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The Plant Growth Regulation  
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## QUARTERLY Reports on Plant Growth Regulation and Activities of the PGRSA

Volume 34, No. 2  
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*The Quarterly* is published four times a year by the Plant Growth Regulation Society of America. *The Quarterly* supercedes the Society's *Bulletin* which was established in 1973 and published 16 volumes until July 1988 (Vol. 16, No. 3). Volume number for *The Quarterly* is continued without interruption beginning with Volume 16, No. 4 in 1988.

PGRSA membership is open to all persons interested in the regulation of plant growth and development. Inquiries regarding membership should be directed to...

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*The Quarterly* is open to papers of merit dealing with all aspects of plant growth regulation and plant growth regulators. Manuscripts will be reviewed by two or more reviewers. Membership in the Society is not required. Newsworthy items, viewpoints and abstracts of theses and dissertations are also published as space permits.

## TABLE OF CONTENTS

<b>Articles</b>	<b>Page</b>
<b>PGRSA 33rd Annual Conference Schedule Summary</b>	<b>16</b>
<b>Abstracts</b>	<b>18</b>
<b>PGRSA Publication List</b>	<b>53</b>
<b>PGRSA Steering Committee</b>	<b>54</b>
<b>PGRSA Standing Committees</b>	<b>55</b>
<b>PGRSA Sustaining Members</b>	<b>56</b>
<b>Till We Meet Again</b>	<b>57</b>
<b>Down The Road</b>	<b>58</b>

**2006**  
**PLANT GROWTH REGULATION SOCIETY OF AMERICA**  
**33rd ANNUAL MEETING**  
**July 8-13, 2006**  
**Hilton Quebec,**  
**Quebec City, Canada**

*Program Summary*

**Saturday, July 8, 2006**

1600-2000      Pre-Conference PGRSA Steering Committee Meeting  
(Courville Boardroom)

**Sunday, July 9, 2006**

1400-1700      Tour of Old Quebec City  
Meet in courtyard outside Hilton Quebec  
1300-1800      Registration Open – Ballroom Foyer  
1900-2100      Opening Reception (Panorama Citadelle)

**Monday July 10, 2006**

0730-1700      Registration Open - Ballroom Foyer  
0800-0815      Welcoming Remarks  
*Dr. Jeff Norrie, PGRSA 1<sup>st</sup> Vice President*  
0815-0830      Welcoming Remarks  
*Dr. Sonja Maki, PGRSA President*  
0830-0900      **Keynote Address**  
**THE CENTER OF HORTICULTURAL RESEARCH**  
**LE Centre de recherche en horticulture:**  
**a model of partnership**  
*Dr. André Gosselin*  
0900-1115      **SYMPOSIUM I: (Porte St-Louis)**  
**PGR PRODUCING MICRO-ORGANISMS**  
Moderator: Dr. Jeffrey Norrie  
1115-1200      **Session 1: Contributed papers**  
*Moderator: Dr. Louise Ferguson*  
1200-1400      LUNCH DANS LA BELLE VILLE  
1400-1630      **SYMPOSIUM II : (Porte St-Louis)**  
**ADVANCES IN PGR MODE-OF-ACTION RESEARCH**  
*Moderator: Dr. Ron Smith*  
1530-1545      BREAK  
1615-1730      **Session II: Contributed Papers**  
*Moderator: Dr. J. Pablo Morales-Payan*

**Tuesday, July 11, 2006**

- 0700-0800      **SUSTAINING MEMBERS BREAKFAST** (Courville)  
*Chair: Dr. Sonja Maki*
- 0730-1700      Registration Open - Ballroom Foyer
- 0900-1115      **SYMPOSIUM III** : (Porte St-Louis)  
**PGR USE IN T&O HORTICULTURE**  
*Moderator: Dr. Gary Custis*
- 1000-1015      BREAK
- 1115-1200      **Session III: Contributed Papers**  
*Moderator: Dr. Sonja Maki*
- 1200-1400      LUNCH
- 1400-1615      **SYMPOSIUM IV**: (Porte St-Louis)  
**PGR APPLICATIONS IN FRUIT AND VINE CROPS**  
*Moderator: Dr. Thomas Chao*
- 1530-1545      BREAK
- 1615-1745      **Session IV: Contributed Papers**  
*Moderator: Dr. Richard Dunand*
- 1830-2130      **POSTER SESSION RECEPTION**: (Porte Kent)  
*Moderator: Dr. Bob Beede*

**Wednesday, July 12, 2006**

- 0800-1000      Registration Opens - Ballroom Foyer
- 0830-1015      **INDUSTRY UPDATE SESSION** : (Porte St-Louis)  
*Moderator: Dr. John Immaraju*
- 1015-1030      Break
- 1030-1115      **Session V: Contributed Papers**  
*Moderator: Dr. Steve McArtney*
- 1130-1300      Business Luncheon (Panorama Vieux-Port/Citadelle)  
*Chair: Dr. Sonja Maki*
- 1330-1630      Steering Committee Meeting (Courville)
- 1800-2230      Dinner Cruise on St-Lawrence River (Louis Joliette)  
Board Louis Joliette at Chouinard Pier at 1800  
Departs at 1900. Return at 2300

**Thursday, July 13, 2006**

- 0830-1500      **POST-CONFERENCE TOUR**  
Post-Conference Excursion - Bus Charter - to Laval University  
and the Ven den Hende gardens (Breakfast at Laval),  
Quebec Multiplants (Lunch at QM) and Les Chutes de la Chaudière.

## ABSTRACTS

(1)

### KEYNOTE PRESENTATION

#### THE CENTER OF HORTICULTURAL RESEARCH

[Le Centre de recherche en horticulture]:

#### A MODEL OF PARTNERSHIP

**André Gosselin\***, founder and **Russell Tweddell**, Chairman

**Université Laval, Quebec, Canada G1K 7P4**

The Horticultural Research Centre <Le Centre de recherche en horticulture> (CRH) at Laval university was officially created in 1990. CRH is composed of 21 professors, 30 research assistants and technicians, and 80-100 graduate students working in plant, soil and food sciences. Fifty percent of the graduate students are registered in Master Degree programs with one-third of those originating from foreign countries. Since its creation in 1990, more than 600 graduate students have been trained, most of them in collaboration with the private sector. The majority of these students are now working in the horticultural industry, either in Quebec or abroad.

The research budget for the CRH comes mainly from external sources. Traditionally, CRH obtained more than 50% of its funding from the Quebec horticulture sector or from Canada-Quebec partnership programs with industry. The 'Pavilion Envirotron', head office of CRH, was built in 1993 at a cost of 12M\$ with the support of the private sector. Daishowa, a pulp and paper company, invested more than 7M\$ to create the facility and sponsored a research program on paper mill residue composting. Today, around 200 tonnes of residues are composted daily. Provigo, the largest food distributor in Quebec, sponsored a laboratory and a research program in food science and nutrition. ICG Propane, a division of Petro Canada, invested in various gas technologies including greenhouse heating and weed burners for field vegetable production. Many other projects have been conducted in collaboration with the private industry: The development of the biofungicide, Sporodex with Plant Products; the development of peat substrates and composts with Premier Horticulture and Compost du Quebec; the improvement of yield and quality of horticulture produce with Savoura Greenhouse, Hydroserre Mirabel, Canneberge Atoca, Patate Dolbec, Coop Multi-Veg, Nutrite, etc.

