



Plant Growth Regulation Society of America

<http://www.pgrsa.org>

Message from the President

On behalf of the Plant Growth Regulation Society of America, I am pleased to welcome you to the 35th Annual Meeting of the Plant Growth Regulation Society of America. The program for this year's conference has been developed to facilitate discussion on current trends in plant growth regulation and speakers from diverse fields will share their perspectives on various topics in this exciting area of research.

Other program elements such as the poster session, the industry update session, the business meeting, and the conference excursion will give you the opportunity to network with colleagues both old and new as well as experience the eloquent cuisine and culture of San Francisco and the surrounding areas.

I do hope you enjoy the 2008 conference and your time in San Francisco, CA.

Gary Custis
PGRSA President

Message from the Conference Chair

I also welcome you to our 35th Annual meeting, in beautiful San Francisco, California. This year's meeting includes attendees from more than 15 different countries, making it a truly international event. Many students and young scientists have contributed to the program; their enthusiasm and hard work will contribute to the knowledge and understanding needed to advance our science. I encourage the many new members who joined the society this year to participate in the Sunday night mixer and Tuesday night poster session, as they are wonderful networking opportunities. New members will find that the society's diverse membership, which includes university and industry scientists, practitioners, and business people, offers unique opportunities to facilitate collaborative research and development.

I thank the members of the Program Committee who assisted and encouraged me as I planned the meeting. I also acknowledge our sustaining industry members, especially those who provided additional meeting support. Their contributions are essential to our success.

I trust you will find time during your stay to explore San Francisco, and the greater bay area, which is rich in culture and natural beauty. Enjoy the conference.

Matthew Fidelibus
PGRSA 1st Vice President and Program Chairman

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2008
PLANT GROWTH REGULATION SOCIETY OF AMERICA
35TH ANNUAL MEETING

August 2-7, 2008
Hotel Whitcomb
San Francisco, California

Program Summary

Saturday, August 2, 2008

1400-1800 Pre-conference PGRSA Steering Committee Meeting
Nob Hill Room

Sunday, August 3, 2008

1200-1330 Tour of Alcatraz

1330-1800 Registration Open - Lobby

1900-2000 Opening Reception
Ghirardelli Square

Monday August 4, 2008

0730-1715 Registration/Information Desk Open – Lobby

0800-0830 Welcoming Remarks
Ballroom

0830-0900 Keynote Address
PIERCING FIGS IN 2008: EXTRACTING VALUE FROM ETHYLENE
BIOLOGY
Dr. Randy Beaudry

0900-1115 **SYMPOSIUM I**
FRUIT QUALITY
Moderator: Dr. Matthew Fidelibus

1115-1500 **Session I:** Contributed Papers

1500-1515 Break

1515-1530 **SYMPOSIUM II** (Ballroom)
APPLIED TECHNOLOGY
Moderator: Dr. Franz Niederholzer

Tuesday, August 5, 2008

0730-1715 Registration/Information Desk Open – Lobby

0730-0900 Sustaining Member Breakfast (Lombard Room)

0900-1115 **SYMPOSIUM III** (Ballroom)
BIOSTIMULANTS
Moderator: Dr. Carol Lovatt

1115-1200 **Session II:** Contributed Papers

1330-1530 **SYMPOSIUM IV** (Ballroom)
ORNAMENTALS
Moderator: Dr. Brian Whipker

1530-1545 Break

1545-1730 **Session III:** Contributed Papers

1830-2115 Poster Session Reception

Wednesday, August 6, 2008

0730-1200 Registration/Information Desk Open – Lobby

0800-1000 Industry Update Session
Dr. Peter Petracek

1000-1015 Break

1015-1200 **Session IV:** Contributed Papers

1200-1330 Business Lunch

1330-1600 PGRSA Steering Committee Meeting

1830-2200 Theater
The Drowsy Chaperone Musical

Thursday, August 7, 2008

0900-1500 **POST CONFERENCE TOUR**

Rosenblum Cellars and
Scharffen Berger Chocolates

2008
PLANT GROWTH REGULATION SOCIETY OF AMERICA
35TH ANNUAL MEETING

August 2-7, 2008
Hotel Whitcomb
San Francisco, California

Expanded Program Summary

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Ballroom

0830-0900 Keynote Address
PIERCING FIGS IN 2008: EXTRACTING VALUE FROM ETHYLENE
BIOLOGY (1)
Dr. Randy Beaudry

0900-1115 **SYMPOSIUM I**
FRUIT QUALITY
Moderator: Dr. Matthew Fidelibus

0900-0930 FLAVONOID ACCUMULATION IN GRAPEVINE BERRY: GENETIC
REGULATION & PHYSIOLOGICAL CONTROL (2)
S. D. Castellarin

- 0930-1000 USING GENOMIC TOOLS TO UNRAVEL PEACH FRUIT MEALINESS AND COLD STORAGE BROWNING (3)
E. A. Ogundiwin*, A. Granell, T. M. Gradziel, and C. H. Crisosto
- 1000-1015 BREAK
- 1015-1045 GREEN OR ORANGE – TOWARDS UNDERSTANDING THE MOLECULAR BASIS OF CITRUS FRUIT PEEL COLOR DEVELOPMENT (4)
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- 1045-1115 REVERSE GENOMICS ANALYSIS OF ETHYLENE REGULATION IN APPLE FRUIT TISSUES (5)
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- 1130-1145 DIFFERENTIAL EFFECTS OF 1-MCP IN POME AND STONE FRUIT DEPEND ON THE RIPENING STAGE AS REVEALED BY THE INDEX OF ABSORBANCE DIFFERENCE (I_{AD}) (7)
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- 1145-1200 EFFECTS OF PREHARVEST 1-MCP SPRAYS ON APPLE QUALITY (8)
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Tuesday, August 5, 2008

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- 0730-0900 Sustaining Member Breakfast
Lombard Room

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Moderator: Dr. Carol Lovatt
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Wednesday, August 6, 2008

- 0730-1200 Registration/Information Desk Open – Lobby
- 0800-1000 Industry Update Session
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- 1000-1015 BREAK
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- 1200-1330 BUSINESS LUNCH
- 1330-1600 PGRSA Steering Committee Meeting
- 1830-2200 Theater
The Drowsy Chaperone Musical

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Rosenblum Cellars and
Scharffen Berger Chocolates

KEYNOTE PRESENTATION ABSTRACT

(1)

PIERCING FIGS IN 2008: EXTRACTING VALUE FROM ETHYLENE BIOLOGY

R.M. Beaudry

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The first written reference to ethylene biology and its value come from a Greek translation of the Bible, in which the prophet Amos said, "I was a herdsman and a piercer of figs". In the Biblical reference, the wounded fruit are thought to yield the highly desirable response of inducing the uniform ripening of neighboring figs via enhanced ethylene biosynthesis. The value of manipulating ethylene biology has persisted across the ages to include controlled atmosphere storage of fruits and vegetables whose ripening and/or senescence processes are driven by ethylene. Most recently, ethylene biosynthesis and perception inhibitors have entered the commercial realm with remarkable results. In particular, the 4-carbon gaseous cyclic olefin, 1-methylcyclopropene (1-MCP), has revolutionized apple fruit storage and enabled storage operators to nearly completely suppress ripening in some varieties of apple fruit. Commercial use of SmartFresh, a formulation of 1-MCP used for storage applications, currently extends to over 25 fruit crops and will likely continue to expand to include new crops. Exciting results for field application of sprayable formulations of 1-MCP suggest significant value can be extracted from the inhibition of ethylene driven developmental processes in the field including fruit ripening and abscission in fruit crops and stress responses in grain crops.

ORAL ABSTRACTS

(2)

FLAVONOID ACCUMULATION IN GRAPEVINE BERRY: GENETIC REGULATION & PHYSIOLOGICAL CONTROL

S.D. Castellarin

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Flavonoids are important determinants of quality in red grapes and wines. The biosynthesis of anthocyanins, proanthocyanidins, and flavonols shares several common steps in the flavonoid pathway. Water deficits actively induced anthocyanin biosynthesis, but had limited effects on proanthocyanidins and flavonols. The majority of structural and regulatory genes of the flavonoid pathway showed increased transcript accumulation in fruit of water deficit plants. However, water deficits caused a differential upregulation of the structural genes that code for two flavonoid hydroxylases, flavonoid 3'-hydroxylase (*F3'H*) and flavonoid 3',5'-hydroxylase (*F3'5'H*). These hydroxylases convey flavonoid intermediates to the synthesis of either cyanidin- or delphinidin-type anthocyanin. The increase in total anthocyanin content resulted predominantly from 3',4',5' hydroxylated (delphinidin) forms through a greater upregulation of *F3'5'H* than *F3'H*.

The transcription of genes committed to brassinosteroid control of maturation processes, that encompass color accumulation, was also triggered in water deficit plants.

In separate work, color variation among the different red-skinned grape varieties, was associated with genotype-specific patterns expression of the whole set of anthocyanin genes in a direct transcript –metabolite-phenotype relationship.

(3)

USING GENOMIC TOOLS TO UNRAVEL PEACH FRUIT MEALINESS AND COLD STORAGE BROWNING

Ebenezer A. Ogundiwin¹, Antonio Granel², Thomas M. Gradziel¹, and Carlos H. Crisosto¹

¹ Department of Plant Sciences, University of California, Davis, CA USA

² IBMCP CSIC-Universidad Politécnic, E-48022 Valencia, SPAIN

Mealiness and cold storage flesh browning are major symptoms of internal breakdown (IB) in peach fruit. Other symptoms are internal bleeding, loss of flavor and development of off flavors. IB or chilling injury occurs in fruit stored at cold temperatures for the purpose of extending shelf life. A dedicated ChillPeach™ EST database and cDNA microarray are being used in combination with the candidate gene approach to identify IB-controlling genes in a peach progeny population (Pop-DG) segregating for IB resistance. A linkage map covering ~95% of the peach genome was constructed for Pop-DG. This map is co-linear with *Prunus* T×E reference map allowing cross referencing of markers and traits. Included on both Pop-DG and T×E reference map (through bin-mapping) are 70 novel ChillPeach SSR markers and 80 additional ChillPeach unigenes differentially regulated in normal peach mesocarp tissue versus cold-treated tissue. Several quantitative trait loci (QTL) were detected for IB symptoms in Pop-DG. Some ChillPeach unigenes and candidate genes mapped to the vicinity of QTLs controlling mealiness, flesh browning and other IB symptoms. Detailed analysis of a gene encoding leucoanthocyanidin dioxygenase enzyme (PpLDOX) that mapped to a major QTL for browning (qP-Brn5.1^m), revealed strong evidence for its control of this IB symptom. Ongoing efforts on further mapping and functional characterization of IB-controlling genes through testing the effects of gibberellin on IB gene expression, extensive microarray analyses, and the validation of IB QTLs obtained from Pop-DG in other peach progeny populations with different genetic backgrounds will be presented.

