consumed vegetables in the world, with annual production reaching to 38 million tons in 2011 (www.fao.org). Pepper fruits have significant diversity in morphology and color, and they provide good models for fruit developmental biology (Paran and van der Knaap, 2007; Rivera et al., 2016). Like all other crops, pepper plants are often confronted with different pathogens and pests (Pernezny et al., 2003), and diverse abiotic stress conditions, which necessitate basic studies on the mechanisms of pepper plants responding to various stimuli to facilitate breeding efforts for tolerant cultivars.

Centralized and specialized informatic webservers, such as Sol genomics (www.solgenomics.net) have integrated the genomic, transcriptomic, and proteomic data for *Solanaceae* plants, provided convenient public platforms for the research communities. Despite its significant agricultural importance and interesting fruit biology, development of genetic resources and informatics platforms for pepper research has lagged far behind that of other crop plants such as rice and tomato. The release of three draft pepper genomes constituted a milestone in the development of genetic resources for the pepper research community (Kim et al., 2014; Qin et al., 2014). Although some of the data are accessible from public databases, a comprehensive informatics platform remains to be developed to cover different aspects of omics data, and to be friendly to biologists without bioinformatics expertise.

Here we present the Pepper Informatics Hub (PepperHub), which consists of five main modules, including Genome (pepper genome database), Transcriptome (pepper transcriptome database), sRNome (pepper small RNA database), Variome (pepper genetic variation), and Proteome (pepper proteome database). PepperHub provides an integrative public platform for sharing and analyzing research data. Undoubtedly, PepperHub will accelerate research in pepper functional genomics and would serve as a valuable resource for studying fruit developmental biology and stress responses in general. PepperHub is available at <http://www.hnivr.org/pepperhub>.

Presenter Bio: Dr. Deng is an associate researcher in horticultural vegetable genetic breeding and molecular biology, especially focus on the important functional genes in peppers.

IDENTIFICATION OF BIOMARKERS AND CHEMICAL DESCRIPTORS OF TASTE AND AROMA IN NATIVE PERUVIAN CHILI PEPPERS THROUGH A METABOLOMIC APPROACH

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The genus *Capsicum* involve 30 species, including 5 that have been domesticated: *Capsicum annum*, *C. chinense*, *C. frutescens*, *C. baccatum* and *C. pubescens*. Although the genus *Capsicum* has been studied from a taxonomic point of view, there are still some problems related to the taxonomic delimitation of the genus and its species. *C. annum*, *C. chinense* and *C. frutescens* form a taxonomic complex whose discrimination between species and varieties is still difficult to carry out. The flavor and aroma are attractive attributes of importance to the consumers of chili peppers, the knowledge of their attributes will allow the improvement of the quality. In the present work we report the metabolomic study of 5 varieties of Peruvian native peppers: "Ayucllo" and "Red Tomatito" (*C. baccatum*); "Miscucho" and "Dulce rojo" (*C. chinense*) and "Charapita amarillo" (*C. frutescens*). The agronomic research was carried out in three localities of Peru: Chiclayo, Chíncha and Huaral. Two datasets were obtained by two analytical platforms (GCMS, UHPLC-HRMS) along a sensory dataset. The sensory analysis was carried out by a trained tasting panel constituted by 9 tasters using ten descriptors of flavor and aroma. The acquisition of non-targeted metabolomic data by GCMS was carried out by solid phase microextraction (SPME) and ionization by electronic impact (EI). UHPLC-HRMS was performed in two ionization modes (ESI (+) and (-)) on reversed phase column. The multivariate analysis by Principal components (PCA) clustered samples according to their species for both GC and LC-MS approaches. Discriminant analysis by OPLS-DA (Orthogonal projection to latent structure-discriminant analysis) highlighted characteristic biomarkers of each species. A Multiple Factorial Analysis (MFA) was used to filter the most well modeled sensory descriptors in consensus with the perceptions of the panelists and to correlate the tendencies between flavor and aroma descriptors linked to the three species. To correlate the GCMS, UHPLC-HRMS, and sensory datasets a Multi-Block Holistic Integration Analysis was set up using the DIABLO approach. Our results displayed the common or correlated information among the three datasets (GCMS, LCMS and sensory analysis), optimally identifying key omic variables, which explained and classified reliably subgroups or phenotypes of interest. The validation of the model was carried out through cross-validation (p-value = 0.001), using the Mahalanobis distance classification criterion.

Presenter Bio: M.Sc. Fabio Espichan is a PhD student in Life Sciences, the present work was carried as part of his doctoral thesis.

DIFFERENTIAL RESPONSE IN *CAPSICUM ANNUUM* WITH *RHIZOBIUM RHIZOGENES*-TRANSFORMED ROOTS INOCULATED WITH BACTERIAL OR FUNGAL BIOCONTROL AGENTS AND PATHOGENS

Jaime Sagredo-Beltrán¹, Yumiko De la Cruz-Rodríguez¹, Alejandro Alvarado-Gutiérrez¹, Miguel Alvarado-Rodríguez², and Saúl Fraire-Velázquez¹

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The root systems in plants co-occur with a high diversity of microorganisms including bacteria and fungi as native inhabitants of soils. Commonly, a number of microorganisms in the soil interact with plants through the colonization in the rhizosphere, the interaction in some cases beneficial for both, the plant and microorganism. The transformation of roots of plants using *Rhizobium rhizogenes* entails an increase in lateral branching and a greater size of the radical system, a desirable characteristic in crop species in terms of a mayor area to explore the soil for nutrient absorption and water uptake. Other level of this scenario is the interaction between plant with transformed roots and biocontrol agents with the object to counteract phytopathogens. In chili pepper, a major problem is the root rot and wilt where the prominent causal agents are *Phytophthora capsici*, *Fusarium solani*, *Fusarium oxysporum* and *Rhizoctonia solani*.

The object in this work is to analyze the variability in the response in “mirasol” chili pepper plants with *Rhizobium rhizogenes* transformed roots when inoculated with bacterial or fungal biocontrol agents and afterward with two root rot causal pathogens. The experiments included three *R. rhizogenes* strains used to transform the roots, three bacterial strains and a binucleate *R. solani* avirulent strain as biocontrol agents, all of these in independent experiments, and *P. capsici* and *R. solani* virulent strains simultaneously. Disease index, dry weight accumulation and the expression of two defense genes were quantified to assess the plant response.

In results, from *in vitro* experiments, in all plants with transformed roots the index disease equivalent as plants with normal roots; bacterial biocontrol agents in plants with transformed roots protect differentially against pathogens, correlating with dry biomass accumulation. In greenhouse experiments, all the biocontrol agents including bacteria and the avirulent *R. solani* strain protect notably with statistical differences against the phytopathogens in comparison to control treatment, also correlating with dry biomass accumulation. In the defense gene expression in plant, two genes (PR1 and sesquiterpene cyclase) shows notable differences between the *R. rhizogenes* strain used to transform the root, and more notable in comparison to plants with not transformed roots.

In conclusions, the genotypes of the *R. rhizogenes* strain used to transform and in the bacterial strain used to protect the plant against pathogens, contribute each one notably and differently in the protection against pathogens.

Presenter Bio: Dr. Saúl Fraire is a senior researcher with 15 years of experience in research in plant-microorganism interactions, and currently focusing in genomics of bacterial biocontrol agents to counteract phytopathogens.

GENOMIC AND BIOLOGICAL TRAITS IN FOUR NATIVE BACTERIAL STRAINS ACTING AS PLANT GROWTH PROMOTERS AND BIOCONTROL AGENTS AGAINST ROOT PATHOGENS IN *CAPSICUM ANNUUM* L.

Jaime Sagredo-Beltrán¹, Yumiko De la Cruz-Rodríguez¹, Alejandro Alvarado-Gutiérrez¹, Julio Vega-Arreguín², Miguel Alvarado-Rodríguez², **Saúl Fraire-Velázquez¹**

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With the increasing social pressure to produce farm foods free of pesticides, besides the need to safeguard our environment, including the biodiversity, the biocontrol of phytopathogens is an option that arrived to stay. The advances in biological sciences with the omics tools have allowed deciphering general and specific genomic characteristics in outstanding organisms, in this case of agricultural relevance. In *Capsicum annuum*, a notable and persistent disease is the root rot and wilt caused firstly by *Phytophthora capsici*, *Fusarium solani*, *Fusarium oxysporum*, and *Rhizoctonia solani*.

The object of this work is the isolation of soil and rhizospheric native bacterial strains with the outstanding properties of biocontrol against four root rot causal pathogens in *C. annuum*, and the genome sequencing and biological function's description as notable traits in the more outstanding bacterial strains.

In twenty six successful scrutinized bacterial strains antagonists to root rot causal pathogens in chili pepper, half of them exhibit friendly interaction when inoculated in roots of the pepper plant, four antagonize to at least three of the four phytopathogens tested (*P. capsici*, *F. solani*, *F. oxysporum*, and *R. solani*), the four strains are outstanding in indoleacetic acid (IAA) biosynthesis and one is siderophore producer. The genomes of these four bacteria were sequenced. In comparative genomic analysis, these bacteria correspond to *Bacillus* genus, with a genome size ranging around 4 MB, containing in average 4,100 genes. All of these *Bacillus* sp strains count with genes with antifungal functions including nonribosomal peptide synthetases implied in the production of the antibiotic anticapsin; beta-glucanase, probably involved in cell wall degradation in fungi, *BacA*; butanediol dehydrogenase, butanediol as inducer of systemic resistance (ISR) in plants; the *CheA*, *CheC* and *CheY* genes involved in chemotaxis, surely making easier the way to the plant root colonization; one *Bacillus* sp. strain with glycine/betaine ABC transporter system correlating with outstanding properties in salt stress.

In conclusion, in 26 bacterial strains with inhibition against root rot causal pathogens, of these, 12 with friendly interaction in root in pepper plants, four antagonists to at least 3 of these pathogens, and in these four microorganisms, the sequenced genomes and comparative genomic analysis shows these bacteria pertain to species of *Bacillus* genus, furthermore, the sequenced genomes exhibit genes with the biological functions of antibiotic production against fungus, chemotaxis, ISR activation in plant and halotolerance.

Presenter Bio: Dr. Fraire is a senior researcher with 15 years of experience in research in plant-microorganism interactions, and currently focusing in genomics of bacterial biocontrol agents to counteract phytopathogens.

AN EXPERIMENTAL SHAKE METHOD OF BELL PEPPER FRUIT REMOVAL YIELDS INFORMATION USEFUL IN BREEDING FOR MECHANICAL HARVEST

Glen Fischer, Robert Heisey and Nathan Sano

California Pepper Commission, Dinuba, CA USA

As the cost of labor in California continues to climb, it is clear that the pepper industry will have to move to mechanical harvest of bell pepper for the processing industry. Peppers destined for fresh market would also be harvested mechanically if the quality of the product were to be acceptable.

Currently about one fourth of the green and mature bell peppers destined for processing are harvested mechanically, by machines which are mostly modified tomato harvesters. The California Pepper Commission is funding a research project aimed at developing methodology we can use to evaluate removal characteristics of bell pepper fruit, to determine if we can breed a pepper plant with fruit removal characteristics which would make the fruits easier to remove by machine, with less damage to the pods.

We are also interested in determining if shake technology can be adapted to a harvest machine, to improve the handling of the fruit during mechanical harvesting.

Seed companies were asked to contribute any of their bell pepper varieties to the CPC trial. We specified that the varieties did not have to be California-adapted varieties. Plants from four of these trials (one green fruit, three red) were subjected to the “shake” method of fruit removal, with a modified paint-can shaker. Data has been collected and will be analyzed, to determine if any of these currently available varieties have an easy-detachment characteristic which would be useful in improving mechanical harvest of bell pepper.

Presenter Bio: Dr. Heisey is chairman of the California Pepper Commission Research Committee, He has more than 35 years of experience as a pepper and tomato breeder, currently with United Genetics Seeds in Hollister, CA.