The CRH has also established various research networks on: 1) nursery production with 7 partners including 3 substrate manufacturers and 4 growers; 2) turfgrass management with 3 growers and input suppliers; 3) pest bio-control in greenhouses with NSERC, Valorisation recherché Quebec, FQRNT and many private partners across Canada; and 4) nutraceuticals with the Institut des nutraceutiques et des aliments fonctionnels of Laval university.

Finally, CRH was successful in obtaining significant funding from the Canadian Foundation on innovation to replace the older greenhouses (14M\$) and to support many young scientists.

## ORAL ABSTRACTS

(2)

### **A HORMONE AND PROTEOME APPROACH TO PICTURING THE INITIAL METABOLIC EVENTS DURING CLUBROOT DISEASE ON ARABIDOPSIS**

**Sylvie Devos\* and Els Prinsen**

**Laboratory of Plant Physiology and Plant Biochemistry, University of Antwerp,  
Groenenborgerlaan 171, B-2020 Antwerp, Belgium**

Clubroot disease causes gall formation on Brassica roots. A holistic approach was undertaken to understand the role of plant hormones in early clubroot symptom development in Arabidopsis. We used the *CYCBI*;1::GUS, *DR5*::GUS and *ARR5*::GUS constructs to assess clubroot initiation. Hormone concentration between control and infected plants were screened using different hormone mutants for resistance and evaluated auxin transport. Also, a differential proteome study was performed using two dimensional gel electrophoresis coupled to MALDI-TOF. Combining the hormone and proteome data, we postulate that at the first stages of clubroot disease, cytokinins are produced by the pathogen. This triggers a local re-initiation of cell division in the root cortex. Consequently, a *de novo* meristematic area is established that acts as a sink for host-derived IAA, carbohydrates, nitrogen and energy to maintain the pathogen and to trigger gall development.

(3)

### **USING ARBUSCULAR MYCORRHIZAL FUNGI TO IMPROVE INPUT USE EFFICIENCY**

**C. Hamel\***

**Semiarid Prairie Agricultural Research Centre, AAFC, Box 1030 Airport Rd. Swift  
Current SK, Canada, S9H 3X2**

Biotechnology is expected to bring about a second Green Revolution in which more food is produced with fewer inputs and in a sustainable manner. Arbuscular mycorrhizal fungi (AMF) possess important attributes to be major players in tomorrow's agriculture. They have evolved as sun-powered resource managers in successful ecosystems. Advances in mycorrhizal research are revealing AMF as a heterogeneous group of soil fungi with requirements of their own, a picture contrasting with our initial understanding of these organisms. The value of their input to agricultural production can be enhanced through plant breeding, soil management, inoculation and use of signal molecules. The development of AMF-based technologies to enhance plant productivity under reduced input systems is seen as a means to improve farming profitability at a time of increasing resource costs.

(4)  
**PROMOTION OF PLANT GROWTH BY SOIL BACTERIA THAT REGULATE  
PLANT ETHYLENE LEVELS**

**B.R. Glick\***

**Dept. of Biology, University of Waterloo, Waterloo, ON, Canada N2L 3G1**

A mechanism used by many soil bacteria to promote plant growth is the production of the enzyme 1-aminocyclopropane-1-carboxylate (ACC) deaminase which cleaves plant-produced ACC, lowering the level of ethylene in the plant allowing it to be more resistant to environmental stresses including phytopathogens, extremes of temperature, high salt, flooding, drought, exposure to metals and organic contaminants, and insect predation. ACC deaminase-containing *Rhizobium* spp. are also more efficient at nodulating their legume hosts than are strains that lack this enzyme. A wide range of studies using different plants and soil bacteria will be discussed in the context of a previously proposed model for the functioning of ACC deaminase-containing bacteria. In addition, plant genes that are expressed as a consequence of the interaction with ACC deaminase-containing soil bacteria, and some of the bacterial regulatory factors involved will also be discussed.

(5)  
**BIOSYNTHESIS OF PLANT HORMONES BY MICROORGANISMS**

**W. Rademacher\***

**BASF Agricultural Center, 67114 Limburgerhof, Germany**

Higher plants are exposed to a multitude of fungi and bacteria, which are present in the surrounding phyllosphere and rhizosphere and which may also grow inside the shoot and the root. Compounds, known to act as hormones in higher plants, are produced by many of these microorganisms and are often functionalized in "friendly" or "hostile" interaction with the host plant. A large number of bacteria and fungi are capable of producing auxins, cytokinins or ethylene. In contrast, the ability of forming gibberellins or abscisic acid is much less common. *Gibberella fujikuroi* predominantly produces GA<sub>3</sub>, GA<sub>4</sub> and GA<sub>7</sub> as active GAs. Fermentations of high-yielding strains provide these GAs for commercial use. The fungi *Sphaceloma manihoticola* and *Phaeosphaeria* sp. produce primarily GA<sub>4</sub> and GA<sub>1</sub>, respectively. *Cercospora rosicola* and *Botrytis cinerea* represent fungi that synthesize abscisic acid. Strains of the latter organism are in use to produce this hormone on a commercial scale. The pathways for the biosynthesis of the different plant hormones in microorganisms are, in general, similar to the ones present in higher plants. However, significant deviations exist in several details.

(6)  
**GROWTH STIMULATION OF GREENHOUSE TOMATO PLANTS BY  
*PSEUDOMONAS PUTIDA* AND *TRICHODERMA ATROVIRIDE***

**V. Gravel\*, H. Antoun and R. Tweddell.**

**Centre de recherche en horticulture, Université Laval, Québec,  
Québec, Canada, G1K 7P4**

A study was undertaken to evaluate the effect of *Pseudomonas putida* and *Trichoderma atroviride* on the growth of healthy tomato plants. Results showed that inoculation of these microorganisms in the rhizosphere increased significantly the vegetative as well as the reproductive growth. Subsequently, the production and the catabolism of indole-3-acetic acid (IAA) by these microorganisms were evaluated *in vitro* to further assess the possible role of this plant growth regulator in the effect observed *in planta*. Results showed that both microorganisms were able to produce IAA in the presence of different precursors and were also able to degrade and to use IAA for their own development. Such degradation of exogenous IAA by *P. putida* and *T. atroviride* was also observed in the rhizosphere of tomato seedlings. This study suggests that the effect on plant growth of *P. putida* and *T. atroviride* could be related, at least in part, to a regulation of the concentration of IAA in the rhizosphere of tomato plants.