(4)

GREEN OR ORANGE – TOWARDS UNDERSTANDING THE MOLECULAR BASIS OF CITRUS FRUIT PEEL COLOR DEVELOPMENT

K. Inoue*, X. Qin, and A. Ikegami.

Department of Plant Sciences, University of California, Davis, CA 956116 USA

Peel color development is one of the most important factors to determine commercial quality of citrus fruits. Fruits of late season varieties such as Valencia orange are known to show an apparent revert in their peel color from orange to green when they remain on the tree through late spring to summer. This “regreening” phenomenon can cause a significant marketing problem. Previous studies showed that this color change associates with the conversion of non-photosynthetic chromoplasts to photosynthetic chloroplasts. As a first step to develop efficient strategies to control citrus fruit peel color development, we have analyzed accumulation of chlorophylls and carotenoids, as well as that of transcripts involved in the biosynthesis of pigments and plastid biogenesis, in peels from different developmental stages of Valencia orange fruits. HPLC analyses revealed no major difference between unripe green and ripe regreened fruits in their pigment compositions. Interestingly, several genes involved in the biosynthesis of photosynthetic pigments, i.e., chlorophylls and a carotenoid lutein, were found to be expressed in non-photosynthetic orange peels by quantitative RT-PCR analyses. Supported by the California Citrus Research Board.

(5)

REVERSE GENOMICS ANALYSIS OF ETHYLENE REGULATION IN APPLE FRUIT TISSUES

A.M. Dandekar

Plant Sciences Department, University of California, Davis CA 95616 USA

A unique attribute of fruit development is the ethylene mediated regulation of fruit quality and nutritional attributes. We have defined the network genes that are regulated by ethylene in transgenic apple fruit tissues obtained from plants silenced for ethylene biosynthesis. Using RNA obtained from these fruit tissues and custom microarrays that contain 8,976 apple genes we were able to examine the differential gene expression patterns identifying 3204 genes significantly ($p < 0.05$) regulated by ethylene, 57 of these were regulated by both ethylene and sorbitol, the latter a key translocated sugar that is a product of photosynthesis synthesized in many Rosaceae crops including apple. We have classified (unsupervised) the expression of these gene to define their tissue specific expression patterns as well as their functional categorization using Arabidopsis gene annotations. Defining the pathways and their regulation is the first step as it will provide a unique insight into how ethylene regulates complex traits like fruit quality, shelf-life, nutrition, flavor, disease, disorders and fruit safety.

(6)

EVALUATING ETHEPHON AS A TOOL TO REDUCE BREBA CROP LOAD ON *FICUS CARICA*

Vanessa Bremer^{1*}, Maxwell Norton², Todd Einhorn³, and Carlos H. Crisosto¹.

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² University of California Cooperative Extension, Merced County, CA USA

³ Plant Sciences, California State University, Fresno, CA USA

In some fig cultivars, the first crop of the season (breba crop) yields very low production and less flavorful fruits, resulting in cost prohibitive harvests. If breba fruit are not harvested they may become potential sites for fungal pathogens, attract insects, and represent nutritional competition with the commercial crop. Therefore, removal of the breba crop is needed. Exogenous applications of ethephon were tested during three seasons using two approaches: fall applications (10-20% leaf abscission) to reduce breba crop by affecting flower differentiation, and early spring applications to promote early fruit abscission. Fall applications of 500 ppm ethephon resulted in reductions of approximately 49% of breba fruit per tree while spring applications of 300 ppm ethephon resulted in reductions of 90% of breba fruit per tree. These treatments did not affect shoot bud break or cause phytotoxicity, and there were no detectable ethephon residues.

(7)

DIFFERENTIAL EFFECTS OF 1-MCP IN POME AND STONE FRUIT DEPEND ON THE RIPENING STAGE AS REVEALED BY THE INDEX OF ABSORBANCE DIFFERENCE (I_{AD})

V. Ziosi¹, M. Noferini¹, G. Fiori¹, L. Trainotti², and G. Costa^{1*}

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²Dip. di Biologia, University of Padova, Via G. Colombo 3, Padova, Italy

The ethylene antagonist 1-methylcyclopropene (1-MCP) is an effective tool to clarify ethylene physiology and improve fruit shelf-life and quality. Its efficacy strictly depends upon fruit ripening stage; since in any commercial consignment there is mixture of fruit maturity, 1-MCP has often a limited commercial potential. In the present study, the I_{AD} , a non-destructive ripening index developed by means of vis spectroscopy, was used to grade pome and stone fruit according to their ripening stage. A comparative analysis displayed a broad range of responses to 1-MCP ranging from stimulation to total inhibition of ethylene production. In peach, transcriptome profiling of treated vs control fruit showed a differential regulation of the ethylene biosynthetic gene 1-aminocyclopropane-1-carboxylic acid synthase in fruit at different ripening stages.

(8)

EFFECTS OF PREHARVEST 1-MCP SPRAYS ON APPLE QUALITY

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² Department of Horticultural Science, North Carolina State University, Raleigh, NC 27695 USA

Studies were undertaken to evaluate the effects of preharvest 1-Methylcyclopropene (1-MCP) spray treatments on apple (*Malus × domestica* Borkh.) fruit quality at harvest and after long-term storage in regular atmosphere (RA) or controlled atmosphere (CA). ‘Law Rome’ trees were sprayed within 7 d of the normal harvest date (NH) and fruit sampled at NH or from delayed harvests. Preharvest 1-MCP sprays reduced fruit drop, internal ethylene concentration and starch index, and maintained firmness of fruit at delayed harvest dates, but had only minor effects on the maturity of fruit harvested at NH. Preharvest 1-MCP maintained fruit firmness after storage, and reduced the incidence of superficial scald more effectively than either diphenylamine or CA storage.

(9)

A SEARCH FOR BOTH (i) VOLATILE, AND (ii) NON-VOLATILE AND WATER SOLUBLE CYCLOPROPENE DERIVATIVES - ETHYLENE ACTION ANTAGONISTS

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The potency of seventeen new cyclopropene analogues was tested on ethylene-induced ripening of climacteric fruits, on etiolated pea seedlings and leaf explants abscission. They were in some plant systems more potent as ethylene antagonists than 1-MCP and in other systems less potent. A novel non-volatile inhibitor of ethylene action (WS-CPD, patent pending), was synthesized from one of the new analogues. It counteracted ethylene-induced abscission of citrus leaf explants and of peduncles of avocado fruits. It also inhibited ethylene-induced leaf epinasty in tomato seedlings, and prolonged vase-life of carnation and petunia cut flowers. It considerably delayed fruit ripening processes like skin color change in ‘Hass’ avocado and banana fruit. WS-CPD delayed to a lesser extent banana and avocado fruit softening, may be due to insufficient penetration.

(10)

JASMONATES NEGATIVELY INTERFERE WITH FRUIT DEVELOPMENT AND RIPENING IN PEACH (*Prunus persica* L. Batsch)

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Jasmonates (JAs) are signal molecules which elicit stress responses through JAs-responsive genes; they are also involved in developmental processes, including fruit growth and ripening. In the present study, methyl jasmonate (MJ) and n-propyl dihydrojasmonate (PDJ) were applied to peach trees at the S1, S3 and S4 phases. In all cases, both chemicals inhibited climacteric ethylene production and delayed flesh softening leading to a ripening delay. A transcriptome profiling of JA-treated versus control fruit indicated that MJ down-regulates genes positively involved in fruit ripening (1-aminocyclopropane-1-carboxylic acid oxidase and polygalacturonase) while up-regulates defence-related genes including JA biosynthetic (allene oxide synthase) and other cell wall-related genes.

(11)

EFFECTS OF ABSCISIC ACID ON GRAPE COLORATION IN THE SOUTHERN HEMISPHERE

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Fruit color is an important quality factor in red table grapes. Commercial harvest requires sufficient levels of color in commercially mature fruit, and this can be a significant challenge for table grape growers. Fruit color development can be influenced by a number of factors including the grape cultivar, rootstock, plant vigor, climate, canopy management, light exposure, crop load, irrigation, fertilization, and plant growth regulators. Consequently, achieving optimal fruit color requires a programmatic approach rather than the use of a single tool or practice. The plant growth regulator ethephon is one tool that can be used to help improve color development. However, ethephon can be inconsistent and can cause berry softening. Because of the importance of fruit color development, there is a need for additional tools to help improve grape coloration. In the past, the limited availability of abscisic acid has prevented its evaluation and development as a potential tool for commercial agriculture. However, Valent BioSciences Corporation is currently evaluating the use and potential registration of abscisic acid as a plant regulator on a variety of crops, including table grapes. Small plot and larger scale research studies have been conducted on Crimson Seedless, Flame Seedless and Red Globe in major table grape producing regions throughout the world. Results from our replicated small plot experiments and larger plot field studies have confirmed the previous published research findings showing that abscisic acid improves red grape berry color development. Spray applications of abscisic acid made to Crimson Seedless, Flame Seedless and Red Globe are effective in accelerating red color development and increasing red color levels. The rates of abscisic acid required can vary according to the growing region, the cultivar, and the desired level of color development. Typically, a concentration of 200 mg/L abscisic acid applied in a spray volume to achieve good coverage of the grape clusters is effective. The improvement in red color development from abscisic acid can result in earlier commercial harvests, improved harvest management, and improved pack-out yields due to more bunches being harvested with commercially marketable levels of color. These global field results demonstrate that abscisic acid has the potential to become an important new tool for the table grape industry.

(12)

AN IMPEDANCE IMMUNOSENSOR FOR THE DETECTION OF PHYTOHORMONE ABSCISIC ACID

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ABA is the major player in mediating the adaptation of the plant to stresses. Formerly developed phytohormonal biosensors usually employ indirect detection of the products of conjugated oxidase reactions. A label-free electrochemical impedance immunosensor for abscisic acid detection was developed using the anti-ABA antibody adsorbed directly on a porous nano-gold film. The film was produced electrochemically on a glassy carbon electrode in 0.008 mol/L hydrogen tetrachloroaurate solution containing 0.004 mol/L lead acetate with applied potential of -0.5 V (versus Ag/AgCl) for 50s. The anti-ABA antibody was immobilized onto the porous nano-gold through electrostatic adsorption and covalently conjugation. The electrochemical impedance spectroscopy (EIS) was used to characterize the successful construction of the porous nano-gold film and the stepwise modification of the glassy-carbon electrode. The concentration increase of the antigen brought the decrease of the interfacial electron transfer, which also means the increase of the impedance signal. Experimental parameters as pH and antibody incubation time were optimized. The results showed significant linearity ($R=0.9942$) in the range of 0.5 ng/mL-5000 ng/mL with a detection limit at 0.1 ng/mL.