DOUBLED HAPLOID BREEDING TECHNOLOGY FOR PEPPER

Marco Vennik, **Wessel Holtman**, and Bert van Duijn

Fytagoras BV, Leiden, The Netherlands

For pepper (*Capsicum* spp.) doubled haploid technology is used by numerous breeders all over the world. In a single step 100% homozygous plants can be produced from microspores in tissue culture. In comparison, traditional back-crossing takes several generations, and even then plants are still not 100% homozygous. Using doubled haploid technology, the breeding progress is accelerated enormously, new varieties can be released much faster in the market and faster anticipation towards demands of customers is possible. Furthermore, generation of homozygous parent lines enables seed production of identical and homogenous elite off-spring (F1 hybrids). The elite offspring cannot be further propagated by seed without losing the elite characteristics. This offers hybrid variety protection because the parents of the elite hybrids are only in possession of the owner.

Though benefits of using doubled haploids are obvious, in the production of doubled haploids often poor androgenic responses are encountered for many genotypes. Several studies show a strong dependency of the androgenic response on genotype, type of pretreatment and growth medium composition. The exact underlying mechanism of androgenesis induction has not yet been elucidated, which makes its application not self-evident.

Fytagoras is a research company pursuing research and application of doubled haploid technology for many years. Protocols were developed for several species, including vegetable crops and ornamentals. In this respect, recalcitrant behavior of pepper, and poor androgenic response for specific genotypes was recognized. Therefore, Fytagoras initiated research activities to increase the efficiency of doubled haploid pepper plant production, aiming at applicability of the technique for all genotypes. Much effort has been expended to understand the issues, while enhanced understanding is now available as services to the industry. In doing so, Fytagoras offers production of doubled haploid pepper plants on demand, while screening of genotypes enables pepper breeders to visualize characteristics of a wide range of their genetic pool.

Presenter Bio: Dr. Holtman is a researcher with more than 20 years of experience in applied plant science research projects. In his current position as a commercial manager he links demands from seed companies to research activities at Fytagoras.

MANAGING (?) PEPPER WEEVIL IN NEW JERSEY

Joseph Ingerson-Mahar

Rutgers University, New Brunswick, NJ, USA

New Jersey has a long history of sporadic pepper weevil infestations. Only recently (2013) have we been able to determine how pepper weevils arrive in the state and how they spread field to field. Since chemical control only suppresses the field population, I have been looking at all possible non-chemical options including crop placement, sanitation, and cooperation from processors to manage weevils. Currently, I am looking at the use of vacuums to remove infested aborted fruit; developing a means to estimate crop loss; and strategic placement of pheromone traps.

Presenter Bio: IPM consultant in Michigan from 1980 to 1987; Rutgers Field Crops IPM Agent 1988 to 1998; and Rutgers Vegetable IPM Senior Program Coordinator since 1999. MS Entomology, 1987, Michigan State University; PhD Entomology, 2014, Rutgers University

MANAGEMENT OF THRIPS, VECTOR OF TOSPOVIRUS AFFECTING PEPPER IN SOUTH FLORIDA

R. A. Khan and D. R. Seal

University of Florida/IFAS, Tropical Research and Education Center, Homestead, FL, USA

Florida ranks first in the nation in growing about 19,000 acres of pepper. Pepper is grown in south Florida as a fresh market winter vegetable. Pepper is susceptible to various pests and disease pathogens. *Tomato chlorotic spot virus* is one of the emerging tospoviruses in south Florida. The virus has been detected in tomato and pepper in south Florida, causing 30-40% yield loss, and in tomato, pepper, jimsonweed and lettuce in Puerto Rico. Thrips are the efficient vector of tosviruses and transmit the disease in a persistent propagative manner. Western flower thrips (*Frankliniella occidentalis*) and common blossom thrips (*F. schultzei*) are two known vectors of TCSV in Florida. Once the early immature stage of thrips acquire the virus from an infected plant during feeding, the developed adults can be viruliferous up to the life time and can transmit the disease to a new healthy plant. In this present study, we used pepper, bean, squash, cucumber, eggplant and okra as associated plants (treatments) of tomato to observe the effect of these vegetable plants in introducing TCSV and its vector thrips in tomato. The treatments were evaluated for thrips abundance by collecting leaf and flower samples. Higher number of thrips (various species) was observed in both flower and leaf samples of squash, cucumber and eggplant. Comparatively higher number of adult vector thrips (common blossom thrips and western flower thrips) were found in pepper flowers than the pepper leaf. Tomatoes planted with pepper showed higher number of TCSV infestation compared to other vegetable treatments. Information from this study will be helpful for the growers to manage both TCSV and its vector thrips.

Presenter Bio: Rafia A. Khan is a Graduate Research Assistant, doing Ph.D. research on tospovirus (*Tomato chlorotic spot virus*), its vector and hosts plants for 3 years in Miami-Dade County.

SCREENING BELL PEPPERS FOR RESISTANCE TO BACTERIAL LEAF SPOT (*XANTHOMONAS SPP*)

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Bacterial leaf spot (BLS), caused by the pathogens *Xanthomonas euvesicatoria*, *X. perforans*, *X. gardneri*, and *X. vesicatoria*, is the second most important disease on peppers in New Jersey. Disease development is favored by high humidity, hard driving rains, vigorous plant growth, infected stakes and working in the field when plants are wet. There are eleven (0-10) races of BLS identified in the United States. Most commercial bell pepper cultivars grown in New Jersey are resistant to races 1-3 which have been the main races found in the Northern United States. In 2004, growers reported resistant cultivars to races 1-3 were being infected with BLS. A series of screening trials were carried out to determine if other races were present in the state. It was determined that race four was found in southern New Jersey, but not in the North. Since 2004, cultivars (e.g., 'Turnpike', 'PS0994-1819', 'Vanguard' and 'Tomcat') have been released with resistance to race 4.

In 2013, NJ growers noticed BLS showing up on cultivars which were resistant to races 0-5. Differential studies were established to determine if additional races were present in New Jersey. Plots were setup in the southern and northern regions of the state with cultivars with resistance to different BLS races. As in previous differential studies, it was determined that other races were prevalent in South Jersey, but not North Jersey. The only cultivars that did not express any symptoms were those resistant to all races. Races 6 and 10 could not be distinguished from one another since they are closely related. This screening trial has been repeated twice with similar results.

In 2016, we started screening cultivars and advanced breeding lines for resistance to all races of bacterial leaf spot. In 2017, the trial was carried out in a grower's field where BLS has been a problem for several years. Plots were established on black plastic mulch with one drip line, plants at 18 inches in double rows and 5 ft. between beds center to center. All cultural practices such as staking/tying, fertilization and pest management was carried out by the grower.

Based on seed company information, the entries '9325', 'CLX-1108', 'Tracer', 'Raven' and Prowler had resistance or intermediate resistance to all known races; 'Paladin' no resistance; 'Turnpike' resistant to 0-5 and 7-9; 'Revolution' resistant to 1-3 and 5. The plots were rated on a weekly basis for BLS. The first BLS was observed on July 18 in the following entries: 'Paladin', 'Turnpike', and 'Revolution'. By the end of the harvest season all entries except '9325' and 'CLX-1108' had BLS symptoms. All the symptoms were on leaves and none observed on the fruit during harvest.

The entries were harvested five times and graded for size. 'Turnpike' had statistically more boxes of extra-large peppers and had the greatest number of total boxes per acre. However, for total boxes it was not statistically different from 'Paladin', 'Prowler', or 'CLX-1108'. The line 'CLX-1108' showed no BLS symptoms by the end of the trial. The other entry with no symptoms had the lowest yield.

Presenter Bio: Dr. Kline is a Cooperative Extension Agent and Associate Professor with more than 20 years of experience in pepper crop management and cultivar selection.

DEVELOPMENT AND TESTING OF A COMMERCIAL FULLY AUTOMATED FRESH GREEN CHILE AND JALAPENO DESTEMMER

Nag Kodali

DeStem Cell, LLC, Pelham, NH, USA

The chile pepper industry is under tremendous pressure due to mounting harvesting costs and a diminishing manual labor pool. The cost of manual labor to harvest the crop constitutes approximately 50% of the total cost of farming chile peppers. Chile researchers, farmers and processors have been actively trying for many years to help the industry switch from manual harvesting to mechanical harvesting just to keep the industry alive. For the processing industry, manual laborers pick chile fruit without the stem as canning is normally completed within 24 hours from the time the chile leaves the field. Mechanical harvesters do a reasonably good job of picking peppers, albeit with stem in place. Therefore, an automated mechanical destemmer is an absolute necessity for the farmers to widely embrace mechanical harvesting.

This presentation discusses the development and field trials of a fully automated green chile and jalapeno destemmer that is ready for commercial deployment by the industry. The development of the destemmer that occurred over the last five years as it progressed from a concept into four successive prototypes and the final product will be described. The destemmer's mechanism of gently detaching the stems from the pods at high throughput rates resulting in whole, unopened, destemmed pods will be presented. Retention of the complete structural integrity of the pod after destemming is critical as broken or cut pods are susceptible to moisture loss, degradation and reduced quality. In addition, undamaged pods allow canneries more processing time. The destemmer's field trials on multiple varieties of green chile, jalapenos and anchos in New Mexico, Arizona and California will be shown and the results discussed. Advantages of a completely mechanical destemming machine vis-a-vis an imaging and sensor based machine will also be discussed.

Financial support from the New Mexico Chile Association, the New Mexico State University and the New Mexico Chile Commission is gratefully acknowledged. Operational assistance provided by Ed Curry of Curry Seed and Chile Company, and technical advice from Marvin Clary of Clary Ag Service are well appreciated.

Presenter Bio: Nag Kodali has been working on the design, fabrication and testing of a mechanical chile destemmer since 2012 in close association with the New Mexico Chile Association, the New Mexico State University and the Curry Seed and Chile Company. He was issued four patents on this topic by the USPTA. From 2000 to 2012, he developed database applications for Knowledge Management, Inc. and served as its Director of Information Technology. Prior to 2000, Dr. Kodali worked as a post-doctoral research associate and a visiting assistant professor at the University of Massachusetts – Lowell and the University of Toledo, Ohio. Nag holds a Ph.D. in organic chemistry from the Indian Institute of Technology, Mumbai, India, and an EMBA from Yale University.

COMPARISON OF *TYPHLODROMIPS MONTDORENSIS* TO OTHER PHYTOSEIID MITES FOR THE SHORT-SEASON SUPPRESSION OF THRIPS ON GREENHOUSE PEPPER

Roselyne M. Labbe, Dana Gagnier, and Les Shipp

Harrow Research and Development Centre, Agriculture and Agri-Food Canada, Harrow, Ontario, Canada

Under short-season greenhouse conditions, suppression of western flower thrips, *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae) on pepper plants by predatory mites can vary considerably between mite species. Evidence suggests that some mite species are well suited for thrips suppression in both cool and warmer conditions relative to others. Prior to this study, a direct comparison between species remained to be conducted for new and existing predatory mites on greenhouse pepper crops in North America. As such, this study assessed the laboratory and greenhouse performance of a novel phytoseiid mite, *Typhlodromips montdorensis* Schicha (Acari: Phytoseiidae) for suppression of thrips under both summer and winter conditions. Laboratory trials compared rates of thrips predation and oviposition by *T. montdorensis* and showed that this predator could consume similar numbers of L1 thrips under either winter or summer, but that predator oviposition was considerably reduced in wintertime. In short-season greenhouse cage trials, crop establishment of *T. montdorensis* relative to three other phytoseiid mites (Acari: Phytoseiidae): *Amblyseius swirskii* Athias-Henriot, *Amblydromalus limonicus* Garman & McGregor and *Neoseiulus cucumeris* Oudemans, was compared. Over four weeks, the number of predatory mites was greatest for *T. montdorensis* cages, and these exhibited high levels of thrips suppression, equal or above to those achieved by *A. swirskii* or *A. limonicus* treatments, and far superior to those by *N. cucumeris*. Implications for these findings on year-round thrips management in North America are discussed.