(7)  
**ASSESSING THE EFFECTS OF MULCH, COMPOST TEA, AND CHEMICAL  
FERTILIZER ON SOIL MICROORGANISMS AND EARLY GROWTH, BIOMASS  
PARTITIONING, AND NUTRITION OF FIELD-GROWN ROOTED CUTTINGS  
OF CANADA YEW (*TAXUS CANADENSIS*)**

**R.F. Smith<sup>1\*</sup>, S.I. Cameron<sup>2</sup>, J. Letourneau<sup>2</sup>, T. Livingstone<sup>3</sup> and K. Livingstone<sup>3</sup>**

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**<sup>3</sup> Jolly Farmer Products Inc., 56 Crabbe Road, Northampton, NB E7N 1R6, Canada**

A program to domesticate Canada yew (*Taxus canadensis* Marsh.) for the production of taxanes was started in 1997. An important objective of the domestication program is to identify and mass-propagate, fast-growing, high taxane producing clones. However, efficient field-culture protocols for this species have yet to be developed. Towards this goal, semi-commercial nursery trials were initiated in 2004 designed to evaluate the effects of plant spacing, mulch, and organic versus chemical fertilizers on the early growth and establishment of rooted cuttings of Canada yew. In addition to evaluating the observed differences in morphometric measurements and chemical/nutritional analyses, this paper will report on the first-year differences in microorganisms. The relationship between these early differences in growth and soil microorganisms will also be discussed.

(8)

**AUXIN CONJUGATE HYDROLYSIS DURING PLANT-MICROBE  
INTERACTION AND EVOLUTION**

**J. Ludwig-Müller<sup>1\*</sup>, A. Schuller<sup>1</sup>, A.F. Olajide<sup>2</sup>, V. Bakllamaja<sup>2</sup>, and J.J. Campanella<sup>2</sup>.**

<sup>1</sup> **Institut für Botanik, Technische Universität, 01062 Dresden, Germany**

<sup>2</sup> **Montclair State University, Montclair, NJ 07043 USA**

Plants regulate auxin balance through de novo synthesis, degradation, transport and conjugation. Several genes encoding auxin conjugate hydrolases were isolated from the dicots *Arabidopsis suecica*, a close relative to *Arabidopsis thaliana*, *Brassica rapa*, a more distantly related species from the Brassicaceae, *Medicago truncatula*, a model legume, the monocot *Triticum aestivum* and the gymnosperm *Pinus taeda*. Expression of the hydrolase genes in *E. coli* allowed the biochemical characterization of substrate specificity which clearly differed among the amidohydrolases. Also, different temporal and spatial expression patterns for the hydrolase genes from various species were found. In addition, auxin conjugate hydrolases might play a role in the establishment of pathogenic or symbiotic interactions with microorganisms. We have recently started to include lower land plants, e.g. moss, in our analysis to understand how auxin homeostasis has evolved.

(9)  
**INTERACTIONS OF PIN AND PGP EFFLUX MECHANISMS IN  
POLAR AUXIN TRANSPORT**

**Angus Murphy\***

**Dept. Horticulture and Landscape Architecture,  
Purdue University, West Lafayette, IN, 47907 USA**

Directional transport of the phytohormone auxin is required for the establishment and maintenance of plant polarity. The polarity of auxin transport is established primarily at the point of cellular efflux, but the activity of the efflux transporters has been difficult to characterize. Two classes of proteins have been shown to mediate auxin export: members of the PIN subfamily of major facilitator proteins and P-glycoprotein (PGP) ABC transporters. Mutations in the *PIN1* genes in Arabidopsis result in developmental defects and reduced polar auxin transport, while triple and quadruple *pin* mutations result in a loss of embryonic polarity. Defects in *PGP1*, *PGP4*, and *PGP19* result in reductions in growth and auxin transport of varying severity in Arabidopsis (*pgp1*, *pgp4*, *pgp19*), maize (*brachytic2*), and sorghum (*dwarf3*). Auxin transport defects and dwarf phenotypes are more exaggerated in *pgp1 pgp19* double mutants, suggesting overlapping function. Both PGPs and PINs have been shown to directly mediate auxin transport at the cellular level. PIN2 and PIN7 have been shown to mediate auxin transport when heterologously expressed in yeast, mammalian cells, and BY-2 cells, and *PIN1* overexpression in Arabidopsis cell cultures (but not other heterologous systems) results in increased auxin transport. Arabidopsis *pgp1*, *pgp19*, and *pgp1 pgp19* protoplasts display reductions in the transport of natural and synthetic auxins and oxidative auxin breakdown products consistent with the defects in auxin transport observed in whole plants and seedlings. Heterologous expression of PGP1 and PGP19 in yeast and mammalian cells results in increased efflux of natural and synthetic auxins, while expression of PGP4 results in auxin influx. However, heterologously expressed PGPs also transport oxidative auxin breakdown products and benzoic acid, but fail to mediate transport of mammalian multiple drug resistance substrates. These data indicate that in plants PGPs do not function as “multiple-drug resistance proteins”, but instead function as ATP-dependent hydrophobic anion transporters. Interactions with PIN proteins appear to modulate activity and enhance substrate and inhibitor specificities. PGP-PIN interactions were confirmed using yeast two-hybrid and co-immunoprecipitation assays, and PIN1 and PGP19 were found to co-localize in detergent resistant “lipid raft” membrane microdomains. PGP19 appears to stabilize PIN1 in these structures, as PIN1 was preferentially detergent-solubilized from *pgp19* membranes. Although PGP19 and PIN1 colocalize in shoot apices and the root endodermis, they do not appear to colocalize in other light-grown tissues. However, PIN1 membrane localization is more readily perturbed in vascular tissues of the root tip, suggesting an indirect effect from loss of PGP19 function. The results suggest that PINs and PGPs can function as both independent and interactive efflux mechanisms.

(10)

**ROLE OF GIBBERELLIN AND *PICKLE* IN DETERMINATION OF  
DEVELOPMENTAL IDENTITY**

**H.-C. Li<sup>1</sup>, J. Henderson<sup>1</sup>, S. D. Rider<sup>1</sup>, H. Zhang<sup>1</sup>, K. Chuang<sup>1</sup>, Y. Bai<sup>1</sup>, M. Fountain<sup>1</sup>, B. Muir<sup>2</sup>, and J. Ogas<sup>1\*</sup>**

**<sup>1</sup>Department of Biochemistry, Purdue University, West Lafayette, IN 47907 USA**

**<sup>2</sup>Department of Animal Sciences, Purdue University, West Lafayette, IN 47907 USA**

The ability of gibberellin (GA) to promote developmental transitions such as germination or flowering is well known. Similarly, it is also well appreciated that acquisition of a new developmental state is accompanied by expression of a new suite of genes that typify that state. Much remains to be learned regarding the regulatory mechanisms by which this change in gene expression is achieved, particularly with respect to repression. We study an ATP-dependent chromatin remodeling factor, *PICKLE* (*PKL*) that acts during germination to repress genes that promote embryonic identity and thus facilitate the developmental transition from seed to seedling. In addition, *PKL* appears to mediate a branch of the GA response pathway. Our studies suggest that GA promotes developmental transitions in part by acting through a *PKL*-dependent and a *PKL*-independent pathway to repress gene expression.