(13)

EFFECT OF LIGHT QUALITY ON MORPHOLOGY AND ANTI-OXIDANT CONTENT IN RED LEAF LETTUCE

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Lactuca sativa cv. Outredgeous was grown under either fluorescent lamps or light emitting diodes (LEDs) to test the hypothesis that anti-oxidant potential could be regulated by light quality. Red leaf lettuce was grown at 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$ of photosynthetically active radiation (PAR), 1200 $\mu\text{mol mol}^{-1} \text{CO}_2$, 23 °C, and an 18h light /6 hr dark photoperiod in controlled environment chambers. The LED treatments were selected to provide different amounts of red (640 nm), blue (440 nm), green (530 nm) and far red (730 nm) light in the spectra. Total anthocyanin content and the oxygen radical absorbance capacity (ORAC) of the tissue were measured at harvest. The source of light had a dramatic effect on both plant growth and production of radioprotective compounds. LED's resulted in 50% greater bioprotectant content per plant at the same light level over triphosphore fluorescent lamps. Blue LED's (440 nm) appeared to regulate the pathways leading to increased concentration of bioprotective compounds in leaf tissue. LED lighting induced a number of effects on morphology that increased both accumulation of bioprotective compounds and total yield.

(14)

APPLICATION TECHNOLOGY AND EFFICACY OF AGROCHEMICALS

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The efficacy of field applied agrochemicals depends on the characteristics of the application technique. Critical aspects include spray nozzle design and the resulting spray droplet size and droplet velocity. Physical properties of the spray mixture, such as viscosity (shear and extensional) and surface tension (dynamic and equilibrium) affect the behavior of the nozzles and the droplets during the in flight, impact and deposition phases. The fundamental and practical aspects of agricultural spraying will be presented with particular emphasis on growth regulators.

(15)

FORMULATIONS: WHY THOSE “OTHER INGREDIENTS” ARE SO IMPORTANT

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PGR active ingredients can require complex systems of inert ingredients and processing methods to be transformed into a product that can be readily mixed in a spray tank and applied by end-users. Depending on the nature of the active ingredient and formulation type, the inert ingredients can serve many key roles such as wetters, dispersants, suspension aids, adjuvants, preservatives, antifoams, solvents, emulsifiers, buffers and others. The formulation and processing specifications can impact such aspects as biological control, crop and human safety and tank mix compatibility.

(16)

MOLECULAR STRUCTURE AND BIOMECHANICS OF FRUIT CUTICLES

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The leaf, stem, and fruit cuticles of higher plants regulate the flow of water and chemicals from the outside environment and form a barrier to bacterial and fungal attack. Fruit cuticles may be viewed as ‘smart’ surfaces – capable of spatially selective self cleaning and regulation of their mechanical performance during ripening. However, the molecular architectures underlying the protective functions of these biomaterials have been challenging to study because of cuticle insolubility and amorphous character. We have developed a non-destructive and complementary protocol of solid-state nuclear magnetic resonance (ssNMR) and atomic force microscopy (AFM) for the spatial, mechanical, and molecular characterization of intact fruit cuticles. Both wild-type and genetically modified tomatoes serve to illustrate the resulting information on chemical composition, covalent bonding patterns, polymer flexibility, and surface elastic modulus that is obtained with these state-of-the-art biophysical methods.

(17)

IMPROVING EFFICACY OF CITRUS ABSCISSION SPRAYS THROUGH MORE UNIFORM SPRAY COVERAGE

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The selective fruit abscission compound 5-chloro-3-methyl-4-nitro-1*H*-pyrazole (CMNP) improves mature fruit removal of mechanically harvested orange trees in Florida. Uniform fruit removal depends on peel contact by CMNP sprays. When conventional radial-discharging air-blast (AB) sprayers are used, fruit removal is variable, especially in tall dense canopies. Fruit detachment force (FDF) and fruit removal were measured when CMNP was applied with an AB or a multi-head air-blast 'OXBO T-1000' (OX) sprayer. CMNP (200 ppm [200 mg·L⁻¹]) was applied at 1873 and 2810 L·ha⁻¹ (200 and 300 gal·acre⁻¹) with the AB or OB sprayers to Hamlin' sweet orange [*Citrus sinensis* (L.) Osb.] in Immokalee, Fla, in Dec 2005. Additional trials were conducted in 'Valencia' sweet orange at various locations throughout Florida from 2008 to 2008 that included 1405 L·ha⁻¹ (100 gal·acre⁻¹) applications. Application volumes were adjusted by varying tractor travel speed and pressure of delivery if necessary. In some cases, water sensitive paper was placed in the canopy at heights of 1, 2, and 4 m (approx. 3', 6', and 12') at inside and outside canopy positions and viewed immediately after application. Four days after treatment, FDF at the same heights and canopy depths (1, 2, and 4 m at inside and outside canopy positions) was determined. Fruit from OX-sprayed trees had lower and more uniform FDF at all canopy positions. In contrast, fruit from AB-sprayed trees had greater variability in FDF, especially at the top and inside the canopy. Fruit were mechanically harvested using a tractor-pulled canopy shaker, a trunk shake-and-catch or a self-propelled canopy shake-and-catch system. Mature fruit removal was greater and less variable in OX-sprayed than AB-sprayed trees and required less spray volume. The results demonstrate that uniform CMNP coverage can minimize variation in its efficacy and improve mature fruit removal of trees harvested with any commercial citrus mechanical harvester operating in Florida.

(18)

ASCOPHYLLUM NODOSUM EXTRACTS AS PLANT BIOSTIMULANTS: FROM GENE EXPRESSION TO PHENOTYPE

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Extracts of the brown macroalga, *Ascophyllum nodosum*, is widely on field and horticultural crops for over a century as it improves plant growth, yield, and quality and imparts tolerance to biotic and abiotic stresses. However, the biochemical and molecular mechanisms of action of *A. nodosum* extracts are largely unknown. The biostimulant activities of *A. nodosum* extracts were studied using the model plant *Arabidopsis thaliana* under salinity stress. *A. nodosum* extract significantly improved plant performance under 150mM NaCl stress. Whole genome transcriptome profiling revealed significant and specific effect of *A. nodosum* extract on gene expression. This research opens up a novel area of chemical regulation of gene expression to improve plant growth and quantitative traits in crop plants. This potential will be discussed.

(19)

ROLE OF CYTOKININS IN SEAWEED EXTRACTS IN IMPROVING TURFGRASS RESPONSES TO HEAT AND DROUGHT STRESS

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Biostimulants containing seaweed extracts as a base ingredient are in common use in the turfgrass market, but their role in abiotic stress amelioration remains unclear. Our lab has made small steps over the last decade in uncovering the anti-senescence, cytokinin-like effects of these extracts. Stay-green effects under drought and heat stress were initially linked to improved antioxidant activity. Later, naturally high levels of cytokinins were measured in the extracts, with endogenous cytokinin increases being correlated with improvements in various metabolic functions during stress. Most recently, the rate of seaweed extract needed to provide adequate natural cytokinin concentrations for improved heat stress response have been confirmed relative to exogenous applications of *trans*-zeatin riboside. Supporting data will be reviewed in this presentation.

(20)

EFFECT OF BIOSTIMULANTS +/- MICRONUTRIENTS, HYDROXY-PROPANOIC ACID, CYTOKININS AND HUMIC ACID AS A TRANSPLANT DIP AND PLANT SPRAY ON ONIONS

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A variety of products were tested as growth stimulants on short-day onions in the Vidalia growing region of southeastern Georgia over a three-year period. These included 2-hydroxy-propanoic acid, humic acid, cytokinin, and seaweed extracts. These products whether applied as a foliar spray or as a transplant dip did not have any affect on onion growth, yield, or graded size. In one year 2-hydroxy-propanoic acid had a higher percent marketable onions after 4.5 months of controlled atmosphere (3% O₂, 5% CO₂, 34 deg. F.) storage compared to humic acid, humic acid with seaweed extracts, or cytokinin. The 2-hydroxy-propanoic acid treatment did not, however, differ from the check of plain water with surfactant. These growth stimulants have been reported to have positive effects on many plants including onions in some cases, but without consistent results from one study to the next or from one year to the next these products are of marginal usefulness in onion production.

(21)

DEFINITIONS AND REGULATIONS FOR COMMERCIAL USE OF PLANT GROWTH REGULATORS, BIOSTIMULANTS AND FERTILIZERS IN THE USA AND CALIFORNIA

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Products containing substances that alter plant growth, development, maturation, and retardation, etc. through physiological actions are classified as Plant Growth Regulators (FIFRA Sec. 2, Food and Agricultural Code Sec. 12756) requiring registration as a pesticide. The California Department of Pesticide Regulation grants CA registration after USEPA has registered the pesticide product and the product also meets data evaluation requirements in California. In addition to other data requirements, Plan Growth Regulators must demonstrate product efficacy under CA and/or CA like field conditions. Efficacy studies must be conducted at the recommended label rate utilizing the principals of experimental research. Results must be statistically significant in comparison to a control and a standard product when available.

(22)

EFFECT OF SEAWEED EXTRACT ON FRUIT SET, YIELD, AND QUALITY IN PINOT NOIR WINEGRAPES

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Pinot noir wine grapes are susceptible to shatter, and growers often look for ways to increase set. Over two years, the effects of multiple applications of seaweed extract (Acadian LSC, Acadian Seaplants Limited) were examined. At veraison, cluster weights were significantly greater on treated vines than the control, while individual berry weights were unaffected. In addition, rachis length was significantly longer in the treated vines. Treated clusters reached a greater percentage of their final weight earlier in the season than the control. More bunches were produced on treated vines than on the control in year two, but not year one. More uniformity in ripening was also exhibited with seaweed treatment. No significant differences in pH, brix, or titratable acidity were detected between treatments. These results indicate that Acadian LSC is a viable option to help reduce shatter, increase rachis stretch, and overall yield, in Pinot noir wine grapes, while still producing quality juice.