Presenter Bio: Dr. Roselyne Labbe is a Research Scientist in Greenhouse Entomology at the Harrow Research and Development Centre (HRDC) at Agriculture and Agri-Food Canada. Dr. Labbe has worked to develop greenhouse biological control and novel pest management strategies for crops such as pepper since 2002 when she first studied the intraguild interactions among biological control agents used to suppress greenhouse pests. She has previously worked to understand and mediate the molecular mechanisms of resistance in greenhouse crop pests. Dr. Labbe's current work focuses on the development of new tools for the integrated control of pests including the pepper weevil and western flower thrips through multiple projects she has either led or collaborated including surveys for parasitoid wasps that attack the pepper weevil, exploring the use of supplemental foods for improved predatory mite suppression on pepper crops, and evaluating new agents such as the predatory mite *Typhlodromips montdorensis*. She also studies the impact of supplemental lighting on greenhouse arthropods and is working to identify new biocontrol agents for the suppression of invasive and emerging crop pests in North American greenhouse crops.

PARASITIDS OF THE PEPPER WEEVIL ACROSS NORTH AMERICA: IDENTITY, BEHAVIOR AND BIOLOGICAL CONTROL POTENTIAL

Roselyne M. Labbe, Dana Gagnier, Rebecca Rizzato and Catalina Fernandez

Harrow Research and Development Centre, Agriculture and Agri-Food Canada, Harrow, Ontario, Canada

The pepper weevil, *Anthonomus eugeni* Cano, is an important crop pest in North America where it poses ongoing challenges to commercial pepper production. Recently, the pepper weevil has been encountered as far north as Canada, normally following importation in wintertime when local production is insufficient to meet market demand. Due to the cryptic biology of this species, in which larvae are protected within the pepper fruit, targeting this life stage for management through conventional means is a challenge. However, parasitoids that attack the pepper weevil may confer a degree of suppression of these immature life stages, and may be useful for the integrated management of this pest on pepper crops. In 2016, following reports of local and transient populations of the pepper weevil, a field survey was conducted in Ontario to find natural enemies that may contribute to its control. The survey discovered a diversity of parasitoids that may use the pepper weevil as a host, including members of three hymenopteran families; Pteromalidae, Braconidae and Eupelmidae. Some parasitoid species identified have previously been known to attack the pepper weevil in Mexico and the United States, but are new records to Canada. Others are known parasitoids of congeneric species such as the cotton boll weevil, *Anthonomus grandis*. Following these findings, we now report on trials that have begun to further our understanding of the biology and control potential of *Jaliscoa hunteri*, the dominant parasitoid of the pepper weevil now found throughout North America.

Presenter Bio: Dr. Roselyne Labbe is a Research Scientist in Greenhouse Entomology at the Harrow Research and Development Centre (HRDC) at Agriculture and Agri-Food Canada. Dr. Labbe has worked to develop greenhouse biological control and novel pest management strategies for crops such as pepper since 2002 when she first studied the intraguild interactions among biological control agents used to suppress greenhouse pests. She has previously worked to understand and mediate the molecular mechanisms of resistance in greenhouse crop pests. Dr. Labbe's current work focuses on the development of new tools for the integrated control of pests including the pepper weevil and western flower thrips through multiple projects she has either led or collaborated including surveys for parasitoid wasps that attack the pepper weevil, exploring the use of supplemental foods for improved predatory mite suppression on pepper crops, and evaluating new agents such as the predatory mite *Typhlodromips montdorensis*. She also studies the impact of supplemental lighting on greenhouse arthropods and is working to identify new biocontrol agents for the suppression of invasive and emerging crop pests in North American greenhouse crops.

ASSESSMENT OF RECONSTITUTION OF THE RECURRENT PARENT (CMS A-LINES) GENOME BY USING MOLECULAR MARKERS

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²Directorate of Research, Punjab Agricultural University, Ludhiana, India

The homology between newly developed three cytoplasmic male sterile (CMS) A- and their corresponding CMS B-lines (alloplasmic maintainer) was assessed by using SSR markers. The purpose was to ascertain whether genome of the recurrent parent has been fully recovered after 5 cycles of backcrossing (BC_5F_1) and selection. For this purpose, 120 SSR markers covering the whole *Capsicum* genome were screened. Out of 120 markers screened, 84 markers (70.0%) were amplified in 'CMS4611A' and 'CMS4611B' lines, 90 markers (75.0%) in 'CMS4626A' and 'CMS4626B' lines and 88 markers (73.3%) in 'CMD463D13A' and 'CMD463D13B' lines. Almost all the amplified markers showed monomorphic bands between the A- and the B- lines. Between 'CMS463D13A' and 'CMS463D13B' line, polymorphic banding patterns were observed by two markers for chromosome 1 (GPMS 191 and CAMS 679), and by one marker for chromosome 2 (CAMS 177). One marker showed polymorphic bands between 'CMS4626A' and 'CMS4626B' line for chromosome 1 (GPMS 191), and one marker (HpmsE 065) between 'CMS4611A' and 'CMS4611B' line for chromosome 10, but the percentage of marker which showed the polymorphic bands, were negligible (1.2% in CMS4611A and B-line, 1.1% in CMS4626A and B-line, and 3.4% in CMD463D13A and B-line). The probable reasons for polymorphism between the A- and their corresponding B-lines could be attributed to either some genetic drag between lines or due to the technological limitations. After five cycles of backcrossing (BC_5F_1) and selection, the genome recovery of the recurrent parent in 'CMS4611A', 'CMS4626A' and 'CMS463D13A' was estimated to be 98.8, 98.9 and 96.6%, respectively, measured by percentage of the monomorphic marker ratios. Since the CMS lines are maintained by backcrossing with the respective maintainer lines, 100% genome the recurrent parent will be recovered with additional one or two backcrosses.

Presenter Bio: Dr Meena obtained his Ph.D. degree in 2017 at Punjab Agricultural University (PAU), Ludhiana, India. Since December 2017, he is working as Research Fellow in the Department of Vegetable Science, PAU, Ludhiana. He has published 15 research and two review articles in peer reviewed journals, and authored one book, one book chapter and three magazine articles. He also developed genetic stocks incorporating cytoplasmic male sterility gene in chili pepper.

EVALUATION OF 37 DIFFERENT PEPPER CULTIVARS IN SOUTH FLORIDA, 2014 - 2018

Christian F. Miller¹, Gene McAvoy², Richard Raid³, and Monica Ozores Hampton⁴

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Responsible for 29% of the total U.S. value for fresh market bell peppers, Florida's 13,500 acres of planted bell peppers is second only to California. The relatively warm and dry winter climate of south Florida makes the region an ideal location for vegetable production. The subtropical environment is however conducive to year-round pest populations and disease development. Consequently, the pepper industry relies on the release of new resistant cultivars to replace older varieties suffering from yield and quality decline. A 2015 survey of area pepper growers revealed switching from disease susceptible to resistant cultivars resulted in an average savings of \$450 per acre per crop due to higher yields and reduced pesticide applications.

Bacterial leaf spot (BLS), caused by the bacterium, *Xanthomonas euvesicatoria*, has traditionally been one of the most serious diseases of pepper in south Florida. The University of Florida (UF) Extension Service therefore conducts annual bell pepper cultivar trials with the cooperation of local commercial growers to evaluate yield performance and disease resistance. Since last reported to the International Pepper Conference in 2013, 37 different bell pepper cultivars were evaluated by UF in south Florida.

Where feasible, two harvests were collected to determine yield by size categories. Postharvest quality traits such as number of lobes, pepper length, width, and thickness were also evaluated. No symptoms of BLS were detected on any evaluated cultivar despite conditions conducive for disease development.

Over the 2014 – 2018 trials, total marketable yield from the first harvest ranged from 1,532 (*Blitz*) to 452 (*7141*) 28-lb bu/acre. A second and final harvest was conducted for two of the four cultivar trials and resulted in a yield range between 1,672 (*Bayonet*) and 192 (*Aristotle*) bu/acre.

Quality characteristics including fruit length, width, and thickness were measured in inches with length ranging from 4.48-in (*Samurai*) to 3.10-in (*9325*). Width ranged from 4.27-in (*RPP 43212*) to 3.42-in (*Touchdown*). With 0.303-in, *Aristotle* had the greatest thickness, though several cultivars reached a minimal thickness of 0.220-in. Several cultivars tied at 3.17 for number of lobes per fruit, though *XPP-2622* was highest with 4.33.

These data summarize four cultivar trials conducted on commercial pepper fields at different south Florida locations from 2014 – 2018. Growers are encouraged to take into account the variability of weather, planting dates, and harvest data collected from multiple trials when selecting cultivars to plant.

Presenter Bio: Dr. Miller is the Commercial Vegetable Extension Agent for the University of Florida in Palm Beach County, Florida. Since 2012, Christian has collaborated with other UF/IFAS Extension specialists on research projects relevant to the sustainability, profitability and competitiveness of pepper growers and has 30-years of horticultural experience.

UNDERSTANDING THE SEASON LONG INCIDENCE OF PEPPER WEEVIL IN THE SANTA CLARA AND SAN BENITO PEPPER PRODUCTION AREAS

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Pepper weevil is a serious threat to pepper production in Santa Clara and San Benito counties in California. In California, this pest is known to cause serious problems in southern pepper production regions for many years but not in pepper fields of Santa Clara and San Benito counties. To understand the extent of the pest problem and its seasonal incidence and abundance, sixty-three and sixty pepper fields were monitored in the Santa Clara-San Benito production region from May to November in 2016 and 2017, respectively. Pheromone-baited yellow sticky traps were deployed in grower fields and were assessed weekly. Results show the pepper weevil infestation was more intense in 2017 than in 2016 as 1,106 and 3,100 adults were captured in 2016 and 2017, respectively. Second, it appears that there are two peaks of adult incidence during the production season: first peak in the beginning of the season in June and the second around September-October. During the spray period from June to August, weevil counts were low (~two weevils per field). Starting in August, which overlaps with decrease in insecticidal application, fields became heavily infested until the end of October in 2016 and mid-November in 2017. The peak infestation levels of the season shifted from September in 2016 (330) to October in 2017 (463). From October onwards, severe fruit drop was observed in some infested fields. Upon inspection, dropped fruits were found to be infested with various stages of pepper weevil. The weevil infestations increasing each year over the period 2015-2017 and the presence of the weevil in the fields at the beginning of the season lead us to believe that the pest overwinters and has established in this region.

Presenter Bio: E. Mineo is a Jr Specialist at the UCCE in the Small farm Program, which provides research-based support to growers on pest, irrigation and nutrient management as well as food safety in small-scale farms.

HOT PEPPER IX: MODIFIED ATMOSPHERE PACKAGING AND CHILLING INJURY TOLERANCE OF TWELVE ORNAMENTAL PEPPER GENOTYPES

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Ornamental pepper fruits are susceptible to physiological disorders that influence fruit quality. Among the most important of these is their susceptibility to chilling injury (CI). This problem limits the use of low storage temperature to manage postharvest quality, and seriously affects the ability of handlers to store or transport fruits over long distances, because temperatures that are low enough to delay senescence may also be damaging to the fruit. Evaluation of twelve (12) ornamental pepper genotypes was investigated to determine their relative sensitivity to chilling injury (CI), marketable quality and decay. Five fruits from each genotype were seal-packaged in 0.035 mm thick low density polyethylene bags (LDPE), and stored at 7°C and 90-95% relative humidity and subsequently transferred for an additional day at 28°C. A similar allocation of fruits from each genotype was stored in air as control at 28°C. Although fruits were supplemented with modified atmosphere packaging (MAP), the advent of chilling injury symptom development, marketable quality and decay incidence varied among the 12 genotypes. Genotypes 3 and 4 accounted for the best shelf life with fruits securing marketable values of 67% and 62% respectively after 15 days at 7°C which was almost two-folds greater compared to their counterparts stored at 28°C. While the same two genotypes were chilling tolerant after continuous storage of 15 days at 7°C, obvious symptoms of chilling injury such as pitting, stem and calyx discoloration and seed darkening were manifested even after 1 day exposure to 28°C. At the same time, the majority of genotypes particularly 1, 2, 5, 9 and in particular 8 and 11 succumbed to severe chilling injury due to the high incidence of decay dominated with bacterial soft rot. Secondary infections induced by CI aggravated with multiple infections further compromised marketable quality and usability of genotypes 8 and 11 which were eventually identified with the highest sensitivity to chilling injury. Despite having a modified atmosphere package to store fruits genotypic characteristics appeared to be the major limiting factor in the determination of chilling injury susceptibility and marketable quality of ornamental peppers.