(11)

**HOW AUXIN TURNS GENES ON – REGULATED PROTEIN DESTRUCTION  
AT THE HEART OF AUXIN SIGNALLING**

**Stefan kepinski\*.**

**Department of Biology, University of York, Box 373, York YO10 3DH, UK and  
Umeå Plant Science Centre, SLU, S-90183, Umeå, Sweden (Present address:  
Centre for Plant Sciences, Faculty of Biological Sciences, University of Leeds,  
Leeds LS2 9JT, UK)**

Auxin plays a pivotal role in many important aspects of plant growth and development. Central to auxin response are changes in gene expression that hinge on complex interactions between two families of transcription factors: The Auxin Response Factors or ARFs, of which there are 23 in Arabidopsis, and the Aux/IAA repressor proteins of which there are 29 in Arabidopsis. We have previously shown that auxin prompts the expression of auxin-regulated genes by causing the ubiquitin-dependent proteolysis of Aux/IAA proteins and that this is catalysed by an SCF-type ubiquitin-ligase complex called SCFTIR1. More recently we have also shown that the regulation of the interaction between SCFTIR1 and Aux/IAs depends of the direct binding of auxin to the F-box protein TIR1, and hence that TIR1 is a receptor for transcriptional responses to auxin.

(12)

**CHEMICAL GENETIC APPROACHES TO PLANT GROWTH REGULATION**

**P. McCourt\*, Y. Tsuchiya<sup>1</sup> and J. Patel<sup>1</sup>.**

**Department of Botany, 25 Willcocks Street, University of Toronto,  
Toronto, Canada M5S 3B2**

The use of both genetic and genomic analysis particularly in *Arabidopsis* has greatly improved the molecular understanding of mechanisms of plant growth regulation. For example, over the past ten years or so every major hormone receptor in *Arabidopsis* and rice has been identified. This may lead to the belief that genetic screens are no longer that useful for dissecting problems in plant growth regulation. We believe, however, that mutational analysis in combination other new tools such as chemical biology will allow new insights into how plant growth is regulated. Here, we will present a combined approach of chemical biology with genetic analysis to understand how abscisic acid may function and as a way to find new growth regulators.

(13)

**REGULATION OF INFLORESCENCE MERISTEM FATE IN PEA**

**S.L. Maki\*, H. Mullen, and S.R. Singer**

**Biology Department, Carleton College, One North College Street,  
Northfield, MN 55057 USA**

We are using the garden pea (*Pisum sativum* L.) as a model system to study genes involved in determining inflorescence architecture. In pea, one to several flowers are produced from a secondary inflorescence meristem (I2) at each node. The extended indeterminacy of multi-flowered lines is useful for exploring the developmental genetics of legume inflorescences. Our work has been aimed at understanding the regulation of the number of flowers produced by the I2 meristem and several flowering mutants in pea reveal a network of genes involved in determining overall I2 fate. For example, *PIM*, a floral meristem identity gene, maintains determinacy in the third order axillaries of inflorescences and suppresses the outgrowth of secondary axillary buds in I2 axils. The extent of non-floral development in inflorescence branches of the *pim-1* mutant is under the influence of photoperiod, temperature and gibberellins. A thorough understanding of genes which contribute to variability in inflorescence structure could lead to novel inflorescence phenotypes in both agronomic and ornamental crops.

(14)

**AUXIN TRANSPORT: A MODEL BASED ON VISUAL ESTIMATION OF A  
CROP PLANT'S PGR ACTIVITY**

**Albert Liptay\*, Jerry H. Stoller and Ron A. Salzman.**

**Stoller Enterprises Inc, 4001 W Sam Houston Pkwy N, Houston, TX 77043**

The configuration or architecture of a plant is greatly influenced by auxin transport. Auxin transport in turn, influences the cytokinins, gibberellins (GA), abscisic acid (ABA) and ethylene. In particular, ABA down-regulation (visually, a reduction in dark green color) in horizontally-grown tissue allows the plant tissue to be GA-dominant. This GA-dominant physiological effect of a crop such as with cucurbits, does not appear to be expressed in a plant that is grown

vertically either in nature or experimentally, but is expressed in crop production where the plants are grown horizontally. Auxin transport, in vertically-grown plants, as evidenced by visual evaluation, appears to be more predictable and uniform. We propose that any excessive internode extension in general, is primarily a result of inadequate ABA in plant tissue, allowing Gibberellins to dominate in the tissue.

(15)

### **ACC INDUCTION OF XYLOGENESIS IN HORSERADISH ROOTS**

**R. A. Savidge\***

**Faculty of Forestry & Environmental Management, 28 Dineen Drive,  
University of New Brunswick, Fredericton, New Brunswick, Canada E3B 6C2**

Application of 1-aminocyclopropane 1-carboxylic acid (ACC) in aqueous solution to the basal ends of root segments of *Armoracia rusticana* P. G. Gaertn., B. Mey. & Scherb. (horseradish, Brassicaceae) induced the storied fusiform cells within the vascular cambium to differentiate directly, without preceding cell division or cell enlargement, into clusters of small-diameter tracheary elements (TEs). Control cuttings (provided water only) produced no TEs, and ethephon (2-chloroethylphosphonic acid) induced no TEs to differentiate. The synthetic auxin 1-naphthalene acetic acid (NAA) promoted an increase in the radial width of the cambial zone, but the effect of NAA on xylogenesis was negligible. However, a combination of ACC and NAA stimulated TE production to a greater extent than ACC alone. These observations are evidence that ACC rather than auxin is the hormone controlling induction of TE differentiation, and they corroborate earlier findings with conifers where ACC also induced cells to differentiate into TEs (Kijidani, Y., Wu, Z. and Savidge, R. A. 2001. *Phytomorphology* GJI:185-200).

(16)

### **CHARACTERIZATION OF PEA (*PISUM SATIVUM* L.) PLANTS TRANSFORMED WITH A GIBBERELLIN 3- $\beta$ -HYDROXYLASE GENE**

**A. Wickramarathna\*, J. Ozga and D. Reinecke**

**Dept of Ag, Food and Nutri Sci, Univ of Alberta, Edmonton, AB, T6G 2P5**

To expand our understanding of gibberellin (GA) biosynthesis in reproductive and vegetative growth, pea (*Pisum sativum* L.) plants have been transformed to over-express the GA 3- $\beta$ -hydroxylase gene, *PsGA3ox1*, which encodes for the enzyme that converts GA<sub>20</sub> to bioactive GA<sub>1</sub>. Morphological characterization was carried out on a transgenic line carrying one copy of *PsGA3ox1* (assessed by screening the T<sub>2</sub> generation with kanamycin) along with a transformation control line (where the trans-gene had segregated out) and a wild-type line (non-tissue-cultured seed). The transgenic *PsGA3ox1* line produced significantly longer internodes, larger stipules and longer tendrils than the control lines. The total number of internodes was minimally affected in the *PsGA3ox1*-transformed plants compared to the controls. These data suggest that increasing the *PsGA3ox1* transcript level resulted in increased production of GA<sub>1</sub>, and thus modified the stature of the plant.