(23)

THE EFFECT OF 'SOAR' BIOSTIMULANTS ON FRUIT YIELD OF BELL PEPPERS IN CONSECUTIVE SEASONS

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Seaweed based 'SOAR' biostimulants, 'MicroMix' and 'Bloom Spray' were applied at two rates, 2 qt and 3 qt/A, on bell pepper cultivars 'Wizard X3R' in spring 2004 and fall 2005, and on 'Aristotle' in spring and fall 2006, and fall 2007, in replicated trials to investigate the effect of biostimulant treatments on fruit yield and fruit size. In every season, yield of US Fancy grade fruit was higher with 'SOAR' than with control treatment. The higher yields were due to a larger number of US Fancy grade fruit rather than heavier weight per fruit.

(24)

GROWTH STIMULATING ACTIVITY OF PLANTS FROM FLORA KYRGYZSTAN

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Laboratory and field screening of substances extracted from plants allowed detecting several preparations with high growth stimulating activity. In the series of experiments on germination of wheat and alfalfa seeds after exposure to 1% solutions of plant extracts (17 preparations) stimulating effect of most preparations on germination power, germinating capability, seedling length and length of roots was demonstrated. The analysis of this information allows establishing that the best protective and stimulating effect to germinating seeds of wheat is recorded after their treatment with extracts of *Capsella bursa-pastoris* L., *Cotynus coggygia* Scop, *Tripleurospermum inoderum* (L.) Sch. Bip и *Ceratocephallus testiculata* (Crantz.) Bess. In these cases on the 7-10 days of observation the length of roots and seedlings, the weight of seedlings is 27.2-40.6% to controls (100%). Affection of seedlings with root rot (*D. sativum*) decreased from 10% to 1-3%. Positive effect is recorded when wheat seeds are treated with extracts of *Elaeagnus angustifolia* L., *Ailanthus altissima* L., *Gleditschia* spp. , etc. The inhibiting effect was demonstrated by extracts from *Papaver* L. and *Lepidium repens* L. Mass of wheat seedlings was for 35-47% less in comparison with control.

(25)

MANAGING WATER STRESS OF ORNAMENTAL CROPS WITH S-ABSCISIC ACID PLANT GROWTH REGULATOR

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Floriculture nurseries producing crops for the most popular retailers need better ways to manage drought stress while plants are being displayed and sold. Wilting and flower drop commonly limit the market life of potted plants, and nurseries would benefit from improved methods to protect their plants from periods of drought stress. Valent BioSciences Corporation (VBC) is nearing the final stages of U.S. EPA registration of S-abscisic acid (S-ABA) as a new plant growth regulator for stress reduction in ornamentals. Laboratory and field research to date has indicated that this naturally occurring PGR reliably reduces transpiration and improves drought tolerance when applied to numerous floriculture crops the day before shipping. Crops such as impatiens, New Guinea impatiens, petunia, dianthus, chrysanthemum, hydrangea, lantana, euryops, and pentas have generally responded well to S-ABA applications. VBC is currently engaged in a large experimental use permit for cooperative testing with nurseries in 18 states that is designed to lead into full product registration of S-ABA for use on ornamental crops inside and outside of greenhouses.

(26)

CONFIGURE: A NEW PLANT GROWTH REGULATOR FOR ORNAMENTAL CROPS

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Configure™, a new plant growth regulator which contains the active ingredient N-(phenylmethyl)-1H-purine-6-amine (most commonly called benzyladenine or 6-BA) recently received EPA approval for use in enhancing lateral branching and the promotion of flowering in certain ornamental crops. Trials conducted by Dr. Joyce Latimer at Virginia Tech University and Paul Pilon (Perennial Solutions Consulting, Jenison, MI) have demonstrated significant increases in branching on *Echinacea* with foliar applications of Configure. Dr. Latimer also conducted trials in 2007 on *Hosta*, which demonstrated significant increases in offset production with Configure. Additionally, studies have been conducted by Dr. Brian Whipker at North Carolina State University in which Configure was shown to promote vegetative branching and increase the number of flower buds on Christmas cactus (*Schlumbergera* spp.). Fine Americas, Inc. is in the process of expanding the Configure label which, once approved, would give growers the ability to trial Configure on a wide range of crops.

(27)

DEVELOPMENTAL EFFORTS AND FUTURE POTENTIAL NICHES OF THE PLANT GROWTH REGULATOR FLURPRIMIDOL

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Flurprimidol is a nitrogen-containing heterocycle Type II, class B plant growth regulator (PGR) in the pyrimidine class of chemistry. Specifically, flurprimidol inhibits the enzyme cytochrome P₄₅₀ monooxygenase blocking the formation of *ent*-kaurenoic acid, a precursor to active GA's. Since acquisition of flurprimidol in 2001, significant research and development initiatives have led to modifications of previously registered uses and expansions into new market segments including container ornamentals, established landscape ornamentals, and turfgrass systems. A more recent discovery was the patented synergism with other Type II, class A plant growth regulators in turfgrasses and high level of growth regulation in container ornamentals resulting from soil media applications. Future market niches of flurprimidol include edging banding applications to turfgrass and granular applications for vegetation management.

(28)

EFFECTS OF TIBERON (CYCLANILIDE) ON ORNAMENTALS FOR FINISHED CROP PRODUCTION.

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Tiberon (Cyclanilide) was spray or drenched applied to various ornamentals after transplanting into their respective finished sized pots. Rates varied from 0, 25, 50 or 100 PPM. Sprays were to wet and drenches at 8 fl oz per 1 gallon pot.

Tiberon applications allowed release of lower axillary buds and in some cases promoted axillary bud formation. Many species showed positive response such as calibrachoa, geranium, larkspur, pieris, dogwood, ninebark to name a few. Others like pentas, impatiens, maple, olive, juniper have not shown positive results.

Cyclanilide has significantly improved fruit tree shoots and or buds, D. Elfving, WSU and shows strong promise for improving ornamental shoot development in propagation and finished crops.

(29)

S-ABA AND HYDRETAIN AFFECTS TRANSPIRATION AND TIME TO WILT IN *IMPATIENS WALLERANA*.

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Impatiens is an important flowering annual that is recognized as requiring frequent irrigation. It often exhibits wilting in retail displays. S-Abscisic Acid (S-ABA) was applied as a media drench to impatiens in 12 cm containers at concentrations of 62.5, 125, or 250 mg L⁻¹ in volumes ranging from 45 to 180 mL. Transpiration rates in plants treated with S-ABA were reduced to 40-60% of transpiration in control plants. Time to wilt was increased from 3 days for control plants up to 6 days for plants drenched with S-ABA. The effect of S-ABA on transpiration rate and time to wilt was greater at higher concentrations or greater application volumes. In a separate study, Hydretain was applied at concentrations of 7.5 or 15 mL L⁻¹ in 240 mL per pot as recommended and S-ABA was applied at 250 mg L⁻¹ in 60 mL. Time to wilt for control plants was 2 days and 3 days for both Hydretain treatments. Time to wilt was 5 days for the plants treated with S-ABA.

(30)

BENZYLADENINE CONTROLS GROWTH OF VEGETATIVE PETUNIA

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Benzyladenine (Configure, Fine Americas, Inc., Walnut Creek, CA), a cytokinin-based plant growth regulator (PGR), was applied as a foliar spray to determine its efficacy on growth control and branching of vegetative petunias. Foliar sprays of 0 to 160 mgL⁻¹ were applied 10-14 days after planting and the plants were measured 5 weeks later. The average plant height, diameter, and the number of flowers were measured and compared with the control. Benzyladenine at 80 mgL⁻¹ applied once restricted the plant width and increased the number of flowers per plant for the non-free branching cultivar 'Improved Charlie'. Benzyladenine at 160 mgL⁻¹ applied twice restricted the plant width and increased the plant height for the free branching cultivars 'Red Fox Surprise White' and 'Red Fox Surprise Blue Vein Improved'. The free-branching cultivar 'Red Fox Surprise Red' was controlled less. Benzyladenine was effective at controlling growth and increasing branching of vegetative petunia.

(31)

CHARACTERIZATION OF THE MANGO FLORIGENIC PROMOTER IN THE SUBTROPICS AND TROPICS

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Research characterizing the florigenic promoter of 'Keitt' mango during cool, sub-tropical conditions demonstrated that ¼ leaf per stem was sufficient to induce flowering in 95% of initiating lateral shoots on deblossomed stems. In another experiment, three leaves on a donor stem were sufficient to induce flowering in 100% to 80% of initiating lateral shoots on the donor and five adjacent defoliated receiver stems, respectively. Similar experiments in the warm tropics of Colombia determined that four leaves per stem were necessary to induce 50% flowering shoots in 'Tommy Atkins' trees and 20% in 'Keitt' trees. Five leaves on donor stems of 'Tommy Atkins' induced 70% to 20% flowering shoots on the donor and three adjacent receiver stems, respectively. The levels of FP made in 'Keitt' leaves during warm temperatures were estimated to be 3% of that produced in cool temperatures. The amount produced by 'Tommy Atkins' leaves in the tropics was about 8% that of 'Keitt' leaves in the subtropics.

(32)

NAA AND ETHREL ARE FLORIGENIC IN APPLE

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Many modern apple cultivars are genetically predisposed to develop a biennial bearing habit where a heavy crop in one year is followed by little or no flowering in the next spring. Chemical and hand thinning are practiced during early summer to promote return bloom. However reducing the number of fruit by thinning does not consistently guarantee sufficient bloom in the following year, particularly if the cultivar exhibits a strong biennial bearing habit. Application of NAA or Ethrel to heavily cropped apple trees during early summer consistently increased return bloom in the southeast. AVG reduced the positive effects of NAA on return bloom, indicating that ethylene is involved in the switch from vegetative to floral development. Application of NAA during the month prior to harvest also increased return bloom indicating that the fate of developing apple buds can be determined much later than previously thought.

(33)

THE EFFECT OF DIFFERENT CONCENTRATION OF 3-INDOL- EBUTANIOIC ACID (IAA) AND GIBBERELIC ACID (GA3) ON SCARLA SQUASH CULTIVAR.

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Growth regulators (IAA). (GA3) and Mixture of (IAA) and (GA3) increased plant height, number of leaf plant, in the two seasons of planting compared to control. The increase was significantly with increasing the concentration of both (IAA) alone or mixed with (GA3). Number of flower/plant female and male flowers was increased by growth regulators treatments. No Apparent effects of growth regulators treatment on sex ratio of flowers. However, number of female flowers increased with (IAA) higher than (GA3) or the mixture of (IAA) and (GA3) in the two seasons of planting. Fruit weight and size of Scarla Squash cultivar increased with (IAA), (GA3) and the mixture of (IAA) and (GA3) over control. But this increase was not significant in both seasons of planting. Fruit length and fruit diameter also increased with growth regulator treatments. Growth regulator increased yield and improve fruit quality of Scarla Squash cultivar.