HOT PEPPER X: ASSESSMENT OF POSTHARVEST LOSSES OF HOT PEPPERS AT SEVEN MARKET OUTLETS IN TRINIDAD

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Hot pepper fruits are highly perishable resulting in losses at different stages in the postharvest handling system. Assessment of qualitative and quantitative losses at critical control points in the value chain is necessary to optimize quality and reduce losses. Postharvest losses were measured using the Commodity System Assessment Methodology (CSAM) for hot peppers at seven market outlets in Trinidad. Postharvest losses of hot peppers were highest at roadside markets compared to those at other outlets in the dry and wet seasons respectively. Losses in the wet season at roadside outlets were 6.2% greater than those recorded in the dry season. The outlet with the second highest losses in hot peppers was supermarkets with chain stores (SWCS) with 24.1% in the dry season and 29.4% in the wet season. Wholesale markets showed the lowest losses in both seasons. Physical damages such as split and decapped pedicels and calices, fruit cracks and to a lesser extent bruising occurred more often in wholesale markets than in the other outlets in the dry season. Physiological damage due to chilling injury expressed visibly as darkened pedicels and calices, seed discolouration, translucency of pericarp and pitting were most evident from samples taken at roadside outlets and at supermarkets with and without chain stores. As a result, losses due to physiological damages were higher at roadside outlets in both seasons compared with those from physical and pathological damages respectively. Other physiological disorders such as desiccation, sunscald and deformed fruits were prevalent at the other outlets. Pathological losses due to Anthracnose, bacterial soft rots and virus-induced infection from thrips and mite attacks, were more prevalent, and therefore accounted for higher incidence of losses, in the wet than in dry seasons at each market outlet. Anthracnose infected fruits initiated in the field which were barely visible at harvest became more obvious at later stages in the handling system and eventually resulted in a total loss. The CSAM methodology provided the template for identification of the dynamics and logistical factors underlining the causes of losses as well as corrective actions to minimize such losses.

IS POSSIBLE TO ADVANCE BREEDING PROGRAM OF ORNAMENTAL CHILI PEPPERS: BY IN VITRO CULTURE OF ZYGOTIC IMMATURE EMBRYOS?

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The improvement of ornamental chili peppers by hybridization and conduction of segregating populations, require several cycles of self-fertilization to obtain pure lines. Furthermore, it is necessary that fruits are fully ripe, because the germination rate is very low when fruits are harvested immature. In this sense, efforts to reduce self-fertilization cycles can accelerate the breeding program and reduce costs in the cultivar release. The use of in vitro culture of immature zygotic embryos has been gaining importance in breeding programs. Then, the objective of this work was to evaluate the efficiency of the in vitro culture of immature zygotic embryos (IZE System) in the reduction of the improvement cycle of ornamental chili pepper (*C. annuum*) in comparison to the conventional system. Three genotypes of ornamental chile pepper were used: UFPB001, UFPB004 and UFPB099. Embryos with 30 days after the first self-fertilization, were cultured in Murashige & Skoog medium (½ strength), and at the same time, seeds were placed to germinate on commercial substrate, and then the development phases were monitored in both systems for comparison. In the conventional system, it takes 217 days of self-fertilization to fruit maturation, while in the IZE System, is required only 153 days, representing a reduction of 64 days per selection cycle (40% of the time), reducing labor costs and inputs, and decreasing the time of the release of cultivars. In conclusion, the IZE System was efficient to reduce the breeding cycles when compared to the conventional system in the breeding program of ornamental chili peppers.

Presenter Bio: Mailson Monteiro do Rêgo was a Plant Breeder since 1997 and have made use of plant tissue culture as an auxiliary tool to the ornamental pepper breeding program, with another culture, somatic embryogenesis, in vitro fertilization, embryo rescue, and conservation of genetic resources.

NIMITZ[®], A NON-FUMIGANT, CONTACT NEMATICIDE REGISTERED FOR USE IN CAPSICUM CROPS

P. A. Navia Gine, D. J. Erasmus, and S. R. Eskelsen

ADAMA Agricultural Solutions, Raleigh, North Carolina, USA

NIMITZ[®] is an efficacious nematicide providing control of plant-parasitic nematodes with minimal impact on beneficial nematodes. In comparison to fumigants, application of NIMITZ is simple, and "*... represents a safer alternative for nematode control with a new mode of action and a much simpler and straightforward product label.*" (U.S. Environmental Protection Agency, Federal Docket, July 24, 2014). NIMITZ is labelled with a 'CAUTION' signal word. NIMITZ requires no Fumigant Management Plans, no 24-hour field monitoring, no buffer zones, has a 12 hr re-entry interval (REI) and minimal personal protective equipment (PPE).

In addition to earlier registrations for fruiting vegetables and cucurbits in 2014, the following crops were added to the label in June 2016: Crop Group 4, Leafy vegetables (except Brassica vegetables), Crop Group 5, Brassica (Cole) leafy vegetables, Crop Group 13-07G, Low growing berries, including strawberry, and tobacco. More recently, in March and April of 2018, further crops were added to the NIMITZ 480 EC label. These are Crop group 1B, Root Vegetables (except sugar beet) subgroup, including carrot and radish; Crop groups 1C, Tuberous and Corm vegetables including potato and sweet potato; Crop Group 11-10, Pome Fruit; Crop Group 12-12, Stone Fruit; Crop Group 14-12, Tree Nuts; Crop Group 13-07D, fruit, small vine climbing subgroup including grapes and kiwi; and Sugarcane.

The active ingredient, fluensulfone, has a unique mode of action which categorizes the product within a new chemical classification. NIMITZ causes irreversible nematicidal activity resulting in plant-parasitic nematode mortality within 24 to 48 hrs.

NIMITZ provides competitive nematode control when compared to commercial available standard products. Application options include chemigation via drip-injection and sprinkler and soil-applied broadcast or banded spray followed by mechanical incorporation. And, depending on the crop, application is made at plant, 7-10 day pre-plant or at spring and fall root flush in perennial tree crops.

NIMITZ is currently registered in 35 states and Puerto Rico. Two additional states are pending. The most recent Federal EPA labelled crops have been registered in these states with California state registrations in progress.

MACRONUTRIENT MINERAL CONTENT OF *CAPSICUM ANNUUM* FRUITS FROM GENOTYPES RESISTANT AND SUSCEPTIBLE TO *XANTHOMONAS EUVESICATORIA*

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Universidade Estadual do Norte Fluminense Darcy Ribeiro, Rio de Janeiro, Brazil

Chili peppers fruits have high vitamin values and are sources of ascorbic acid, carotenoids, tocopherols, flavonoids and capsaicinoids. Mineral elements constitute only 4 to 6% of the total dry matter of the fruits but are essential for various metabolic functions of the plant. In addition, they may be involved in defense mechanisms, increasing or decreasing the resistance of plants to pathogens. This work aimed to determine the macronutrient mineral content of *Capsicum annuum* fruits from resistant (UENF1381) and susceptible (L11) to *X. euvesicatoria*, one of the pathogens involved in the bacterial spot disease. The seeds were sown in trays of polystyrene with vermiculite as substrate, irrigated with deionized water until the appearance of two pairs of definitive leaves and transplanted into 5L plastic vessels containing sand and vermiculite in a ratio of 2:1. Hoagland solution was used for nutrition and added every three days. The experimental design was completely randomized with two treatments: a) resistant UENF 1381 and b) L11 susceptible to *X. euvesicatoria*. The fruits were collected at 30 and 40 days after the anthesis (DAA), separated into two parts (pericarp and seeds with placenta) and then kept frozen in a freezer at -20 °C. Before analysis, each fruit part was lyophilized, macerated with liquid nitrogen, weighed and digested in nitric acid and the samples mineral content were analyzed by ICP-OES. External calibration with a range of 0.1 mg L⁻¹ to 50 mg L⁻¹ (Ca, Mg, P and S) and 1 mg L⁻¹ to 200 mg L⁻¹ (K) were used to the quantitative analysis of these elements. Averages and standard deviation of the results were obtained. There were significant differences in the mineral content between the genotypes in pericarps of fruits collected 30 DAA. Phosphorus and magnesium concentrations are higher in L11 and potassium concentration higher in UENF1381; in pericarps with 40 DAA, calcium concentration was higher in L11 while magnesium and potassium were higher in UENF1381. Calcium and magnesium are present in higher concentrations in L11 and sulfur in higher concentration in UENF1381, in the seeds with placenta for 30 DAA samples. For 40 DAA samples, magnesium and potassium presented higher concentrations in L11. There were significant differences in the macronutrients mineral contents in pericarp and seeds with placenta related to the genotype and to the ripening stage of the fruits. These differences may be associated with specific characteristics of the genotypes and some elements involved in a biosynthetic route related with a defense mechanism of the UENF1381 genotype. The different levels of some elements in the resistant genotype may be related with some biosynthetic route to be associated with the genetic resistance to *Xanthomonas euvesivatoria*.

Presenter Bio: Sthefanny Almeida doctoral student in Natural Sciences, emphasis on environmental chemistry, working with chili peppers, potentially toxic metals and bacterial spot for 2 years.

IDENTIFICATION, MONITORING AND MANAGEMENT OF SERIOUS PEST INSECTS OF PEPPERS IN FLORIDA AND TRANSFER OF TECHNOLOGY TO SMALL SCALE GROWERS

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In Florida, various pepper cultivars are widely cultivated by small scale farmers and are economically important specialty crops. Pepper production in the Sunshine State faces serious challenges from various pest insects. Among them, pepper weevil, *Anthonomus eugenii* Cano (Coleoptera: Curculionidae); western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae) and silverleaf whitefly, *Bemisia argentifolii* (Homoptera: Aleyrodidae) are serious pest insects to control in both conventional and organic production systems. Indeed, these pests are generalist herbivore and therefore benefit from a wide variety of alternative hosts. Western flower thrips and silverleaf whitefly are vectors of plant viruses that can completely destroy an entire field in the spring and summer. Since 2015, we have cultivated various popular cultivars of peppers in our integrated pest management (IPM) demonstration site. A number of field days and workshops were conducted for small scale growers with a view to provide hands on training on pest identification, monitoring, and management of serious pest insects to increase their crop productivity and profitability. Also, commodity-wise pest information spread sheets on pest identification, proper monitoring tools, and pest management were developed and distributed among pepper growers. These tools help growers in decision making toward effective peppers IPM program.

Presenter Bio: Chinemenma Okoroji is an undergraduate student in the entomology program in the College of Agriculture and Food Sciences, FAMU. Ms. Okoroji has interest on the commodity-wise pest identification, monitoring, and management. She is part of the USDA, AFRI, iPIPE (Integrated Pest Information Platform for Extension and Education) Program in FAMU.

POST-HARVEST EVALUATION OF PROMISSORY ACCESSIONS OF NATIVE CAPSICUM FROM NATIONAL INSTITUTE OF AGRARIAN INNOVATION – PERU

Fredy Quispe¹, Mavel Marcelo¹, José Chanamé¹, and Rosario Rojas²

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The chilli is a native genetic resource from Peru. Its color, aroma, flavor and pungency are part of the history, food and customs in Peru. In recent years, new exotic varieties such as Paprika entered the Peruvian market for its cultivation and exportation. However, actually there are no improved varieties of native chillies for their production at the field according to demands of gastronomic sector, for processing in the food industry or its exportation. The purpose of the study was to evaluate the agronomic behavior and post-harvest characteristics of five promising native chillies that is conserved by the National Institute of Agrarian Innovation from Peru.

The study began with the preparation of the seedlings of the accessions Miscucho (PER 006945), Tomatito rojo (PER 006948), Charapita amarillo (PER 006952), Dulce rojo (PER 007093) and Ayuclo (PER 006030), for their culture under agro-ecological conditions of the Experimental Stations of Donoso in Huaral and Vista Florida in Chiclayo, and the Fundo Agroexport Topara Company.