\* Graduate student

(17)

**DEVELOPMENTAL REGULATION OF GA BIOSYNTHESIS DURING GERMINATION AND EARLY SEEDLING GROWTH OF PEA**

**B. Ayele<sup>1</sup>, J. Ozga<sup>1\*</sup>, L. Kurepin<sup>2</sup>, R. Pharis<sup>2</sup> and D. Reinecke<sup>1</sup>**

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To understand how gibberellin (GA) biosynthesis is regulated during early seedling development in large-seeded dicotyledonous plants, the gene expression patterns of a family of GA biosynthesis genes and endogenous GA levels were examined in pea (*Pisum sativum* L.) during germination and early post-germination stages. Our data support the emerging hypothesis that bioactive GA is minimized in the developing embryo to allow for seed maturation processes to proceed. One day after imbibition, a dramatic change in the expression patterns of these GA biosynthesis genes occurred in the embryo axis for increased capacity to produce bioactive GA for embryo axis expansion. Specific expression of these GA biosynthesis genes in roots and shoots and changes in the levels of GA<sub>20</sub>, GA<sub>1</sub>, and GA<sub>8</sub> in young seedlings support a key role for *de novo* GA biosynthesis in early, post-germination growth phases of the pea seedling.

(18)

**MEFLUIDIDE OR ETHEPHON AND TRINEXAPAC-ETHYL FOR THE SUPPRESSION OF POA ANNUA L. SEEDHEAD PRODUCTION USING GROWING DEGREE DAYS**

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Mefluidide or Ethephon applications can be very effective at limiting the expression of seedheads, however, proper application timing can be difficult. Linking application timing to developmental models like growing degree days can provide much more consistent results. This study tracked growing degree day accumulation for multiple application timings over a four-year period. Mefluidide or ethephon were applied at 12 different timings in each year. Calendar date, growing degree days and soil temperatures were recorded for each application timing. Annual bluegrass seedhead production was measured twice per week during the main spring production period. Results were used to identify which application timings provided the highest level of control with the least amount of turfgrass injury.

(19)  
**GENETIC TRANSFORMATION OF CREEPING BENTGRASS WITH IPT GENE  
CONTROLLING CYTOKININ SYNTHESIS**

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Leaf senescence is a major problem in turfgrass management. The objective of this study was to investigate whether transformation of creeping bentgrass (*Agrostis stolonifera*), a widely-used cover crop on golf courses, with an isopentenyl transferase (*ipt*) gene controlling cytokinin synthesis, could delay leaf senescence and improve plant growth. We have created two types of transgenic bentgrass with a bacterial cytokinin synthesis gene (*ipt*) using an *Agrobacterium* transformation technique. Gene expression was controlled by either a promoter that is activated at the start of leaf senescence (*Psag12-ipt*), or by a heat shock promoter (*Phsp18-ipt*) that is activated by exposure to temperatures  $>35^{\circ}\text{C}$ . Leaf senescence, tiller density, root growth, and cytokinin content of transgenic and non-transgenic plants were determined to evaluate the effects of over-expression of the *ipt* gene on creeping bentgrass.

(20)  
**IMPACT OF SEAWEED EXTRACT-BASED CYTOKININS AND ZEATIN  
RIBOSIDE ON CREEPING BENTGRASS HEAT TOLERANCE**

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Differing seaweed extraction procedures have been shown to provide varying concentrations of cytokinins. Previous research has demonstrated improved abiotic stress resistance of cool-season turfgrasses due to foliar seaweed extract (SWE) applications. Our objective was to compare the effects of two differentially-processed SWEs to synthetic zeatin riboside when applied at equivalent cytokinins concentration on the heat tolerance of creeping bentgrass. Each treatment was applied to the foliage in a solution to provide zeatin riboside at  $3.5\text{ mg L}^{-1}$  and compared to a water-control and an ashed SWE control. The plants were grown in a hydroponic solution culture system under constant heat stress ( $35^{\circ}\text{C}$ ) for 48 days. Natural and synthetic cytokinins treatments resulted in greater visual quality, photochemical efficiency, chlorophyll content, superoxide dismutase activity, and less lipid peroxidation when compared to the controls. Both SWE sources also increased endogenous zeatin riboside levels.

(21)

**CURRENT AND POTENTIAL USES OF PLANT GROWTH REGULATORS IN  
FLORICULTURE AND ORNAMENTAL PLANTS**

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The key processes of interest in ornamentals are regulation of plant height, flowering, propagation of cuttings, increased branching, enhanced post harvest performance and longevity during shipping and marketing, and improved stress tolerance. Although PGRs are extensively used on high value floricultural crops, their use in production of nursery crops and the maintenance of landscape plants is beset with limitations which include inconsistent species specific response, cost effectiveness, limited label registration, and constraints of uncontrolled environments, application methods, variable cultural practices and a relative lack of resources to assist producers. This necessitates expensive prior "on site" trials at the level of grower. If these constraints can be addressed, new avenues may become available to growers. Finally, considerable success has been achieved in preventing injury induced by ethylene during storage, transport and retail display of ornamental plants and cut flowers resulting in enhanced longevity and display life. Products based on, both ethylene biosynthesis and perception inhibition (e.g., Retain, STS, 1-MCP), are being successfully used in commercial floriculture. This talk will highlight current, potential and unrealized opportunities related to use of PGRs in ornamental and floricultural crops.

(22)

**DELAYING FLORET ABSCISSION IN RED CESTRUM (*Cestrum elegans*  
Schlecht) CUT FLOWERS BY 2,4-D AND NAA DEPENDS ON THEIR  
TRANSPORT, METABOLISM AND *Aux/IAA* GENE ACTIVATION**

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Floret abscission in red cestrum (*Cestrum elegans*) cut flowers was delayed by the synthetic auxin 2,4-dichlorophenoxyacetic acid (2,4-D) after pulse treatment but not by  $\alpha$ -naphthaleneacetic acid (NAA). Significant amount of 2,4-D moved acropetally, sufficient to reduce floret abscission, while NAA failed to do so. Although increasing the pH of the pulsing solution increased acropetal translocation of NAA and improved its effectiveness in delaying floret abscission, 2,4-D remained more effective. In florets and leaves, more 2,4-D remained in its active free form, while NAA was quickly conjugated. We hypothesized that these differences in transport and metabolism of the two auxins might result from differential activation of the early auxin responsive (*Aux/IAA*) genes, which were used as molecular markers of auxin activity. Northern hybridization and RT-PCR results of six different *Aux/IAA* cDNAs, cloned from the floret abscission zone (AZ), showed temporal and spatial differences in the expression level of their encoded

ing genes, with 2,4-D inducing higher level than NAA. The expression level of all six genes decreased after three days from harvest, and was inversely related to the increased floret abscission during this period. Taken together, our results suggest that due to the differences in transport and metabolism of the two synthetic auxins, more free auxin accumulates in the floret AZ following 2,4-D treatment, thereby activating continuously the *Aux/IAA* genes, and reducing floret abscission.