(34)

ENHANCEMENT OF CUCURBIT SEED PRODUCTION FROM APPLICATIONS OF PLANT GROWTH REGULATING COMPOUNDS

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Honey bees are critical and required for pollination of female flowers in cucumbers, watermelons, cantaloupes, specialty melons, pumpkins, summer squash and winter squash. Honey bee decline in recent years has caused concern in the seed industries.

Most female flowers of cucurbits are receptive for a short period of time. The use of plant hormones, plant nutrients and the combinations of such regulating compounds has been demonstrated to enhance pollination and fertilization period for cucurbits. Michael D. Orzolek, Dept of Horticulture, Pennsylvania State University recently conducted research trials on the use of compounds to prolong the period of cucumber and squash flowering. These compounds additionally enhanced both male and female flower production. Joint projects with Stoller Enterprises and Harris Moran Seed Company conducted in 2006-2008, using these same compounds in replicated trials, also demonstrated the similar enhancement of cucurbit fruit and seed production.

(35)

ALTERATION OF PLANT ARCHITECTURE IN DETERMINATE MULTIFLOWERED PEAS

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The *determinate (det)* line of pea displays a more synchronous flower development than wildtype (WT) due to the early cessation of growth of the terminal meristem. However, yield may be reduced in determinate lines compared to WT indeterminate lines. We have previously analyzed the effect of different gibberellins (GAs) on the growth and development of a determinate, multiflowered line of pea (*det multi*) in both growth room and greenhouse growing conditions. Gibberellin treatment resulted in yield improvement due mainly to an increase in pod set from axillary buds in the middle portion of the plant. In the current study we crossed the *suppressed axillary meristems (sax-1)* line of pea, which has decreased branching due to continuous empty axils in the middle portion of the plant, with the *det multi* line. Determinate plants which lacked axillary buds from about the third node until a few nodes below the node of flower initiation (NFI) segregated from the cross resulting in plants that flowered and set pods from axillary buds directly below the NFI. Supported by NSF 0422840.

(36)

ABSCISIC ACID EFFECTS ON FRESH CUT VEGETABLES

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Abscisic acid (ABA, S-ABA) is one of the five major plant hormones. ABA is ubiquitous in nature and is found in all higher plants that have been analyzed. Although ABA has been extensively researched over the years, its limited availability and high cost have hindered its evaluation and development as a potential tool for commercial horticulture and agronomy. Valent BioSciences Corporation is currently evaluating the effects, possible benefits, and potential registration of ABA as a plant growth regulator product on a variety of crops. One of the well-known effects of ABA is the regulation of water relations in plants. ABA decreases transpiration and water use by temporarily closing the stomata, and thus reduces water stress in many plants. Reduction of water stress has many potential uses. For example, spray or drench applications of ABA at rates of 250 – 1000 mg/L to ornamental crops such as Impatiens, New Guinea Impatiens, Chrysanthemum, and Euryops and to vegetable crops such as pepper and tomato significantly delays wilting of plants compared to controls. We have found that application of ABA to leafy crops such as leaf lettuce, sweet basil, spinach, and aoshiso shortly before harvest reduces water loss and helps maintain post-harvest turgidity for 2 to 12 h longer than the control. Comparison of time lapse videos and weight loss curves shows that control plants lose their turgidity at lower amounts of water loss than ABA-treated plants. This delay in wilting may be useful for maintaining fresh cut quality of leafy vegetables and herbs.

(37)

OPTIMIZING SHOOT AND ROOT GROWTH IN SMALL GRAINS WITH PLANT GROWTH RETARDANTS

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Several inhibitors of gibberellin biosynthesis [chlormequat chloride (CCC), mepiquat chloride (MQC), trinexapac-ethyl (TrixE), prohexadione-Ca (ProCa)] and the ethylene-releasing compound ethephon (ETH) are presently used in intense small grain production in Europe and some other countries. The main objective to apply these compounds is to reduce the risk of lodging, which may have a severe negative impact on seed yield and quality. Each of the compounds reduces shoot growth. However, some compounds act almost immediately (ETH and ProCa), TrixE requires several days for metabolic activation, and the onset of activity of CCC and MQC is also delayed. Likewise, there are significant differences in the duration of biological activity: ETH, ProCa, and TrixE are relatively short-lived, whereas CCC and MQC are more persistent. A well-developed root system is also of importance to counteract lodging. Here, little effect results from applying ETH. CCC, MQC and TrixE increase root growth to some extent. However, a significant stimulation of root growth is induced by ProCa. Against this background, the recently introduced Medax® Top (50 g/l ProCa + 300 g/l MQC) is seen as an optimal combination to reduce the risk of lodging in small grains.

(38)

OVEREXPRESSION OF GIBBERELLIN 3 β -HYDROXYLASE GENE ALTERS THE EXPRESSION PATTERNS OF OTHER LATE GIBBERELLIN BIOSYNTHESIS GENES IN PEA

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Gibberellins (GAs) regulate many aspects of plant growth and development. To expand our understanding of the importance of gibberellin biosynthesis in reproductive and vegetative growth, pea (*Pisum sativum* L. cv. Carneval) plants have been transformed to over-express the GA 3 β -hydroxylase gene, *PsGA3ox1*, under the control of CaMV 35S promoter. *PsGA3ox1* codes for the enzyme that converts GA₂₀ to bioactive GA₁. Three independent homozygous transgenic lines carrying one copy of *PsGA3ox1* were used for the study. Transgenic lines showed varying degrees of phenotypic changes from the control lines. Expression patterns of *PsGA3ox1* (transgene and endogenous gene) and the late GA biosynthesis genes *PsGA20ox1*, *PsGA20ox2*, *PsGA2ox1*, and *PsGA2ox2*, were investigated in three different tissues (internodes, tendrils and stipules) using qRT-PCR. The *PsGA3ox1* transgene was expressed in all tissues tested, with transcript levels always highest in line 17-3, followed by line 12-2, then line 6-3. Expression patterns of the *PsGA20ox* and *PsGA2ox* regulatory genes varied with the transgenic line and developmental stage of the tissue and showed that feedback regulation comes into play in maintaining GA homeostasis in these plant tissues. Biochemical studies are in progress to determine if the changes in the expression profiles of the GA biosynthesis genes studied reflect steady-state endogenous GA levels.

(39)

INOCULATION OF RHIZOBIUM JAPONICUM AND β -SITOSTEROL EFFECT ON GROWTH, YIELD AND SOME BIOCHEMICAL CONSTITUENTS OF SOYBEAN (*Glycine max* L.) PLANT

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To study the possibility of promoting effect of β -sitosterol for increasing the nodule development through inoculation of *Rhizobium japonicum* and their interaction effect on growth, yield and biochemical constituents of soybean plant, two trials were conducted under green house conditions. β -sitosterol application significantly increased nodes number/plant at 40 mg/l. The increases of photosynthetic pigments, total sugars and protein at flowering stage, and indoles at filling seed stage were significantly related with β -sitosterol level. In seeds, protein and phenols content were significantly increased. β -sitosterol 10 mg/l caused a significant increment of seed yield and 100-seed. Biochemical constituents in the leaves, as sugars, free amino acids, protein, phenols and indoles were significant differed according to Rhizobacterin inoculation rate and β -sitosterol concentration at all physiological stages. Inoculation of Rhizobium and β -sitosterol interaction significantly induced nodes number formation/plant at vegetative and flowering stages with 20 g/kg rhizobacterin and 20 mg/kg β -sitosterol.

(40)

HIGH ALKALOIDS PROMISING INDUCED MUTANTS BY GAMMA RAYS AND THEIR MOLECULAR MARKERS IN ATROPA BELLADONNA L.

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This investigation was carried out to induce gamma rays mutants in *Atropa belladonna* L. possessing high alkaloids contents. The used gamma rays doses were 50, 80, 110 and 150 Gy. The mutants had apparent morphological changes in plant height, no. of leaves and flowers as well as large leaf area. Three promising high alkaloids mutants were selected from M2, M-11-1, M-11-2 and M-15-1. These promising mutants seemed to be a very important for their high alkaloids content, they possessed twice values than the control. These high alkaloids mutants, possessed stable morphological criteria at M3 generation. Molecular studies on these mutants were done for identification of them by ISSR technique confirming the difference between these mutants and control. The three mutants were distinguished by unique molecular markers, i.e. Mutant M-11-1 distinguished by three molecular markers with molecular sizes 1397, 1149 and 874 bp (base pair). Mutant M-11-2 distinguished by four molecular markers with molecular sizes 1537, 1075, 839 and 510 bp. Mutant M-15-1 distinguished by three molecular markers with molecular sizes 1749, 817 and 756 bp. These findings drew the attention to the importance of genetic variation between these mutants and mother genotype, as well as, it considered a primary study to finger printing them.

(41)

ONION YIELD AND THRIP SUPPRESSION ARE ENHANCED WITH STOLLER'S ROOT POWER

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In a multi-year year study, Root Power applied through drip irrigation either weekly for 6 weeks or at a higher concentration with one application, yielded as well or slightly better than the insecticide, Lannate treatment. Yields were substantially higher than the untreated plots. The yield increase was a result of more large, jumbo onions. Onion thrip suppression was as good as with the insecticide treatment. Suppression of thrips was effective at either low or high insect pressures. The value of this treatment not only includes yield enhancement but also some level of insect tolerance, a rather unexpected phenomenon.

(42)

DROUGHT-RELATED GENE REGULATION IN ARABIDOPSIS BY BIOFORGE

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In addition to documented yield increases, improvements in crop water status in the field have been anecdotally observed in plants treated with Stoller's Bioforge (diformyl urea). Research into this phenomenon using *Arabidopsis thaliana* indicated that treatment with Bioforge previous to the imposition of drought increased survival of water-deprived plants by an average of 44% compared to water-only controls. In experiments on Petri dishes, a phenotype of deeper green leaf color, known to be associated with increased ABA content, was observed under Bioforge treatment. Molecular investigation of these effects by DNA microarray and quantitative real-time PCR analyses revealed upregulated expression of the transcription factor Dreb1A, as well as other genes involved in several aspects of drought and oxidative stress tolerance, ABA production, photosynthesis, and genes of unknown function. Taken together, our experiments suggest that Bioforge can activate several gene-expression-based drought tolerance mechanisms in plants, which could account for the increased drought survival observed.