Post-harvest analyzes corresponding to nutritional composition, bioactive compounds, vitamin C, carotenoids, total phenolic compounds, total flavonoids and antioxidant activity by DPPH and ABTS, as well as other quality parameters in chilli were performed according to validated methodologies.

The characteristics of the crop were conventional production to Donoso and Vista Florida, unlike Topara where the production was organic. The results at the field have shown morphological differences in plant for five accessions, and for the fruits harvested in the characters of weight, length, width, as well as yield among the accessions and localities evaluated for their production.

Regarding the nutritional parameters, the values of ash were between 6.67 and 8.92%, with the highest value for Miscucho in Chincha. At the protein level, Dulce rojo was higher in Huaral and Chincha, while Tomatito rojo in Chiclayo. The fiber values were highest for Charapita in the three locations. The values found for insoluble dietary fiber were between 26.80 and 52.74%, while for soluble dietary fiber between 2.64 and 11.13%. In relation to total fat Charapita and Ayuclo were highest in the three locations. For total carotenoids in the 2016-2017 campaign, Tomatito rojo and Dulce rojo stood out in three locations with similar values for the 2017-2018 campaign in Huaral and Chincha. With respect to vitamin C the values were between 74.11 and 249.91 mg/100 g sample, for the 2016-2017 campaign, comparing these results with the 2017-2018 campaign, the values reached 146.87 mg/100 g sample, for Charapita. The values of color according to CIE L*a*b* scale have shown Dulce rojo as the darkest fruits in Chincha (34.15) and Chiclayo (35.20). The total phenolic compounds, total flavonoids were superior for Charapita in the three localities, as well as their antioxidant activity according to DPPH and ABTS.

In conclusion the five accessions of chilli have shown interesting functional properties and nutritional composition to continue its breeding under certain agro ecological condition.

Presenter Bio: Fredy Quispe Jacobo is a researcher from National Institute of Agrarian Innovation (INIA). He has expertise in Researching and Technological Development (RTD) of Natural and Agro industrial products. He is a leader of Nutritional Area from Genetic Resources and Biotechnology Division at INIA.

BRAZILIAN ORNAMENTAL PEPPER BREEDING PROGRAM

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Development of a new variety with high quality traits is one of the major goals of any breeding program and the presence of genetic diversity is the principal criteria for success of selection and progress in a breeding program. The Federal University of Paraíba (UFPB) in cooperation with Ministry of Education and Brazilian Council for Research and Technologic Development (CNPq) has been developing a breeding program for ornamental peppers, with the goal to evaluate and select breeding lines and promote the hybridization among the selected lines in order to distribute to small farmers in Brazilian states. The pepper program is composed of three stages: 1) searching, evaluation and selection of cultivars for growing in vase and longer post production life; 2) mass selection with progenitor's selection and 3) hybridization and evaluation of the single, triple and double hybrids and segregating generations. The genetic diversity between and within different species has been explored in this breeding program, developing potted and garden peppers type using the landraces held in the UFPB pepper germplasm bank Using mass selection and selection in advanced generations (F7) it was possible to select new commercial lines. Eight new lines will be release in the next year with increased shelf life as potted plant (72 days) and resistant to ethylene leaf and fruit abscission. This program has been a unique opportunity to give better training to students and small farmers.

Presenter Bio: Professor Elizanilda is a senior research with more than 20 years of experience breeding peppers, and she has extensive experience with developing cultivars and several published articles in this area.

BREEDING FOR IMPROVED FRUIT QUALITY IN PEPPERS: SELECTION OF SIB LINES TO IDENTIFY NOVEL FRUIT SHAPE AND PERICARP TRAITS AND THEIR RELATIONSHIP TO POSTHARVEST QUALITY

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To understand the origin of novel traits related to fruit quality, we developed F₄ sib-lines of *Capsicum annuum* selected from single F₂ progeny of a cross between 'Jalapeno' and 'Round of Hungary', two varieties drastically differing in fruit shape, pungency and fruit size. Plants were advanced from F₂ to F₆ by the single seed descent method. Fruit were harvested from individual F₄ sib-lines and the two varieties used as parents, grown under identical greenhouse conditions. Quantitative parameters related to fruit shape, color of ripe and unripe fruit, pericarp thickness, rate of water loss, total soluble solids content, carotenoid levels and postharvest quality were collected. Several fruit phenotypes observed in the derived F₄ lines were not found in the parental lines 'Jalapeno' and 'Round of Hungary'. These new traits were: fruit shape - Round, Long, Heart, and Oxheart; fruit size - smaller than fruit from either parent; fruit length - longer than either parent; pericarp thickness - thinner than either parent; pericarp crinkling and ripe fruit color - brighter red than either parent; unripe fruit color - lighter green than either parent. In some lines, change of fruit color during ripening was at a slower rate and ripe fruit flavor was distinguishable from either parent. Our results suggest that new combinations of alleles from the two parents and their epistatic interactions are the basis for the observed new heritable phenotypes. Our results are consistent with the hypothesis that at least some of the fruit type variations naturally found in *Capsicum annuum*, important in defining horticultural types, evolved relatively rapidly by sexual reproduction between widely differing types. This research has implications for breeding to add novel fruit traits to *Capsicum* varieties.

Presenter Bio: Dr. Rathinasabapathi, professor of Horticultural Sciences at the University of Florida leads a program to develop pepper varieties improved for fruit quality and adapted to Florida growing conditions. This project involves undergraduate students in plant breeding research and combines the methods of science with elements of creativity for variety development.

THE WILD SPECIES OF CHILI IN BOLIVIA

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Bolivia is a country with diverse ecosystems and varied climatic and pedological conditions, constituting an important center of origin, domestication and diversification of many species.

In the case of the *Capsicum* genus, there is a great diversity of species and varieties of native peppers, its morphological and genetic diversity is quite broad, since its range of distribution covers different ecological regions of the country. In the world the existence of about 40 species of *Capsicum* has been reported, for Bolivia 15 have been described, 10 of which are wild type.

Most of the efforts for the revaluation of this crop focused on domesticated species, as *Capsicum baccatum*, *Capsicum annum*, *Capsicum pubescens*, *Capsicum frutescens* and *Capsicum chinense*, being those that are mostly in commerce. There are also foreign varieties that have been entering the Bolivian market, as is the case of Cayenne pepper, paprika and the “ancho” variety.

Because little was reported in the botanical and systematic part about Bolivian wild peppers, it’s necessary to complement this information by studying taxonomically the native peppers and the cultivars selected by the farmers. In the same way it’s important to know their morphological and agronomic characteristics, In order to revalue its genetic richness and favor the small farmer of the Bolivian Andes.

Lately due to the growth of rural populations and communities it has been observed that some of the environments most intervened by man in an unsustainable or environmentally friendly way, are precisely where wild peppers are found.

It is intended to show data of different collections and data of the habitats in which different species of wild chili are present. The information will be used to the development of future conservation, rescue and revalorization works.

Presenter Bio: Lic. X. Reyes, is a research whit more 10 years of experience in biotechnology and management and conservation of genetics resources.

BRS TUI: A NEW BRAZILIAN SWEET BIQUINHO-TYPE PEPPER CULTIVAR

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The Biquinho (little beak) pepper group is very appreciated by Brazilians because of its distinctive aroma and flavor like other *Capsicum chinense* pepper-types, but its fruit is sweet. BRS Tui was derived from a red Biquinho pepper segregating cultivar (CNPH 4162). Four generations of selection and selfing were performed until the progenies showed no segregation. During each generation, selection for agronomic and processing characteristics relevant to the industry was undertaken. Selection was based on plant and fruit traits such as plant height and architecture, fruit shape and size, mature fruit color (orange-fleshed), no pungency, high yield, and disease resistance. BRS Tui has orange-fleshed fruits and yields around 30 t ha⁻¹ (23,000 plants ha⁻¹) in a harvesting period of six months. Fruit pungency is *circa* 170 SHU (Scoville Heat Unit) and fruits are extremely aromatic, tasty, and very crunchy. BRS Tui was developed to meet both the fresh fruit market and the processing industries, particularly for production of pepper preserves, in addition to the potential use in many gourmet products as sauces, jellies, flavored oils and vinegars, or even the ornamental pepper niche. The orange-fleshed coloration of the fruits differentiates BRS Tui from the other Biquinho pepper cultivars, with great potential to meet new niches that seek the development of differentiated products. BRS Tui plants present intermediate growth habit, approximately 0.7 m in height and 1.0 m in width. The pendent fruits present triangular shape, smooth surface, light green color when immature and orange flesh when ripe, with 1.8 cm long by 3.2 cm wide and 2.0 mm in wall thickness. BRS Tui has shown field resistance to several viruses (GRSV, TCSV, PepYMV and PVY) and *Meloidogyne incognita*, and presents intermediate resistance to *Oidiopsis sicula* and bacterial spot (*Xanthomonas euvesicatoria* and *X. gardneri*). BRS Tui is recommended for open field, as well as greenhouse/screenhouse cultivation; it has been registered (RNC 36495) and protected in the *Brazilian Ministry of Agriculture, Livestock and Food Supply* (MAPA). Embrapa Vegetables will provide seeds of BRS Tui under contract to interested seed-producing companies.

Presenter Bio: Dr. Ribeiro is researcher at Embrapa, working in genetic breeding of peppers with more than 20 years of experience in breeding of hot and bell peppers, genetics resources of *Capsicum* spp., plant resistance to diseases and pepper industrial processing.

EMBRAPA'S JALAPEÑO PEPPER BREEDING FOR MECHANICAL HARVESTING

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The cultivation of Jalapeño pepper in Brazil has increased in the last years, mainly in regions next to sauce processing industries. Since 2002, the Brazilian Agricultural Research Corporation (Embrapa) has conducted a Jalapeño pepper breeding program, which has been partly financed by the private sector. The Jalapeño-type cultivars 'BRS Sarakura' and 'BRS Garça' were released in 2009, resulting from a joint research project between Embrapa and Sakura-Nakaya Alimentos Ltda. More than two thousand tons of BRS Sarakura pulp are produced annually in the Central region of Brazil, responsible for around 50% of the total pepper sauce produced in the country. However, labor shortage in rural areas has caused significant production losses and affected Jalapeño pepper farmers and processing industries. The use of pepper mechanical harvesters has been a worldwide alternative to overcome the deficiency of labor in rural areas. The main objective of this work was the selection of Jalapeño pepper lines adapted to Central Brazil with characteristics favorable to mechanized harvesting, with high pungency, concentrated fruit set/maturity. Embrapa's Jalapeño pepper breeding for mechanical harvesting began in 2015, and plant selection has been mainly based on plant height (> 60 cm), height of first bifurcation (> 16 cm), erect plant growth habit (erect and intermediated), precocity, high yield (> 1kg/plant), fruit pungency (> 30.000 SHU), °Brix (> 7) and concentrated fruit set. Four cycles of individual plant selection were advanced based on progeny tests, and four selected lines (CNPH 30.375, CNPH 30.777, CNPH 30.607 and CNPH 30.609) are being cultivated in Brasília-DF and Catalão-GO for additional tests that will be done using the Israeli mechanical harvester Moses 1000-Etgar. The genetic potential of the selected lines for high height of first bifurcation, associated to a proper soil preparation and uniform planting of seedlings (aligned and at the correct depth), could enable mechanized harvesting of the fruits.

Presenter Bio: Dr. Ribeiro is researcher at Embrapa, working in genetic breeding of peppers with more than 20 years of experience in breeding of hot and bell peppers, genetics resources of *Capsicum* spp., plant resistance to diseases and pepper industrial processing.

DELICIOUS, ORNAMENTAL NEW SNACKING PEPPERS

Emily Rodekohr, Lauren Brzozowski, Isabella Yannuzzi and Michael Mazourek

Cornell University, Ithaca, NY, USA

We sought to create a kid-friendly snacking pepper that utilized the beautiful fruit and foliar variegation of 'Fish' peppers, without their pungency. The pedigree of these peppers combines genetics from 'Fish' for variegation, 'Lipstick' for non-pungency and adaptability, 'Czech Black' for anthocyanin retention, and modern Corno del Toro types for disease resistance and plant architecture. In addition to developing new cultivars, we used the process to explore different approaches to stabilize the variegation; as part of NOVIC (Northern Organic Vegetable Improvement Collaborative) we compared a pedigree breeding approach to recurrent selection in both local and multi-regional environments on collaborator farms across the Northern US.