(23)

**THE IMPACT OF GROWTH PROMOTANTS AND RETARDANTS ON SECOND CROP PRODUCTION IN DRILL-SEEDED RICE**

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Grain filling in the first crop must be completed before initiation of second crop growth in tropical and subtropical, lowland rice production. The ability of plant growth regulators to stimulate second crop production during the period of grain filling in the first crop was explored. Gibberellic acid and cell division inhibitors were applied during grain filling of the first crop, approximately 1 to 4 weeks before harvest. Little impact was noted on first crop yield and maturity, and yield in the second crop was increased significantly. Time of application and rate of the plant growth regulator had variable effects. There was no impact on total crop (first plus second crop) grain yield.

(24)

**MANIPULATING TRANSPLANT MORPHOLOGY TO ADVANCE POST-TRANSPLANT GROWTH AND YIELD IN STRAWBERRY**

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Prohexadione-calcium (BASF Corp. trade name Apogee and Regalis) is a gibberellin biosynthesis inhibitor which can be used to reduce leaf growth and petiole elongation. This gibberellin biosynthesis inhibitor was applied to 'Camarosa' and 'Sweet Charlie' strawberry nursery plants in Nova Scotia before they were harvested in the fall and transported to Florida to be transplanted in a winter annual plasticulture strawberry production system. Application of prohexadione-calcium to strawberry plants in Canadian nurseries resulted in several morphological changes in the transplants: reduced plant height and total leaf area, increased root to shoot ratio, and decreased specific leaf area. Physiological changes in response to treatment included; a higher rate of photosynthesis, an increase in root initials, an increase in fruit number, and osmotic adjustment that pre-adapted transplants to water stress. Production changes caused by treatments included; an increase in the number of harvestable daughter transplants produced in the nurseries, decreased irrigation requirement, and increased early or seasonal fruit yield. The application of prohexadione-calcium is effective in manipulating strawberry plant morphology in the Canadian nurseries to produce more robust transplants, resulting in better post-transplant growth, higher fruit yields, earlier fruit production and lower irrigation costs. This has the potential to significantly improve profitability for nursery and fruit producers.

(25)

**ETHEPHON AND 1-MCP TO LOOSEN SWEET CHERRIES FOR MECHANICAL HARVEST WHILE PRESERVING FRUIT QUALITY**

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Harvest labor shortages are prompting renewed interest in mechanical harvest of sweet cherries for the fresh market. Successful mechanical harvest depends on loosening the fruit so they can be easily removed with shake-and-catch machines. Ethephon is the only bioregulator product that is both effective for loosening cherries and registered for that use. However, ethephon-loosened cherries soften more rapidly and have a shorter postharvest life. Preharvest spray applications of the  $C_2H_4$ -action inhibitor 1-MCP to sweet cherry trees in conjunction with ethephon applications 2- to 3-weeks before harvest were tested for effects on fruit loosening and reduction of postharvest fruit quality loss. In one season, MCP application resulted in no effect on ethephon-induced fruit loosening but did reduce postharvest fruit firmness loss. In two additional years of trials, MCP did not affect ethephon-induced loosening but did not improve flesh firmness retention. Spray application method may play a key role in the efficacy of preharvest applications of MCP when used in conjunction with ethephon for preservation of fruit quality in mechanically harvested sweet cherries.

(26)

**APPLICATION OF BLOSSOM THINNERS FOR CROPLoad MANAGEMENT IN APPLES AND STONE FRUIT**

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Hydrogen cyanamide (Dormex), sulcarbamide (Wilthin), pelargonic acid (Thinex), endothalic acid (Endothal), and ammonium thiosulfate (ATS) were used at full bloom for blossom thinning of apples and stone fruit during the last 17 years. In our search for an effective blossom thinner, effects of various rates and/or timings of hydrogen cyanamide, ATS, and Wilthin on fruit set, quality, and yield of 'Fuji', 'Delicious', and 'Rome' apples and different cultivars of peaches and plums have been extensively studied. We also found that Tergitol TMN-6 at 0.75% to 1.25% reduced blossoms in peaches, nectarines, and plums in the Pacific Northwest. Tergitol TMN-6 also has been an effective blossom thinner for 'Rome Beauty' apples. We have also used lime sulfur and Fish oil and combination of these chemicals and found them to be effective organic blossom thinners for apples and peaches. Higher concentrations of these chemicals were more effective and double application often resulted in more blossom thinning than a single application. Fruit size was increased when effective blossom thinning occurred. Wilthin, at high concentrations, caused fruit marking in apples. Application of blossom thinners, such as Dormex, fish oil, lime sulfur, or Tergitol TMN-6 can result in regular cropping and reduce the cost of fruit production.

(27)

**ETHYLENE AND PISTILLATE FLOWER ABORTION OF WALNUT**

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Walnut (*Juglans regia*) may be affected by abortion of pistillate flowers shortly after bloom. The resulting loss of pistillate flowers can be the most significant factor limiting productivity in the most susceptible cultivars. High pollen loads induce the abortion of pistillate flowers. Within 24hr of pollination the pistillate flowers show a burst of ethylene production. The level of ethylene produced is highest in the most susceptible cultivars. Applications of inhibitors of ethylene synthesis and ethylene reception can reduce the incidence of pistillate flower abortion. We will report results of field experiments using aminoethoxyvinyl-glycine (ReTain®, Valent Biosciences) and 1-Methylcyclopropene (SmartFresh®, Agrofresh, Inc.) to control pistillate flower abortion in walnut orchards.

(28)

**ABSCISIC ACID: A POTENTIAL TOOL FOR IMPROVING THE COLOR  
OF TABLE GRAPES**

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In warm climates, poor color is a common problem that decreases the value of red grapes. The inhibitory effect of high temperatures on grape color is related to a deficiency in endogenous abscisic acid (ABA), and exogenous application of ABA can improve color. A recent breakthrough in ABA synthesis may reduce its cost, thus enabling growers to use ABA on grapes. Therefore, we evaluated the effect of ABA (0, 75, 150, or 300 ppm) or ethephon (250 ppm) applied at veraison, one month post-veraison, or two months post veraison, on 'Crimson Seedless' grapes (*Vitis vinifera* L.) harvested between August and October. Application time and plant growth regulator (PGR) treatments interacted to affect color and firmness but had few other effects. Applied at veraison, ABA and Ethrel treatments increased red skin color compared to the non-treated fruit; 150 and 300 ppm ABA were equally effective and both were better than Ethrel. Applied a month after veraison, 150 and 300 ppm ABA still improved color but neither treatment was superior to Ethrel. Applied two months after veraison, neither PGR was effective. The PGR treatments that enhanced color also caused softening.