PGRSA 2008 Annual Meeting, August 3-7, San Francisco, CA

POSTER SESSION

(1)

PROMOTING EARLY YIELD IN WATERMELON WITH EXTRACTS OF KELP (*Ascophyllum nodosum*)

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Three kelp extract formulations were evaluated in field experiments in Puerto Rico to determine their effect on watermelon early yield (first harvest). ‘Crimson Sweet’ watermelon was treated with a commercial kelp extract (Stimplex™) (= CEK, at the rates of 0, 1, 2 L/ha), and an experimental variation of CEK (with humic acid, carbohydrates, amino acids, peptides, saponins, and betaines) formulated for foliar application (= FF) applied alone or combined with an experimental variation of CEK (with humic acid, carbohydrates, amino acids, peptides, saponins, and betaines) formulated for soil application (SF). FF rates were 0 to 4 L/ha, whereas SF rates were 0 and 2 L/ha. The kelp extract applications started at the flowering stage and repeated 10 and 20 days after the first application. There was a general trend of increasing watermelon early yield as the kelp extract rates were higher. Early yields obtained with FF alone were not significantly higher than those obtained with CEK at the same rates. However, combined applications of FF plus SF, particularly at the higher rates, resulted in early yields significantly higher than those found when FF was applied alone. These results indicate that high rates of kelp extract could be used to augment the yield of watermelon in the first fruit picking, which are usually the fruits that command higher prices in the watermelon season.

(2)

ACCELERATING THE GROWTH OF ‘ORLANDO’ TANGELO (*Citrus reticulata* x *C. paradisi*) IN NURSERY WITH A COMMERCIAL AMINO ACID FORMULATION, A COMMERCIAL EXTRACT OF KELP (*Ascophyllum nodosum*), AND A FERTILIZER

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Nursery experiments were carried out in Mayagüez, Puerto Rico, to determine the effect of increasing rates of a kelp extract (Stimplex™), a commercial formulation of amino acids (Macro-Sorb Radicular™) and a fertilizer (Photogro™ = 2% N, 0.9% Zn and 0.9% B) on the in-nursery growth of ‘Orlando’ tangelo budded on ‘Cleopatra’ rootstock. Every two weeks, Stimplex and Macro-Sorb were applied to the soil and Photogro™ was sprayed on the tangelo canopy. Untreated plants reached the adequate transplanting stage significantly later than biostimulant-treated plants. Tangelo responded in a similar fashion to Stimplex™ and Macro-Sorb, and the time to reach adequate transplanting size was reduced as the biostimulant rates increased. Applications of Stimplex™ and Photogro™ or of Macro-Sorb and Photogro™ accelerated the growth of tangelo more than the separate application of either Stimplex™ or Macro-Sorb.

(3)

ASEXUAL PROPAGULE PRODUCTION AND FRUIT YIELD OF 'SMOOTH CAYENNE' AND 'CABEZONA' PINEAPPLE AS AFFECTED BY SELECTED PHYSIOLOGICAL REGULATORS

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Field experiments were conducted in Arecibo and Lajas, Puerto Rico, to assess the effects of chlorflurenol (0 to 125 mg/L), kinetin (0, 130 mg/L), and a commercial extract of the kelp *Ascophyllum nodosum* (0, 60 ml/L) on asexual propagules of pineapple. Those physiological regulators were sprayed individually or tank-mixed on 'Smooth Cayenne' and 'Cabezona' pineapples at the early fruit formation stage. Fruit and crown size tended to decrease as chlorflurenol rates were higher, the effect being more dramatic on the fruit crowns (approximately 90% reduction at the highest rate, as compared to untreated plants) than in the fleshy portion of the fruit. Fruit size increased when kinetin and the kelp extract were applied singly. Applying kinetin or the kelp extract tank-mixed with chlorflurenol alleviated the growth inhibition effects of chlorflurenol on the fruit and crown size. None of the treatments significantly affected asexual propagule production in 'Smooth Cayenne'. In 'Cabezona', significantly higher production of slips and basal shoots were found at the highest rates of chlorflurenol. High rates of chlorflurenol may be useful to stimulate higher productivity of asexual propagules in 'Cabezona' pineapple, but for dual purpose crops (fruit and propagule production) high rates of chlorflurenol may significantly reduce fruit yield at the expense of higher propagule yield. In future research we will explore the effect of chlorflurenol tank-mixed with higher rates of kinetin or kelp extracts to seek satisfactory pineapple fruit and propagule yields.

(4)

INCREASING WATERMELON YIELD WITH 3-INDOLEBUTYRIC ACID + KINETIN AND AN EXTRACT OF KELP (*Ascophyllum nodosum*)

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Treatments of a commercial formulation of 3-indolebutyric acid+kinetin (MegaGro™ = IAK) and a commercial extract of kelp (Stimplex = CEK) were evaluated for their effect on watermelon growth and yield in Puerto Rico. IAK was applied at the recommended rate (0.14 L/acre) on the 'Crimson Sweet' watermelon leaves when the plants reached the 3-true leaf stage, and again 12 days later. CEK was applied at the rate of 1 L/ha (a) 12, 24 and 36 days after the last application of IAK, (b) 12, 24, 36, and 48 d after the plants reached the 3-true leaf stage (no IAK applied), (c) when plants reached the 3-true leaf stage and repeated 12, 24, 36, and 48 days later (no IAK applied). As compared to the control, all IAK and CEK treatments significantly increased watermelon fruit yield by at least 20%. The sequence of IAK followed by CEK resulted in the highest yield increase.

(5)

**GIBBERELLIN EFFECTS ON SOYBEAN YIELD AND QUALITY SEED IN
CONDITION OF KYRGYZSTAN**

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Field experiments were conducted in Chu region in Kyrgyzstan, during 2006-2007 to determine the effects of gibberellin's application of the plant growth regulator on soybean yield, quality and yield components. Seeds were treated with GA₃ (50 mg L⁻¹). GA₃ treatments increased seed yield from 24.8 to 36%, essential amino acid content from 3.12% to 7.09%, total amino acid content from 3.94 to 5.85%, protein content from 2.2 to 8.78% and yield components (grain number and seed weight) compared with the control, expert for variety Amantay. The ability of roots to absorb and transform, and leaves to reduce and transform, nitrogen was improved by GA₃ treatments.

(6)

EFFECT OF POLYAMINES ON POSTHARVEST LEMON QUALITY

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Inexpensive treatments that improve the shelf life of stored lemons and reduce economic loss are needed. The efficacy of polyamines compared to GA₃ combined with 2,4-D to maintain lemon fruit quality was quantified. Fruit from three orchards were treated by submersion in spermidine or spermine (100 mg·L⁻¹) for 2 or 6 mins. All fruit were waxed [Stay Fresh 705 with Imazilil[®] (IMZ), Freshguard 2000 ppm]. Control fruit were treated with wax + IMZ or wax + IMZ + GA₃ (50 ppm) + 2,4-D (225 ppm). After 8 weeks of storage (12 °C), percent juice, total soluble solids and total acidity of spermine-treated fruit were equal to fruit treated with GA₃ + 2,4-D. Fruit treated with spermidine (6 mins), spermine (2 mins), or GA₃ + 2,4-D had equal weight loss over 8 weeks. All treatments had equally low decay for 8 weeks; all polyamine-treated fruit had less decay at week 10. With the exception of not delaying peel or button color development, fruit treated with spermine for 2 mins were equal in all quality parameters to GA₃ + 2,4-D-treated fruit. Spermine could prove a cost-effective alternative to 2,4-D.

(7)

THE USE OF CPPU IN WINE GRAPES TO INCREASE FRUIT SET

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In wine grape varieties (*Vitis vinifera* cv), CPPU (forchlorfenuron) will cause an increase in fruit set when applied at bloom. This effect is rate and timing dependent. As CPPU rate is increased, berry size increases and accumulation of soluble solids is delayed. An increase in berries per cluster is desirable in specific varieties that consistently have variable set, low set due to cool growing conditions or are in sites infested with grapevine fan leaf virus (GFLV). An increase in berry size is not desirable. In 2 of 3 trials, CPPU application resulted in a slight delay in maturity and berry size was not affected. In a GFLV infested Merlot vineyard, 4 g a.i./acre CPPU application resulted in a higher mean yield per vine. Cluster samples had lower pH and higher TA than in the 2 g a.i./acre or in untreated control vines indicating lower maturity; however soluble solids were not affected by treatment. The 2 g rate resulted in fruit that appeared to have more color than in other treatments. In a Pinot Noir vineyard grown in a cool site, both 2 g and 4 g rates, applied early and late in the bloom period resulted in significantly increased cluster weights compared to untreated control vines. Control vines had fruit with greater soluble solids and higher pH.

(8)

COMPARING THE EFFECTS OF PRE- AND POST-HARVEST JASMONATE APPLICATIONS ON COLOUR DEVELOPMENT IN APPLE FRUIT

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Jasmonates (JAs) are signal molecules which elicit stress responses through JAs-responsive genes. Exogenously applied on fruit, JAs stimulate β -carotene and anthocyanin accumulation, volatile emission, reduce chilling injury and increase disease resistance. In the present study, n-propyl dihydrojasmonate (PDJ) was applied to apple trees and detached fruit (cvs Royal Gala and Pink Lady®) at different developmental stages as revealed by the Index of Absorbance Difference (I_{AD}), a non-destructive ripening parameter developed by means of vis spectroscopy. While post-harvest PDJ application enhanced skin colour and phenolic content in both cvs at all the physiological stages, differential effects were observed in treated fruit *in planta*. In fact, late PDJ applications were more effective than the early ones, and Royal Gala more responsive than Pink Lady® in terms of colour development.

(9)

PLANT GROWTH RETARDANTS ARE EFFECTIVE IN PROMOTING RHIZOME GROWTH IN RHUBARB (*RHEUM RHABBARUM* L.)

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Inadequate availability of propagules and their exorbitant cost has limited the expansion of Individually Quick Frozen (IQF) rhubarb industry in North America. Accelerating rhizome growth will enhance propagule generation as the plant is propagated through rhizome divisions. This can be achieved through source-sink manipulation and it is expected that regulating shoot growth will result in enhanced rhizome growth. To explore this, an experiment was conducted to evaluate the effect of synthetic plant growth retardants Prohexidione-Ca (Apogee[®]) and CCC (Cycocel[®]) in enhancing rhizome growth in rhubarb cultivar German Wine under green house conditions. The plant growth retardant CCC at 3000 mg L⁻¹ effectively enhanced the rhizome diameter, fresh weight, number of viable buds and dry mass allocation in treated plants. The role of CCC in rhizome growth enhancement could be possibly *via* inhibiting the biosynthesis of endogenous GA and/or by preferential reallocation of carbohydrates towards the rhizome.