Presenter Bio: Emily Rodekohr manages trials and seed production in the Mazourek Program and is a Cornell University graduate student with roots in the homeland of the 'Fish' pepper.

INTEGRATED APPROACH FOR MANAGING PEPPER WEEVIL, *ANTHONOMUS EUGENII* CANO (COLEOPTERA: CURCULIONIDAE) ON VARIOUS PEPPER CULTIVARS

Dakshina R. Seal, Mohammad Razzak, Rafia A. Khan, Victoria Adeleye, Catherine M. Sabines and Shawbeta A. Seal

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Pepper is an important vegetable crop. There are almost 50 thousand cultivars grown worldwide. They vary from sweet (red bell) to extreme hot (Scorpion), and large to small size. Florida's hot climate and ideal soil condition is perfect for growing pepper. Florida grows 27% of nation's total bell pepper valued at \$220 million. The pepper weevil, *Anthonomus eugenii* Cano is a significant key pest of peppers of almost all cultivars in Florida and elsewhere outside Florida. Pepper weevil can cause 100% crop loss in the absence of any proper and effective management tool. Even when insecticides are used routinely, growers may lose 10-20% of their yield due to pepper weevil infestation. Pepper weevil infestation begins when pepper plants start producing buds. Egg to adult development takes place inside small buds, flowers and fruits. In the present study, we conducted various experiments using conventional and reduced risk insecticides along with sex-pheromone and yellow sticky traps to manage pepper weevil. We integrated the above mentioned tools with biological control agents and varietal resistance to develop a sustainable management program for controlling pepper weevil.

Presenter Bio: Dr. Seal is a senior entomologist in the Tropical Research and Education Center, University of Florida-IFAS, Florida, USA. His main research focus is to develop integrated pest management program for controlling key pests of vegetable crops.

ACCUMULATION OF MACRONUTRIENTS IN LEAVES OF *CAPSICUM ANNUUM* SUSCEPTIBLE AND RESISTANT TO *XANTHOMONAS EUVESICATORIA*

Aminthia P. S. da Silva, Sthefanny de A. Neto, Rosana Rodrigues, and Sergio Luis Cardoso

Universidade Estadual do Norte Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ, Brazil

Bacterial spot caused by *Xanthomonas* spp is one of the most important diseases in sweet and chili pepper in different production areas. Minerals nutrients are associated with important functions in plants, including defense mechanisms. It is important to understand the pathosystem and its relationship to mineral nutrition. The aim of this work was to analyze the macronutrient content in two genotypes of *Capsicum annuum* var. *annuum*, one resistant (UENF 1381) and another susceptible (L11) to *Xanthomonas euvesicatoria*. These two genotypes were sown in a polystyrene tray and kept in a growth chamber at 28°C and 80% humidity. The trays were irrigated once a day with deionized water until the appearance of definitive leaves. The seedlings were transplanted when they reached two pairs of definitive leaves for 5L black plastic pots installed in a greenhouse located at *Universidade Estadual do Norte Fluminense Darcy Ribeiro campus*, Campos dos Goytacazes, RJ, Brazil. Sand and vermiculite were used as substrate in the proportion of 2:1. The experimental design was completely randomized with two treatments a) resistant UENF 1381 and b) L11 susceptible to *X. euvesicatoria*, treated with Hoagland nutrient solution. Leaves were collected at two different growth stages: a) vegetative stage - 23 days after transplant (DAT) and b) beginning of reproductive stage when 50% of plants of the same treatment had at least one mature fruit (94 and 104 DAT). The leaves were collected between the second and fourth node of the stem apex, when they were fully expanded. Afterwards, collected leaves samples were lyophilized, macerated with liquid nitrogen, weighed, digested in nitric acid and analyzed for P, K, Ca, Mg, and S by ICP-OES. External calibrations with the concentration range 0.1 mg L⁻¹ to 50 mg L⁻¹ (P, Ca, Mg and S) and 1 mg L⁻¹ to 200 mg L⁻¹ (K) were used to the quantitative analysis of these elements. The average of the contents of each element in the leaves and the respective standard deviations were analyzed. Mineral analysis showed there were differences in the content of some elements present in the leaves of both genotypes. These differences were more accentuated in leaves collected during the reproductive stage. For leaves collected at vegetative stage, the susceptible genotype (L11) presented higher calcium content than those of the resistant one (UENF1381). For leaves collected at beginning of reproductive stage, the resistant genotype (UENF1381) presented higher content of P, K, Ca, Mg and S. The different levels of some elements in the resistant genotype may indicated a possible involvement in a pre-existing biosynthetic route to be associated with the genetic resistance to *Xanthomonas euvesicatoria*. Considering these preliminary results, further studies should be carried out to investigate the influence of these elements as players in bacterial spot genetic resistance expression.

Presenter Bio: Aminthia is a doctoral student with experience in germplasm evaluation and utilization with emphasis in peppers and bacterial spot, has been working with these topics for 2 years.

RECENT EXPERIENCES WITH PEPPER WEEVIL IN SOUTHERN GEORGIA

David Riley, and Alton Sparks

University of Georgia, Tifton Campus, Tifton, GA, USA

Pepper weevil, *Anthonomus eugenii*, is the key arthropod pest of pepper where it occurs. This insect has been a sporadic pest of pepper in southern Georgia and infestations have been largely attributed to man-aided movement within individual fields. This situation appears to have possibly changed, with infestations becoming more common and widespread infestations in southern Georgia in the fall of 2017. The 2017 infestations followed two consecutive mild winters. In conjunction with more common infestations in pepper, pepper weevil has become a fairly common occurrence in eggplant, with weevils reproducing in blooms, causing bloom abscission, and producing feeding scares on young fruit.

In the fall of 2017, multiple commercial fields in southern Georgia were lost to pepper weevil. Infestations were severe enough to allow easy collection of adult weevils from pepper foliage, despite multiple insecticide applications in these fields. Infested pods were collected from these fields and emergent adults were bioassayed. The most significant finding was a lack of efficacy of pyrethroid insecticides, which were the standard insecticides being used for pepper weevil.

The winter of 2017-2018 presented multiple dates with freezing temperatures, and it was hoped that this would destroy weevil food sources and eliminate weevil populations in southern Georgia – returning us to our “normal” situation. However, field surveys in late winter revealed live adults in old jalapeno fields. Pepper weevil pheromone traps were placed in commercial fields throughout southern Georgia to monitor the situation. Adult weevils were caught in most fields prior to transplanting of peppers. Thus, it was obvious that we did overwinter adult weevils throughout southern Georgia. Pheromone traps captures ceased once pepper plants were available in the fields.

Presenter Bio: Dr. Sparks is an Extension Entomologist with more than 30 years’ experience in vegetable IPM between positions in southern Texas and Georgia.

THE PEPPER WEEVIL PROBLEM, PAST, PRESENT AND FUTURE

Phil Stansly

University of Florida IFAS SWFREC, Immokalee, FL, USA

Pepper weevil, *Anthonomus eugenii* was introduced to the US from Mexico in the early 1900s, commensurate with its congener the boll weevil. Both spread quickly through the southern tier of the US. Pepper weevil is a key pest of all pepper cultivars in much of the Southern US as well as Mexico, and the Caribbean. Easily moved with infested fruit, it has extended its range northward where protected agriculture may provide refuge from winter conditions. Larvae are protected within developing fruit and adults feed little on exterior tissues. Therefore, control is difficult due to ineffectiveness of insecticides and lack of effective natural enemies. Cultural controls consist of shortening crop cycles, timely destruction of crop residues and fallows. These measures can be undone by unseasonable weather, market conditions and weed hosts such as black nightshade. It is unlikely that management in open field crops can be significantly improved with present-day technology. Improvements through enhancement of biological control and host plant resistance are possible, but will require concerted efforts in research and development.

Additional Information: Philip A. Stansly passed away September 12, 2018.

GENETIC RESISTANCE TO PEPPER ANTHRACNOSE: LESSONS FROM TOMATO

John R. Stommel¹, Umesh K. Reddy², Carlos Lopez Ortiz², Venkata Lakshmi Abburi², and Padma Nimmakayala²

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²Gus R. Douglass Institute and Department of Biology, West Virginia State University, Institute, WV, USA

Anthracnose caused by *Colletotrichum* species is a serious disease of Solanaceous crops grown in North America. It is endemic in production regions of the Eastern and Midwestern United States and south-central Canada. In pepper, variable modes of inheritance for anthracnose resistance have been reported and variation in *Colletotrichum* pathotypes complicates breeding for durable host resistance. Crossing barriers within *Capsicum* and segregation distortion hinder introgression of useful levels of resistance into *C. annuum*. We have selected an unadapted small-fruited tomato line, designated 95L368, that exhibits a high level of resistance to a broad range of *Colletotrichum* species that cause anthracnose on tomato as well as pepper. This resistant genotype is also resistant to *Colletotrichum* isolates responsible for rot of immature pepper. Resistance in 95L368 was primarily additive with two to three genetic factors estimated to be segregating for resistance. Detailed syntenic relationships between the tomato and pepper genomes have been described. Although the pepper genome size is approximately three times larger than that of tomato, gene order is well preserved within syntenic regions. Detailed marker-based linkage maps of tomato and pepper, together with reference genomes for the respective crops have facilitated comparative mapping of loci associated with genes that influence morphological attributes as well as biosynthetic pathways. Utilizing a recombinant inbred line population that we developed from a cross of 95L368 and a susceptible tomato line, genotype by sequencing (GBS) was used to identify and map genomic regions associated with anthracnose lesion development. Using GBS, 15300 polymorphic SNPs were identified of which 1692 SNPs were mapped, spanning a length of 2519cM. A genetic map was constructed with a marker density of 1.48 SNP per cM. Lesion development in fruit for individual RILs was scored over two years. Our analysis resolved only three common QTLs (chromosomes 3, 6, and 9) that showed significant effects for both years. For chromosome 6, we located six QTL peaks at the genomic region (9.6 Mb) located between 41717475 and 51338695. Percent of variance explained by these peaks ranged from 4.2 to 5.7% (LOD 3.21 to 4.34) for the first year and 5.7 to 22% (LOD 13.01 to 14.38) for the second year. On chromosome 9, we located QTL peaks in a region with genome size of 14Mb located between the position 53457523 and 67973214. Percent of variance explained by these regions varied from 4.1 to 6.2% in the first year and 5.5 to 11.2% for the second year. QTLs in other chromosomes (2, 8, 10) manifested strong QTL × year interaction, showing significant effects in the first year and no effect in the second year. All QTLs exhibited negative additive gene action indicating that these QTL effects are manifested by susceptible genes. Research is ongoing to identify candidate genes in these regions that are associated with lesion development (see related presentation by Zhang et al.) and identify corresponding genomic regions in pepper. Strategies for utilizing this knowledge to improve anthracnose resistance in pepper will be discussed.

Presenter Bio: Dr. John Stommel is a Research Geneticist and serves as Research Leader for the USDA, ARS, Genetic Improvement of Fruits and Vegetables Laboratory. His research focuses on breeding and genetics of tomato and pepper.

OCCURRENCE OF PERSISTENT VIRUSES IN *CAPSICUM* SPECIES

Cesar Escalante¹, Ricardo Iván Alcalá-Briseño², Sead Sabanadzovic³, Ryo Okada⁴, **Rodrigo A. Valverde**¹

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Persistent viruses are RNA viruses that infect plants without causing apparent disease or visible symptoms and are transmitted only vertically through seed at rates of nearly 100%. Indirect evidence suggests that these viruses are present in all cells of the plant. Although persistent viruses have been reported in many economically important crops, little is known about their origin or the effect they may have to their hosts. We have identified 10 persistent viruses in domesticated and wild *Capsicum* species which include *C. annuum* (bell pepper, cayenne pepper, Hungarian wax, and jalapeño), *C. annuum* var. *glabrisculum* (Chiltepin), *C. frutescens* (tabasco and Greenleaf tabasco), *C. chinense* (habanero), *C. baccatum* (aji) and *C. chacoense*.