(29)

**DEVELOPING AND TESTING OF A MODEL TO RAPIDLY PREDICT APPLE  
THINNER RESPONSE**

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Over the past several years a number of experiments have been done to test the hypothesis that monitoring fruit growth is an appropriate and accurate method to predict final fruit set following thinner application. Usually it is not possible to determine if a fruit will drop until the thinning window of opportunity has passed. Between 80 and 100 spurs are tagged in total on 5 to 6 trees. All fruit are individually numbered and fruit size measured before thinner application using a digital caliper. Growth is measured at 2 to 3 day intervals for up to 12 days. Fruit are predicted to abscise if growth rate falls to 50% or less of the growth rate of the 20 fastest growing fruit being measured. Prediction can usually be made within 7 days after application, or if cool weather prevails, when at least 130 growing degree units have accumulated after thinner application.

(30)

**APPLICATION OF 2,4-D (CITRUSFIX) FOR FRUIT SIZE INCREASE OF  
MANDARINS AND MANDARIN HYBRIDS IN CALIFORNIA**

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2,4-Dichlorophenoxyacetic acid (CitrusFix) was applied to 'Afourer' mandarin in S. Kern County and 'Minneola' tangelo oranges in Madera from the 2003 to 2005 seasons. Both experiments included combination treatments of three concentrations (12, 24, and 48 ppm) and two timings, 2- and 4-weeks after 75% petal fall, (dapf) and non-spray controls. The 48 ppm, 2 week dapf treatment was able to increase large sized fruit (including large- jumbo-mammoth sizes) of 'Afourer' mandarin by 13.3%, 24.1% and 35.8% for 2003, 2004 and 2005 seasons, respectively (average 25.1% increase over three seasons). This treatment was able to increase large sized fruit by 13,570 kg/ha, yielding an estimated additional net income of \$5,437/ha over three years. 24 ppm of 2,4-D, 30 dapf application was able to increase large sized fruit (including jumbo-mammoth-colossal sizes) of 'Minneola' tangelo by 6.8%, 24.8%, and 2.9% in 2003, 2004 and 2005 seasons, respectively. The benefits, problems and potential permanent registration of this use in California will be discussed.

(31)  
**PLANT GROWTH REGULATORS FOR AVOCADO PRODUCTION**  
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Plant growth regulators (PGRs) are the most powerful tools available for manipulating tree growth and yield in an established orchard. Understanding the phenology and physiology of the avocado (*Persea americana* Mill.) is critical for selecting the correct PGR and for properly timing the application annually to consistently elicit the desired response. Results from several multi-year PGR experiments have provided evidence of promising PGR strategies for increasing 'Hass' avocado yield and fruit size. Gibberellic acid 3 (GA<sub>3</sub>) (25 mg/L) applied at the cauliflower stage of inflorescence development or applied at the end of June-beginning of July significantly increased total yield and yield of large size fruit (packing carton sizes 60-40) as 2-year average and 2-year cumulative yield (P<0.03). 6-BA (25 mg/L) applied at anthesis or GA<sub>3</sub> (25 mg/L) applied in mid-July followed by prohexadione-Ca (125 mg/L) 30 days later significantly increased the yield of large size fruit (packing carton sizes 40-32) as 3-year average and 3-year cumulative yield (P<0.03). These strategies will be tested in additional orchards.

(32)  
**ISOLATION OF GENES POTENTIALLY REGULATING MANGO FLOWERING**  
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Floral induction of mango is thought to be determined by interaction of a short-lived, florigenic promoter that is up-regulated in leaves during exposure to cool temperatures and an age-dependent vegetative promoter at the time that initiation of shoot growth occurs. *Constans* gene is widely conserved in plants and appears to be responsible for induction of a floral signaling mRNA (FT) that is synthesized in leaves and transported in phloem to buds to induce flowering in Arabidopsis. In the present study, a *Constans*-Like *Mangifera indica* gene (*MiCOL*) was isolated from mango and characterized. At the protein level, *MiCOL* was 79%, 76% and 62% identical to *MdCOL2*, *MdCOL1* and *AtCO* respectively. We are currently trying to rescue Arabidopsis *constans* mutant plants with the *MiCOL* gene and to determine if transcription rates correlate with cool temperatures in mango plants. We are also investigating the functionality of the FT gene in mango.

(33)

**ReTain® FOR WALNUT PISTILLATE FLOWER ABORTION (PFA):  
AN EXTENSION SUCCESS STORY**

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Pistillate flower abortion (PFA) in walnut is the abscission of female flowers 2 to 3 weeks after bloom. Field testing of ReTain®, an AVG-based ethylene inhibitor manufactured by Valent BioSciences, was first performed by the lead author in 2003. A four-fold increase in fruit set was observed over untreated flowers. In 2004, speed sprayer trials in Kings and San Joaquin Counties at 25 and 50 grams ai/ac resulted in significant increases in percent set and yield improvements in excess of 1000 dry in-shell pounds per acre compared to untreated trees. In 2005, trials performed in Kings and Tulare Counties examined application timings from prebloom to 70% bloom, as well as concentration (25 and 50 grams ai/ac) and water volume (100 and 200 gal/ac). The 20-30% and 60-70% bloom timings resulted in the greatest yield improvement (163 dry inshell lbs/ac) compared to untreated trees (76 lbs/ac). Half the recommended concentration (25 grams ai/ac) in 100 or 200 gal/ac provided a 30 lb/tree increase. Application of 50 grams ai/ac in 100 gal/ac resulted in a 53 lb/tree increase. No adverse carryover effect in the average two-year yield was observed in trees treated in 2004. A vigorous letter campaign orchestrated by UC Cooperative Extension to the federal and state EPA agencies resulted in accelerated ReTain<sup>®</sup> registration for commercial use in 2006.

(34)

**MOLECULAR CLONING AND ANALYSIS OF *ORYZA SATIVA*  
AUXIN-BINDING PROTEIN 1 GENE**

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Auxin regulates diverse aspects of plant growth and development, the first step in an auxin response pathway is the binding to its receptors, named auxin-binding proteins (ABPs). The *ABP* gene of commercially important *Oryza sativa* is still unknown although some *ABP* genes have been cloned in other plants. In order to understand more about the *Oryza sativa* auxin-binding protein and its signal transduction pathway, we obtained and analyzed its full-length cDNA sequence by bioinformatics and laboratory bench-work. An unnamed *Oryza sativa* cDNA sequence was obtained from online nucleotide sequence database, the putative open reading frame of the sequence encodes a presumptive protein containing 206 amino acid residues. Blast results against the current GenBank DNA and protein databases as well as protein conformation reveal significant homology with the *ABP1* gene and ABP1 protein in other plants. These results suggest that the sequence is *Oryza sativa* ABP1 cDNA. Based on the sequence, ABP1 cDNA of *Oryza sativa* was amplified with RT-PCR and cloned for sequencing, the sequencing results were found to be identical with the former unnamed cDNA sequence obtained from the online database.