(10)

BENZYLADININE SPRAYS INCREASE *SEMPERVIVUM* OFF-SETS

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Foliar sprays of benzyladenine (Configure, Fine Americas, Inc., Walnut Creek, CA) at 0, 50, 100, 200, and 400 mgL⁻¹ were applied to *Sempervivum* 'Red Heart' and 'Green Wheel' to determine its efficacy on increasing offsets. Foliar sprays were applied 22 days after planting and offsets were counted 7 weeks later. *Sempervivum* 'Red Heart' produced 13, 20, 24, and 71% more offsets with 50, 100, 200, and 400 mgL⁻¹ benzyladenine, respectively, when compared with the untreated control. 'Green Wheel' had 26, 180, and 324% more offsets with 100, 200, and 400 mgL⁻¹ benzyladenine, respectively, when compared with the untreated control. Offset diameter was negatively correlated with the increased rates of benzyladenine, requiring extra production time for offsets to grow to marketable size.

(11)

EXPEDITING PROPAGATION THROUGH ADDITIONS OF PLANT GROWTH REGULATORS IN THE FORCING SOLUTION

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Getting difficult to root plant species to propagate has been a challenge for the plant nursery industry. Efforts to achieve successful propagation have turned to incorporating growth stimulators in a planned sequence to optimize growing activity at specific development stages. The goal of this study was to test a sequence model that expedites the propagation of woody plants through modification of a plant growth regulator (PGR) addition sequence in the basic forcing solution. GA₃ and IBA were introduced sequentially in the basic forcing solution to expedite propagation. This model forcing solution system was established by sequentially including one of the two PGRs in the forcing solution using the following sequence: (1) GA₃ was initially included in the basic solution for 1 day to enhance bud break and shoot elongation and then (2) on day 2 the GA₃ was replaced by IBA and transferred to fresh aliquots of basic forcing solution to "prime" the softwood cuttings for rooting. IBA was introduced to counteract the undesirable effects of GA₃ on rooting following its favorable effects on bud break and shoot elongation, and stimulated rooting. This forcing solution system expedited the propagation process of the test species and could be readily used for difficult-to-root species. We recommend it to commercial propagators for propagating softwood cuttings from dormant stems in the off-season as way of minimizing the use of valuable greenhouse space for stock plants.

(12)

STANDARDIZATION OF PROPAGATION TECHNIQUES OF SELECTED INDIGENOUS PLANTS AND EVALUATION OF THEIR PERFORMANCE UNDER URBAN CONDITIONS

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Several ornamental plants were introduced to Kuwait and evaluated for their performance under local arid environmental conditions. The adapted plants were recommended to be utilized in landscape projects according to the plant's aesthetic value and their response to urban conditions. Although exotic plants are essential for increasing the plant diversity they are cost and labor intensive. These plants have higher irrigation, fertilizer and maintenance requirements than native plants. Native plants are also better adapted to the local environment, can endure long drought spells and provide a more natural effect to landscape projects. Use of these plants in landscape projects will both conserve them and promote their sustainable utilization. Therefore, the Kuwait Institute for scientific Research (KISR) initiated the project "Standardization of Propagation Techniques of Selected Indigenous Plants and Evaluation of Their Performance under Urban Conditions" in November 2007.

Eight native plants were selected for this study based on their aesthetic value namely: *Farsetia aegyptia*, *Gyanandiris sisyinchium*, *Horwoodia dicksoniae*, *Lycium shawii*, *Nitraria retusa*, *Ochradenus baccatus*, *Peganum harmala* and *Rhanterium epapposum*. Seeds of these species were mobilized from KISR's seed bank (Task I) and germination experiments were initiated in the green house using agricultural soil: peat moss (3:1) medium (v/v basis). The pre-treatments included 50°C exposure for 10 days and 20 days followed by 0, 500, 750 and 1000 ppm gibberellic acid (GA₃) for 24 hours. Each treatment had five replications with thirty seeds in each replication. The experiments are still in progress and results awaited.

(13)

GERANIUM GROWTH WITH BROILER LITTER SUBSTRATE

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Broiler litter was a mixture of chicken excreta, bedding, and other materials generated during broiler production (e.g., soil, feathers, insects, remaining food, water, etc.). Bedding material was used to absorb droppings and to facilitate removal of excreta. The litter was removed after chickens were raised and was replaced with fresh bedding material. The removed litter was applied to crops or pastures as fertilizer due to its high nutrient content, especially phosphorus and nitrogen.

In order to evaluate the growth of geranium (*Pelargonium zonale* (L.) L'Her) cv. Victor Pacvi with different substrates a greenhouse experiment was carried out.

The study was conducted at the National Institute for Agricultural Research in Madrid, Spain for 90 days. The substrates used were (v/v): 0 %, 25 % and 50 % of Broiler litter-straw of barley (BS) and Broiler litter-wood shaving (BW) with peat (P) or commercial substrate (CS). After three months the plants were extracted from the substrate and were controlled: stem length (SL), root length (RL), leaf number (LN) and flower number (FN).

Results showed that the geranium had a negative response to the mixtures of BS and BW with peat and commercial substrate in all controlled parameters. 50% of BS, BW and their combinations (25% BS + 25% BW), produced in the short term, the death of the plant. 25% BS, BW and their combinations (12.5% BS + 12.5% BW) produced a significant decrease in all growth parameters. This could be due to the electrical conductivity (EC), because it increased (7 dsm^{-1}) when broiler litter was added to the mixture.

(14)

INTRODUCTION OF CAPERS FOR DUAL APPLICATIONS IN KUWAIT

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In an attempt to boost the greenery activities in Kuwait, several ornamental trees and shrubs are being introduced and evaluated for their suitability to the harsh environmental conditions of the country. Several studies have been conducted to assess the impacts of plants on the development of landscape gardens. The multipurpose use of plants provides an invaluable opportunity to enhance the introduction of greenery in Kuwait. Therefore, the Kuwait Institute for Scientific Research (KISR) initiated the project "Introduction of Capers for Dual Purposes in Kuwait, Phase I: Introduction, Propagation and Field Evaluation" in September 2006.

Various activities of Task I (Mobilization), Task II (Germination and Seedling Development of Capers), Task III (Rooting of Stem Cuttings) and Task IV (Field Evaluation) have been pursued. Seeds of capers (*Capparis spinosa* L.) and seedlings of *Capparis spinosa* var. *inermis* were procured and germination experiments were initiated in the growth chamber and germination trays using different medium. The dried caper seeds were difficult to germinate due to their dormancy. A number of pre-treatments such as chilling, acid scarification in 1% H₂SO₄, soaking seeds in gibberellic acid or potassium nitrate solutions were used to break the seed dormancy and enhance the germination percentage. Pre-treatment with 1% H₂SO₄, 400 ppm gibberellic acid resulted in 42% and warm water treatment with three months chilling produced 22% of germination. Acid scarified seeds, sown in potting soil medium were found to be effective and efficient in breaking the dormancy of dry caper seeds.

Semi-hardwood cuttings of *Capparis spinosa* and *Capparis spinosa* var. *inermis* were treated with varying concentrations of rooting hormones (NAA, IBA) to evaluate their effect on the rooting of the cuttings. The experiment is still in progress. Tentative results obtained indicated that utilization of 400 ppm and 2000ppm NAA proved to promote the rooting in caper cuttings.

(15)

EFFECTS OF PACLOBUTRAZOL ON GROWTH PERFORMANCE OF THREE SOUTHERN TREE SPECIES

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Loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), and cherrybark oak (*Quercus falcata* var. *pagodafoila* L.) in Louisiana were monitored for growth performance under the influence of paclobutrazol (PBZ) over a period of 8 years. The initial treatment of PBZ, formulated as Profile 2SC®, was applied in a water suspension by soil drench to sweetgum and loblolly pine at a dosage of 4.8 grams of active ingredient (g a.i.) per tree, and 9.6 g a.i. to cherrybark oak when all the trees were 6-year old and no additional treatment was applied thereafter. The 8-year experiment shows the long-term effect of PBZ varied with species. PBZ reduced diameter growth by 21% in loblolly pine, 45% in cherrybark oak, and 76% in sweetgum. PBZ reduced height growth by 13% in loblolly pine, 34% in cherrybark oak, and 74% in sweetgum. The effect of PBZ on cambium growth and xylem anatomy was moderate on the pine but very profound on the other two species.

(16)

EFFECTS OF METHYL JASMONATE ON THE RESISTANCE OF LOBLOLLY PINE TO SOUTHERN PINE BEETLE

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Three applications of methyl jasmonate (MeJ) (5mM, 50mM, 500mM) were applied to the inner bark of 23-year-old loblolly pine (*Pinus taeda*, L.); a 50mM was applied to the inner bark and as a root drench in juvenile loblolly pine; and a 5mM was applied to loblolly seedlings. Applications of 500mM MeJ caused significant increases in resin flow in 23-year-old trees. The combination of 50mM inner bark/root drench caused significant increases in resin flow in juvenile loblolly. Significant increases in resin flow also occurred in seedlings treated with 5mM MeJ. The seedlings were also treated with 5mM, 50mM, and 100mM MeJ to observe the formation of traumatic resin ducts, which were more prevalent in 5mM seedlings. The MeJ treated 23-year-old trees were inoculated with *Ophiostoma minus* and the 500mM treatment produced the smallest lesions and proved to be more effective in stopping fungal colonization. MeJ also increases monoterpene content which increases oleoresin toxicity, thus making it an effective defense elicitor in loblolly pine against southern pine beetle.

(17)

INTERACTION OF BRASSINOSTEROIDS AND ETHYLENE IN INHIBITORY GROWTH OF ARABIDOPSIS ROOTS

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Exogenous applied brassinosteroids (BRs) or ethylene showed inhibitory growth of *Arabidopsis* roots. Application of BRs activated ethylene production in the *Arabidopsis* roots. AVG or Co²⁺ applied with BRs exhibited activation of root growth than that induced by only BRs. Application of BRs with AVG showed shorter roots than that induced by application of AVG alone. Application of BRs with Co²⁺ showed no difference in root growth compared to application of Co²⁺ alone. These suggest that the BR-induced inhibition of *Arabidopsis* root growth is mediated by ethylene production, especially conversion of ACC to ethylene. In fact, an ACC oxidase in *Arabidopsis*, *AtACO1*, showed up-regulated expression in *Arabidopsis* roots by application of BRs. In addition, transcript level of *AtACO1* was increased in the roots of *bes1-D*, a dominant mutant of BRs transcription factor. Further, electrophoretic mobility shift assay (EMSA) exhibited that one of the BR transcription factor, BES1, binds two of four E-boxes in promoter region of *AtACO1*, demonstrating that a BR signaling for inhibitory growth of *Arabidopsis* roots is mediated by ethylene production, especially up-regulation of *AtACO1*. It suggests that *AtACO1* is the firstly identified meaningful target protein in BES1-mediated BR signaling. In this presentation, more details about molecular evidence for involvement of *AtACO1* in BR signaling pathway of root growth in *Arabidopsis* are discussed.