To detect and identify the persistent viruses, viral dsRNAs were extracted from symptomless plants tissues, analyzed by gel electrophoresis, sequenced, and used in reverse transcription polymerase chain reactions (RT-PCR). Viruses belonging to the families *Endornaviridae*, *Partitiviridae*, and *Totiviridae* were detected. They included: bell pepper endornavirus and several closely related endornaviruses, pepper cryptic virus 1, pepper cryptic virus 2, *Capsicum chacoense* totivirus 1, and several other persistent viruses still under characterization. We investigated their frequency in some capsicum genotypes and in some cases their relationship to other persistent viruses reported in other crop species. In the case of Greenleaf tabasco, we also investigated endornavirus transmission through plant breeding.

Nucleotide sequence comparisons suggest that some of these persistent viruses in capsicum are shared among different pepper cultivars and some belong to new virus species. The variety and relative high percentage of occurrence of these viruses in the genus *Capsicum* is unique among crop species that have been tested for persistent viruses. The effect that persistent viruses may have to capsicum hosts remains to be elucidated.

Presenter Bio: Dr. Valverde is a plant virologist with 30 years of experience on viral diseases of pepper and other vegetable crops. His area of expertise is detection and identification of plant viruses.

PHYSIOLOGICAL TRAITS OF ENDORNAVIRUS-INFECTED AND ENDORNAVIRUS-FREE BELL PEPPER

Cesar Escalante, and Rodrigo A. Valverde

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Endornaviruses are persistent viruses that infect plants without causing apparent disease or visible symptoms and are transmitted through seed at rates of nearly 100%. Although, endornaviruses have been reported in many economically important plant species, little is known about their origin or the effect they have to their hosts. There are only limited studies on the association of endornaviruses with changes in the biology of the host. Endornaviruses activate the plant host gene silencing system and therefore, play an active role in the infected plant. In general, endornaviruses have been reported only in specific crop cultivars and this suggests that their occurrence may have been affected by crop domestication and modern plant breeding. Bell pepper endornavirus (BPEV) has been reported in cultivated peppers. In commercial cultivars of bell pepper grown in the United States, this virus is found at infection rates of 100%. Similarly, another distinct endornavirus species, Cucumis melo endornavirus (CmEV), has been detected in all commercial melon cultivars tested in the United States. This could be an indication that BPEV and CmEV infecting bell pepper and melon respectively, provide unidentified beneficial effects to these crops.

Two bell pepper (cv. Marengo) near-isogenic lines (NILs), one BPEV-infected and the other BPEV-free, have been developed and comparative studies have been conducted. The plant phenotype of the two lines was evaluated throughout the different developmental stages. With the exception of fruit shape, differences in the phenotype were not observed between the BPEV-infected and BPEV-free lines. The plant height, total fresh weight, fruits per plant, and total fruit weight was higher in plants of the BPEV-free line than in plants of the BPEV-infected line; although only the fruit weight was statistically significant. Both NILs were used to conduct inoculations with root knot nematode; but after evaluating the number of eggs and number of second stage juveniles, no statistical difference was found. The two lines were mechanically inoculated with an isolate of tobacco mild green mosaic virus. The BPEV-free line reacted with systemic necrosis and mosaic while the BPEV-infected line reacted only with mosaic. The two NILs lines were also mechanically inoculated with pepper mild mottle virus, tomato spotted wilt virus, potato virus Y, and cucumber mosaic virus, and in all cases, plants showed similar symptoms.

Results obtained in this investigation suggest that BPEV may play a role in plant defense mechanisms against some plant viruses. Nevertheless, more comparative studies should be conducted evaluating other biotic and abiotic factors.

Presenter Bio: Dr. Valverde is a plant virologist with 30 years of experience on viral diseases of pepper and other vegetable crops. His area of expertise is detection and identification of plant viruses.

HIGH QUALITY GENOMES BRING BREEDING SOLUTIONS

Allen Van Deynze¹, Amanda Hulse-Kemp^{1,2}, Jareerat Chunthawodtiporn^{1,3}, Armando Garcia-Llanos¹, Kevin Stoffel¹, Vincenzo Cassibba¹, Shiyu Chen¹ and Theresa A. Hill¹

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Genomics-assisted plant breeding is evolving from loosely-linked markers associated with traits to using markers to define quantitative traits, track them across multiple breeding populations and design new products by creating novel mutations. The former works well for moving simply inherited traits across related populations. Unfortunately, the majority of traits such as yield, tolerance to abiotic stresses and flavor are highly quantitative requiring highly accurate genomes. Similarly, targeted mutagenesis requires perfect sequence and annotation of genes and regulatory elements. Most crops have short reads genomes. We have shown that these are misassembled especially in centromeric regions and areas of low recombination. These regions can make up to ¼ of the chromosome as in pepper. We will present analyses of pepper genomes, limitations and examples of their use with high density genetic maps to characterize and introgress alleles for traits related to mechanical harvesting, disease resistance and fruit quality in breeding programs.

Presenter Bio: Dr. Allen Van Deynze is the Director of Research at the Seed Biotechnology Center and Associate Director of the Plant Breeding Center at University of California, Davis. He has a PhD in plant breeding from University of Guelph, Canada. As part of the SBC's mission to serve as a liaison between public institutions and seed industry, Allen is responsible for developing, coordinating and conducting research and generating and disseminating scientific and informational content for the Seed Biotechnology Center's and Plant Breeding Center's educational and outreach programs.

ADVANCES IN PHYTOPHTHORA RESISTANCE BREEDING AT CORNELL UNIVERSITY

Gregory Vogel^{1,2}, *Christine Smart*², *Michael Mazourek*¹

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Phytophthora blight, caused by the soilborne oomycete pathogen *Phytophthora capsici*, results in severe economic losses for many pepper growers in New York State. Disease symptoms include girdling lesions on roots and stems, fruit rot, wilting, and plant death. Flooding events in recent years have enabled inoculum to spread to previously disease-free fields and establish persistent sexual populations that are nearly impossible to eradicate. As a result, the Cornell breeding program is targeting Phytophthora resistance as a key trait in addition to earliness, large fruit size, and good plant architecture. Much of this work has taken place at the New York State Agricultural Experiment Station Blight Farm, a nine-acre farm dedicated exclusively to Phytophthora field trials and long-term studies of pathogen populations. Molecular markers assist with the transfer of target pungency levels for market classes as we diversify into hot and mild backgrounds: wax, serrano, cherry, jalapeño, and sweet types. Due to the wide degree of phenotypic variation observed in *P. capsici* populations, resistant breeding lines need to be challenged against highly aggressive isolates before release. We have thus far screened 32 isolates from our culture collection for virulence and identified one that causes significantly more disease on intermediately resistant bell cultivar Paladin. Future work will include field evaluations of breeding lines against this isolate and the development of pathogen mapping populations to identify avirulence genes that confer the ability to overcome host resistance.

Presenter Bio: Gregory Vogel is a Ph.D. candidate at Cornell University where he researches resistance to Phytophthora blight in peppers and squash in addition to population genetics of the pathogen.

EFFECT OF PLANT SPACING ON PLANT AND POD ATTRIBUTES FOR MECHANIZED HARVEST OF NEW MEXICO GREEN CHILE (*CAPSICUM ANNUUM*)

Charles D Havlik¹, **Stephanie J. Walker¹**, Paul Funk² and Mark A. Marsalis¹

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Closer plant spacing influences the plant growth habit of New Mexico chile by creating taller plants with fewer basal branches and higher fruit set (main bifurcation). These plant attributes have been shown to increase mechanical harvest efficiency in previous studies; however, plant spacing closer than the current standard of 12 in. between plants may adversely affect the size of NM green chile pods. Experiments conducted in 2015 and 2016 at New Mexico State University's Los Lunas Agricultural Science Center investigated the impact of closer plant spacing on green chile fruit size and mechanical harvest efficiency. Two commercial New Mexico green chile cultivars, 'NuMex Joe E. Parker' (Biad Chili Company, Las Cruces, NM) and 'AZ-1904' (Curry Chile and Seed Company, Pearce, AZ), were direct seeded on 17 Apr. 2015 and 14 Apr. 2016. Three thinning treatments (4, 8 and 12 inch plant spacing) were created in a randomized complete block design with five replications. Plots were thinned on 11 Jun. 2015 and 14 Jun. 2016. The field was flood irrigated, fertilized and cultivated as needed. Plant measurements including height and width, height to main bifurcation, stem diameter, and number of basal branches were recorded immediately before harvest. Plots were mechanically harvested on 2 Sep. 2015 and 31 Aug. 2016 using an Etgar Series MOSES 1010 (Bet-Lehem-Haglilit, Israel) chile harvester. Fruit characteristics were measured on a random subsample of marketable green chile pods from each plot for fruit weight, fruit width, fruit length, wall thickness and number of locules. 'NuMex Joe E. Parker' at the 4 inch thinning treatment had the tallest plants (73.9 cm) and also had the highest height to bifurcation at the 4 and 8 inch thinning treatments, 23.3 cm and 23.6 cm respectively. Plant widths and basal branching were not significantly different by treatment or cultivar ($P < 0.05$). Both cultivars had a higher bifurcation value as the spacing between plants decreased. Stem diameter was thicker in the 'NuMex Joe E. Parker' at the 12 inch thinning (15.80 mm) and thinner in the 'AZ-1904' at the 8 inch thinning. Fruit weight and length were significant along cultivar lines. 'AZ 1904' had heavier pods and 'NuMex Joe E. Parker' shorter. Fruit width and number of locules were not affected by thinning treatment. 'NuMex Joe E. Parker' provided higher mechanically harvested green chile fruit yield than 'AZ-1904'. 'NuMex Joe E. Parker' with the 4 inch thinning had the most marketable green yield of 28,160 lb/acre, 101.4% more than the lowest yielding 'AZ-1904' with the 12 inch thinning.

Presenter Bio: Dr. Walker is the Extension Vegetable Specialist at New Mexico State University where she concentrates on supporting commercial vegetable growers and related industries in enhancing sustainability and profitability of vegetable production in New Mexico.

RESEARCH PROGRESS TOWARDS MECHANICAL HARVEST OF NEW MEXICO POD-TYPE GREEN CHILE

Stephanie J. Walker, and Israel Joukhadar

New Mexico State University, Las Cruces, NM, USA

New Mexico pod-type green chile (*Capsicum annuum* L.) is a celebrated specialty crop that is rooted in the 1913 release of 'New Mexico No. 9' by Fabian Garcia, the first Director of the NM Agricultural Experiment Station at the NM School of Agriculture and Mechanical Arts (now New Mexico State University). NM green chile is completely hand harvested; however, the limited supply and expense of domestic labor threaten the long-term viability of the industry. A transition to mechanized harvest is critical to support and sustain commercial processing of the crop.

Short- and intermediate-term research efforts have focused on identifying harvesting equipment, production practices, chile cultivars and plant attributes for best mechanical harvest efficiency. Long-term efforts involved selective breeding to develop new cultivars more efficient for mechanical harvest by incorporating aligned beneficial traits, including taller plants with a higher primary branch angle, thicker stem diameter, and reduced basal branching.

The best of the advanced NM green chile breeding lines were evaluated in 2017 for mechanical harvest efficiency, along with standard commercial varieties, 'NuMex Joe E. Parker' and 'AZ-1904'. The mechanical harvest trial was conducted at the New Mexico State University Agricultural Science Center in Los Lunas, NM. Plots were direct seeded on 4 Apr. 2017 in a randomized complete block with seven replications, furrow-irrigated, and managed in accordance with local production practices. Key plant measurements were taken immediately before harvest, then the plots were mechanically harvested on 29 Aug. 2017 using an Etgar Series MOSES 1010, double, open-helix, chile harvester. Mechanically harvested material was sorted into marketable green fruit, damaged fruit, trash (sticks and leaves), red and diseased fruit. Field yield loss, including fruit dropped to the ground during harvest and fruit remaining on the plants, was also assessed.