(18)

WHY IS ENDOGENOUS LEVEL OF CASTASTERONE HIGHER THAN OTHER BRASSINOSTEROIDS IN PLANTS?

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Brassinosteroids (BRs) are steroidal plant hormones which regulate diverse phenomena in growth and differentiation of plants. Among over forty naturally-occurring BRs, castasterone (CS) which is an end product of C-24 methylated C₂₈-BRs has been usually identified as the most abundant BRs from many plants. To elucidate the reason, enzymatic conversion of other BRs to CS was investigated by the use of crude enzyme solutions prepared from rice, *P. vulgaris* and *A. thaliana*. When 28-norCS which is an end product of C₂₇-BRs biosynthesis was used as a substrate in the presence of S-adenosylmethionine, an enzyme product of 28-norCS was characterized to be CS by GC-MS analysis. When 28-homoCS, an end product of C₂₉-BRs biosynthesis, was used, CS was identified as the enzyme product. When dolichosterone (DS) which is a biosynthetic end product of C₂₈-BRs with C-24 exomethylene was added to the enzyme solutions, CS was also identified as the product. The three reactions were demonstrated to be irreversible reactions, indicating that the biosynthetic pathways to generate C₂₇-BRs, C₂₈-BRs with C-24 exomethylene and C₂₉-BRs are alternative pathways to produce the most abundant BR, CS, in the plants. All together, CS can be biosynthesized not only by the already established C-24 methylated C₂₈-BRs biosynthesis but also by the biosynthetic pathway for C₂₇-BRs, C₂₈-BRs with C-24 exomethylene and C₂₉-BRs, which maintains a higher endogenous level of CS than that of other BRs in the plants.

(19)

HORMONAL RESPONSE-RELATED GENES ARE SPECIFICALLY REGULATED DURING POPLAR CELL GROWTH KINETICS

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To obtain information on changes in gene expression that could explain morphological and biochemical changes occurring during the developmental course of a batch plant cell culture, we have examined the global growth phase-dependent gene expression of poplar cells by cDNA microarray analysis. Our results reveal that significant changes occur in the expression of genes with functions related to protein synthesis, cell cycling, hormonal responses and cell wall biosynthesis, as cultures progress from initiation to senescence, that are highly correlated with observed developmental and physiological changes in the cells. We also detected a marked up-regulation of genes encoding proteins involved in responses to hormones including auxin, ethylene and gibberellin during both the early-exponential and stationary phases. The results imply that integrated hormonal regulatory mechanisms are involved in the complex cellular changes.

(20)

MUTATION IN THE *ARABIDOPSIS BARD1* BRCT DOMAIN RELEASES *WUSCHEL* EXPRESSION FROM THE ORGANIZING CENTER

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Stem cell fate in *Arabidopsis* shoot apical meristem is controlled by *WUS* and *CLV*. Here we observed severe SAM defects in the *Arabidopsis* knockout mutant *bard1-3*. *WUS* transcripts accumulated more than 238-fold in *bard1-3* compared to wild-type and were located to the outermost cell layers instead of the organizing center (OC). *WUS* promoter region formed complex with wild type nuclear protein extracts, which was recognized by *BARD1* antibodies. *wus-1bard1-3* suppressed the *bard1-3* phenotype by producing prematurely terminated SAM structures identical to *wus-1*. Increased *BARD1* expression in *35S::BARD1* transgenic plants reduced *WUS* transcript levels and resulted in a *wus-1*-like phenotype. Our data suggest that *BARD1* regulates SAM organization by limiting *WUS* expression inside the OC in plants.

(21)

PHYTOCHROME-REGULATED DIFFERENTIAL GENE EXPRESSION OF RAN/TC4 SMALL G-PROTEINS

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Ran/TC4 is a family of small GTP-binding proteins primarily localized inside the nucleus. We cloned a pea *Ran* gene (*PsRan1*) and characterized its expression under different light sources. The amount of total mRNA transcripts representing multiple *Ran* family members increased in response to very low fluence R, while the amount of mRNA transcript encoding *PsRan1* specifically was not affected. In addition, *Ran* genes in *Arabidopsis* were also differentially expressed in various mutants defective in phytochromes or the light-responding HY5 protein. We conclude that *Ran* gene expression is differentially regulated by various light sources and phytochrome-mediated signaling pathways.

(22)

REGULATION OF FLOWING BY HDA6 IN *ARABIDOPSIS*

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Posttranslational modifications of histones including acetylation play a key role in modulating dynamic changes in chromatin structure and gene activity. The reversible acetylation and deacetylation of specific lysine residues on core histone N-terminal tails is catalyzed by histone acetyltransferases (HATs) and deacetylases (HDACs). The competing action of both enzymes generates patterns of acetylation that may specify downstream biological processes such as transcriptional regulation. In general, hyperacetylated histones are associated with gene activation, whereas hypoacetylated histones are related to gene repression. Recent work has demonstrated that histone acetylation is an integral part of transcriptional regulatory systems in yeast and animal cells. Limited information is available regarding the involvement of HDACs in plants. HDA6 is a RPD3-type HDAC in *Arabidopsis*. The *Arabidopsis hda6* mutant, *axe1-5*, and *HDA6* RNA-interfering (*HDA6*-RNAi) plants displayed late-flowering. The expression of *FLC* was upregulated and hyperacetylated in *axe1-5* and *HDA6*-RNAi plants, suggesting that HDA6 is required to deacetylate *FLC* chromatin and thereby repress its expression. Our results suggest that HDA6 is involved in flowering in *Arabidopsis*.

(23)

EFFECT OF 1-MCP ON ETHYLENE SYNTHESIS, DEVELOPMENT AND PHYSIOLOGY OF COTTON FLOWERS UNDER NORMAL AND HIGH TEMPERATURE

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With global warming and climate change, high temperature stress has become a major factor affecting crop growth and yield. Cotton (*Gossypium hirsutum* L.) crops in the U.S.A. experience periods of extreme high temperatures during flowering and boll development, but information is lacking on the physiological response of cotton to high temperatures stress and appropriate techniques to ameliorate this response. The objective of this growth chamber study was to determine the effects of high temperature alone, and in combination with applications of the anti-ethylene compound 1-Methylcyclopropane (1-MCP) on cotton reproductive organs. Treatments consisted of two temperature regimes, 38°C and 30°C, and 1-MCP applications made to flowers on the day of anthesis. High temperature and 1-MCP had significant effect, on ethylene production of cotton reproductive organs. High temperature decreased ethylene synthesis by 2.5 fold at 2 days after the white flower stage. The 1-MCP treatment caused a 1.5 fold decrease in ethylene concentration 1 day after the application at the white flower stage. Both high temperature and 1-MCP treatment increased the weight of cotton bolls collected 8 days after the white flower stage with an increase of 0.7 and 1 g, respectively. Glutathione reductase (GR) activity showed higher values in the high temperature regime, whereas 1-MCP treatment significantly decreased GR activity in flowers collected two days after the white flower stage. These results indicated that although high temperature decreased ethylene production and increased the size of cotton bolls, high temperature treatment increased GR activity and the stress levels of cotton reproductive organs, whereas 1-MCP application had positive amelioration effects of decreasing ethylene and increasing boll size.

(24)

BENZYL ADENINE AND INDOLE BUTYRIC ACID INDUCED SOMACLONAL VARIATION IN RAPD PROFILES OF PETUNIA

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Petunia (Petunia hybrida) is grown worldwide for its beautiful flowers. In recent years micropropagation of petunia is gaining popularity. Somaclonal variation is associated with micropropagation. The present study is aimed at screening somaclonal variation using RAPD (Random Amplified Polymorphic DNA) analysis. Leaf explants of petunia were cultured on MS medium supplemented with 2.5 μ M benzyl adenine (BA) alone or in combination with 5 μ M Indole butyric acid (IBA). A large number of micropropagated plantlets were obtained with distinct variation in floral characteristics. DNA was extracted from each donor plant as well as the in vitro regenerated progeny plants to screen the variability. The RAPD profiles were evaluated by observing the number and size of the amplified fragments. In all 10 primers were used but the response of the regenerated plantlets to each of the primer was different. The fidelity or the variation was determined using the monomorphic or polymorphic bands. The results indicate significant variation in the parental and regenerated progeny.

(25)

AMPEROMETRIC IMMUNOSENSOR BASED ON GOLD NANOPARTICLE/THIONINE MODIFIED GOLD ELECTRODE FOR THE DETECTION OF PHYTOHORMONE ABSCISIC ACID

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An amperometric immunosensor based on gold nanoparticle / thionine modified gold electrode for the determination of ABA was proposed. The sensor was constructed based on the catalytic wave system of H₂O₂ and HRP with thionine as the medium. In the presence of HRP, the reduction current of thionine was substantially increased by the addition of H₂O₂ due to the catalytic wave system, and the current increase was dependent upon the activity of HRP. The activity of HRP could be modulated by the binding event of ABA to ABA-antibody conjugated HRP, producing a decrease in the catalytic wave. BSA was employed to block the possible remaining active sites of the thionine monolayer to avoid the non-specific adsorption. Assay conditions were optimized including the proportion of HRP labeled ABA antibody and thionine, the incubation time, the pH of working buffer and the concentration of the H₂O₂. The reduction current of the immunosensor decreases linearly in the range of ABA from 0.5 ng/mL to 1000 ng/mL with a detection limit of 0.2 ng/mL. Moreover, the immunosensor showed simple procedure, acceptable reproducibility, high sensitivity and stability for ABA analysis.

(26)

PRECISE MULTIPLEXED MEASUREMENT OF GENE EXPRESSION: QUANTITATIVE NUCLEASE PROTECTION ASSAY (qNPA™)

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qNPA is a 21st century gene expression technology that only requires the lysis of samples (no extraction), is multiplexed (16 genes/sample), fast and simple, and has single gene copy sensitivity, but most importantly provides precision associated in the past only with protein assays. Whole assay CV's of cells, tissues and plants are on average <10%, which means that changes in gene expression <1.2-fold are significant. The assay is repeatable between labs and day-to-day, where fold changes can be measured reliably with an average CV of 2%. The precision enables precise EC50 data to be generated useful to scientists and for clustering of genes into mechanistic signatures. Whole plants or plant parts can be lysed, prepped by a Genogrinder, and tested. Results will be presented.