Results indicated progress towards mechanical harvest efficiency in the breeding lines, particularly in significant reductions in field loss. Breeding lines tended to leave less fruit attached to the plant and dropped to the ground during mechanical harvest compared to the standard control cultivars. The best overall breeding was 54W17 which provided the highest marketable yield and harvest efficiency (81%), with significantly less field loss compared to 'NuMex Joe E. Parker' and 'AZ-1904'.

Presenter Bio: Dr. Walker is the Extension Vegetable Specialist at New Mexico State University where she concentrates on supporting commercial vegetable growers and related industries in enhancing sustainability and profitability of vegetable production in New Mexico.

IN VITRO CONSUMPTION PATTERNS OF PEPPER WEEVIL (COLEOPTERA: CURCULIONIDAE) ON TWO COMMERCIAL PEPPER CULTIVARS IN FLORIDA

Pengxiang Wu^{1,2,4}, **Muhammad Haseeb**¹, **Chinemenma Okoroji**¹, **Lambert H.B. Kanga**¹, **Jesusa C. Legaspi**³ and **Runzhi Zhang**⁴

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Pepper weevil (PW), *Anthonomus eugenii* Cano (Coleoptera: Curculionidae), is a serious pest of peppers in Florida and around the world. The species is native to Mexico. To determine the consumption patterns of PW as a reference to develop pest management strategies, functional response, intraspecific competition and preference were evaluated under the laboratory condition. The species was reared and reproduced on the pepper plants at temperature 25±2°C, RH 40–60%, and a photophase of 16L:8D. All adults of PW examined in experiments were less than 12 h old and starved for 24 h. Adult weevils were introduced into plastic collapsible cages each measuring 11-3/4" (299 cm) and were made of plastic-injected white polypropylene. Three side panels were 24 x 24 mesh plastic screen, with openings of 1.1 mm x 0.7 mm. Fresh Habanero and Jalapeño peppers (harvested from unsprayed open fields) fruits were provided to weevils for feeding and to determine their feeding patterns. The study results showed that the pepper cultivar Habanero had a higher weevil feeding resistance due to their less consumption, lower searching rate and longer handling time. Pepper weevils suffered intraspecific competition when both of the cultivars were offered for feeding. Fruit wall thicknesses, weights and sizes were negatively correlated with the numbers of feeding puncture marks per fruit. This means, large-sized, thick-walled and good-quality fruits were more resistant to PW feeding. This study confirmed that choosing pepper cultivars and sizes for low susceptibility to PW, and utilizing the intraspecific interactions between pepper weevils could help to devise effective pest management strategies.

Presenter Bio: Mr. Wu is an exchange Ph.D. (3rd year) student from China. He is focusing on the development of preventive pest management strategies against the pepper weevil in Florida. He has published and presented his scientific findings in numerous meetings. He has interests in biological control and IPM of specialty crops.

PEPPER ANTHRACNOSE RESISTANCE: NEW OPPORTUNITIES EMERGING FROM HOST-PATHOGEN STUDIES

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Anthracnose caused by a diverse number of *Colletotrichum* species poses a great threat to pepper. As a hemibiotrophic pathogen, anthracnose is primarily observed on mature pepper. However, in recent years, anthracnose has become a more serious problem on immature pepper. Thus, genetic resistance to anthracnose in both immature and mature peppers is highly desirable since other means of protection such as fungicide application are often incomplete and cost-inefficient.

USDA-ARS maintains a large collection of *Colletotrichum* isolates that originated from infected pepper and tomato fruits. Those isolates display differential host pathogenicity and extensive phylogenetic diversity. Multi-locus phylogenetic analysis grouped these isolates within four aggregate groups. Lineages were identified that distinguished isolates that rotted both immature and mature pepper fruit from conventional ripe fruit rotting isolates. To determine the gene(s) that are responsible for causing anthracnose lesion development in pepper, we chose 10 isolates for whole genome sequencing. Three of these isolates can cause anthracnose in immature and mature pepper (green fruit rotter), and the other seven rotted ripe but not immature pepper (non-green fruit rotter). Two of these isolates cause lesions only in ripe tomato fruit and do not infect pepper. De-novo assembly and gene prediction were performed to obtain protein sequences. Pan-genome analysis showed that 103 orthogroups were found exclusively shared among green fruit rotters, whereas the number of non-green-rotter-only orthogroups was 37. Predicted proteins were characterized with multiple databases. Functional studies are currently underway to identify the gene(s) responsible for anthracnose development in pepper.

Synteny among *Solanaceous* species and conservation of gene function provide opportunities to apply knowledge about anthracnose resistance from tomato to pepper. A small-fruited tomato breeding line (95L368) provides a high level of ripe fruit rot resistance to a wide range of *Colletotrichum* species, including isolates that rot immature pepper fruit. SNP-based mapping studies using 95L368 revealed three chromosomal regions associated with anthracnose lesion development. To characterize the underlying molecular basis of this resistance and apply this knowledge to pepper, we obtained tissue extracts from 95L368 and a susceptible control (Rio Grande). Results demonstrate that only the tissue extracts from 95L368 inhibited the growth of *C. scovillei* isolate 13NJR5 on Tomato Broth Agar media. Changes to extract pH and heat and protease treatments did not alter inhibitory effects of the 95L368 extracts, suggesting that the inhibition could be caused by a heat-stable, pH-insensitive compound, not a protein product. Further fractionation indicated that the compound is highly polar. HPLC-MS and NMR will be used to determine and report the chemical structure of this compound.

Pathogen functional studies, together with identification of the inhibitory compound in tomato and further analysis of candidate genes mapped to chromosomal regions associated with lesion development, provides unique opportunities to exploit relatedness among *Solanaceous* species for developing durable anthracnose resistance in pepper.

Presenter Bio: Chong Zhang is a postdoc fellow with 10 years of experiences in plant molecular pathology.

SPECIAL SUBMISSION

THE SCIENCE OF NUTRITIONAL FOODS FOR HEALTH AND OTHER WELLNESS INFORMATION

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Forty years of Plant Science Research and exercise has transformed me from a Plant Pathologist/Virologist/Pepper Breeder to a student of the science of foods for health, and a human disease prevention information gatherer. The USA wastes over \$3.5 trillion trying to keep its sick citizens from dying, but they still die too soon. The obesity and diabetes rates in our country have reached tsunamic proportions. A weak immune system results in many human diseases (heart, hypertension, high blood sugar, obesity, diabetes, pancreas, liver, kidney failures, dementia and cancers). The metabolic syndrome can be the result of several inflammatory factors such as **high triglycerides**, low HDL, high number of **small** LDL particles (plaque) and fructose overdose, these lead to diseases. Abundant scientific evidence shows that we can maintain a healthy longevity by following simple lifestyle rules of prevention. This requires a dramatic life style change including daily exercise to strengthen all organs (muscles, stimulate the brain) and reduce the metabolic syndrome by at least 80 % (Katz).

Food is the most important medicine in the world. Conversely, food is the most important poison in the world. Two main sources of food are animals and plants. Animal food (grass fed non-processed meats) provides good proteins, saturated fats, essential minerals, vitamins, and some carbohydrates. Good scientific evidence proves adequate cholesterol and animal saturated fats **do not cause cardiovascular diseases**. Fresh unprocessed plant food provides good proteins, mono and polyunsaturated vegetable fats (i.e., avocados, nuts, olive and coconut oils, etc.), also essential vitamins, minerals, antioxidants, and mainly low glycemic index carbohydrates and high fiber. Good fresh vegetables include **peppers, tomatoes, onions, garlic, legumes, all greens, spices, etc.** Both food sources provide sufficient essential nutrients and powerful heart healthy antioxidants. Science indicates 80% of vegans might have nutritional deficiencies in certain vitamins, minerals, etc. found only in animal foods. Beware of artificial supplements. One should limit to no consumption of **processed** polyunsaturated vegetable oils as they may increase triglycerides, trans fatty acids and omega-6 fatty acids. These saturated fats (oils) include: **canola seed; corn seed; cottonseed; safflower seed; soybean seed; and sunflower seed**. These oils may be toxic (Mercola).

Food is digested down to three main macromolecules: proteins, lipids, and carbohydrates. A perfectly balanced meal must contain the right proportions of these macromolecules in groups. A group collectively could be 9g protein, 7g fat, 1.5g carbohydrates for every meal. The average number of groups may be three to four per meal. No two human life styles are alike.

All foods contain carbs. **Excess sugars** turn into fat and negatively impacts all body organs, leading to fatty liver, cirrhosis and cancers. High sugars force the pancreas to produce excess insulin, this leads to insulin resistance and **type two diabetes**, this can be completely **reversed without drugs and by reducing sugar intake**. Excess sugars can destroy the pancreas, stop beta cell and insulin production leading to **type one diabetes, you may need daily insulin injections**. **Fructose** goes straight to the liver, is toxic, stores fat, and leads to cirrhosis and cancers. All fruits contain fructose, fiber may slow these processes, but it still is fructose. Eliminate high fructose corn syrup (Lustig).

Cancers cannot be prevented, but, new genetic immunotherapy, CAR-T cell and other new procedures are dramatically eliminating many kinds of cancers successfully (Allison). Our government and the entire medical profession should emphasis human disease prevention.

So, eat food, not too much, mainly fresh vegetables, grass fed non-processed meats, minimize fruits, grain products (breads, cereal, pasta, heavy starches, pastries), sodas all kinds with high glycemic index sugars, exercise daily before breakfast, and live healthily ever after.

ACKNOWLEDGEMENTS OF SOME HUMAN DISEASE PREVENTION SCIENTISTS

Dr. Robert Atkins High Protein, Low Carbohydrates
Dr. R. K. Bernstein Diabetes, Blood Sugar Meters
Dr. Johanna Budwig Essential Nutrients Cure Cancer
Dr. Aubrey de Grey Senescence, under 60, might live 1,000 years
Dr. William H. Hay Food Combining – 1911
Dr. David L. Katz Yale University Director Prevention Research Center
MS. Chris Dresser Paleo Nutrition, Functional & Integrative Medicine
Dr. Robert H. Lustig Sugar is toxic, Fructose
Dr. J.P. Mercola Saturated fats & cholesterol are our friends
Dr. Weston A. Price Nutrition & Physical Degeneration
Dr. Berry Sears Zone Diet

There are thousands of other internationally renowned Research Medical Doctors and Scientists dedicated to the prevention of human disease.

Eat food to reduce obesity, diabetes and cancer today

Eating to reduce obesity, diabetes and cancer can be accomplished simply by adding a few of our disease fighting foods to your meals each day. Like life itself, one's diet is all about making choices. Since we all eat every day, why not choose foods that can reduce your risk of disease? Listed below are some food facts, supported by scientific research, to help you get the most cancer/diabetes fighting benefits from your diet? **Some scientific trails may be inconclusive?**

Eliminate excess sugars to reduce weight, obesity, CVD, diabetes and cancers, etc.

Sugar is toxic, deadly, and 10 times more addictive than cocaine and or heroin (Lustig).

Be picky. Bell peppers contain 5 times more Vitamins C and A than tomatoes and 3 times more C and A than any citrus. Red Delicious apples have many cancer fighters. Peppers, tomatoes and onions contain many cancers fighting compounds (salsa picante). Red Wine grapes and many berries contain resveratrol, a cancer fighter. Eat Your Sprouts. Broccoli sprouts can contain more cancer-fighting properties than regular broccoli. Green teas contain cancer-fighting molecules. Most vegetables can be eaten fresh. Raw tomatoes are good but slightly cooking them in olive oil releases more lycopene, the cancer fighter. Chew Your Greens. Chewing leafy greens helps to release enzymes that activate cancer-fighting molecules embedded deep in the leaves. Go Soy, fermented soy, like the kind used in miso soup, contains four times more cancer fighters than regular soybeans.

Choose one cancer fighting food for each meal. At 3 meals each day, that adds up to more than a 1,000 of cancer fighting food choices each year.

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