## POSTER ABSTRACTS

(35)

### **EFFECT OF AUXIN TRANSPORT INHIBITORS ON FRUIT GROWTH AND FRUIT SET OF 'DELICIOUS' AND 'GOLDEN DELICIOUS' APPLES**

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It has been proposed that auxins are intimately involved in the process of fruit abscission and they may play a central role in the promotion of abscission caused by chemical thinners applied to apples. Three auxin transport inhibitors were selected: 2,3,5-triiodobenzoic acid (TIBA), N-1-naphthphthalamic acid (NPA), and 1-pyrenoylbenzoic acid (PBA). All inhibitors were incorporated into lanolin paste at a concentration of 250 mg.l<sup>-1</sup> and applied to the pedicels of fruit when fruit were 9-14 mm in diameter. All inhibitors caused fruit abscission but it required 2 to 3 weeks for fruit to actually drop. Fruit treated with a chemical thinner frequently slow growth and stop growing within 7 to 10 days of application. Fruit that did drop as a result of auxin inhibitor application frequently continued to grow, but at a reduced rate for some time after treatment. Results will be discussed in relation to the involvement of auxins in apple fruit abscission.

(36)

### **C<sub>27</sub>-BRASSINOSTEROIDS BIOSYNTHESIS IN *ARABIDOPSIS THALIANA***

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Metabolic studies using a cell-free enzyme solution prepared from *Arabidopsis thaliana* demonstrated that two parallel biosynthetic pathways to generate 28-norcastasterone, namely the early and late C-6 oxidation for C<sub>27</sub>-brassinosteroids (BRs), are operative in the plants. In the presence of S-adenosylmethionine, the enzyme solution successfully mediated conversion of 28-norcastasterone to castasterone, indicating that the C<sub>27</sub>-BRs biosynthesis is an alternative route to synthesize biologically active C<sub>28</sub>-BRs, castasterone and brassinolide, in the plant. In the presentation, biosynthetic connections between C<sub>28</sub>-BRs and C<sub>27</sub>-BRs biosynthesis as well as between the early and late C-6 oxidation pathway for C<sub>27</sub>-BRs will be explained. In addition, enzymes (genes) involved in the C<sub>27</sub>-BRs biosynthesis will be discussed.

(37)

**AN INCLINATION OF ADK FOR CYTOKININ ISOMERS DURING THE CELL CYCLE OF TOBACCO BY-2 CELL LINE**

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Recently, we identified four tobacco BY-2 adenosine kinase isoforms and suggested that some of them may act specifically in the cell cycle G2/M checkpoint, by reducing the pool of active cytokinins. In the following HPTLC based study, we show that cis-ZR and iPA are, in contrast to trans-ZR, the preferred cytokinin substrates for the recombinant tobacco ADKs. Moreover, the conversion of cis-ZR to ZMP is reduced, in a competitive manner, in the presence of trans-ZR and trans-Z. We demonstrate that the activity of endogenous ADKs varies dependently on the substrate used in the analysis during the course of the cell division. With the use of Ado the ADK activity peaks at the end of S phase, whereas with cis-ZR used as the substrate, the activity peak is visibly shifted towards M phase. These results and detection of a premitotic peak of cis-Z in BY-2 cells is in agreement with the increasing amount of evidence on the potential function of free cis-cytokinins in plants.

<sup>s</sup> Graduate student

(38)

**INFLUENCE OF 5-AMINOLEVULINIC ACID ON THE EFFICIENCY OF DRY-MATTER PRODUCTION IN VEGETABLE POT-SEEDLINGS**

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Effect of 5-aminolevulinic acid (5-ALA) and foliar-fertilizer containing 5-ALA (Penta-keep A) on the efficiency of dry-matter production in cabbage and broccoli potted-seedlings were investigated. In Japan, the raising of good seedlings is an important factor for high-yielding of vegetables. Increases in photosynthetic rate (Po), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) in both the vegetables were observed in both 5-ALA- and Penta-keep A- treated plants. It should be noted that the excellent effect of 5-ALA was controlled through the acceleration of <sup>15</sup>N-labelled nitrogen absorption.

(39)

**THE EFFECT OF ETHEPHON, NAA AND BA, USED SEPARATELY AND JOINTLY, ON THE EFFICIENCY OF THINNING IN APPLE TREES CULTIVARS JONAGOLD, GOLDEN DELICIOUS AND ELSTAR**

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For illustration the effect of sequential thinning by use of different thinning agents the results of three experiments conducted in apple trees will be shown. The trials were conducted in 2002-2003 on cvs. Jonagold, Golden Delicious and Elstar varieties. The following substances were used for thinning: ethephon (in preparation Ethrel, 48% ethephon) at the beginning of bloom, NAA (as Pomonit Super 050 SL, 5% NAA in salt with triethanolamine) soon after bloom, and BA (in Paturyl 050 SL, 9.4% BA) when fruitlets were 10-12 mm in diameter. They were used separately or sequentially for correction of thinning effect of preparation used in the same trees earlier. The effect on fruit set, yield, fruit size, red color and russeting as well as internal quality expressed by firmness and refraction of apple flesh at harvest and after storage, as well as on the subsequent blooming were evaluated.

(40)

**THE EFFICIENCY OF 3,5,6 – TPA USED IN APPLE AND PEAR AGAINST PREHARVEST FRUIT DROP**

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The results of preliminary trials on use of preparation TOPS, containing 3% 3, 5, 6 –TPA, against preharvest fruit drop will be presented. The preparation was used at different doses in apple trees cultivars Sampion and Ligol and ‘Conference’ pears, in two orchards located in different climatic and agro-technical conditions. NAA in salt with triethanolamine (as polish preparation Pomonit Super) was used for comparison. The six experiments were conducted in 2005. Treatments effects on fruit drop, fruit quality at harvest and after storage, as well as shoot growth and subsequent blooming were observed.

(41)

**EFFECTS OF SEAWEED EXTRACT ON ANTIOXIDANT PROPERTIES OF TWO DIFFERENTIALLY CHILLING SENSITIVE MAIZE CULTIVARS**

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Applications of seaweed extracts can improve plant performance and productivity although the components of seaweed extracts which elicit these effects have yet to be reliably identified. In previous work we have shown that application of Acadian Seaplant Ltd.'s Soluble Seaweed Extract Powder (SSEP) can enhance the chilling tolerance of 3-week-old maize as measured by chlorophyll fluorescence. Disrupted chlorophyll fluorescence ( $F_v/F_m$ ) has been associated with increased production of active oxygen species through the process of photo-oxidation. In order to determine if SSEP application affects antioxidant levels of chilled maize, SSEP was applied to two commercial cultivars of maize differing in their sensitivity to chilling. The results of SSEP application on activities of antioxidant enzymes (ascorbate peroxidase, catalase, and superoxide dismutase), compounds (ascorbate and glutathione), and an index of oxidative damage (malondialdehyde) will be presented.

(42)

**EFFECT OF RADIATION SPECTRAL COMPOSITION ON GERMINATION AND GROWTH OF CHESTNUT *IN VITRO***

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The effect of radiation quality (350 - 740 nm) on development of zygotic embryos and plantlets of open-pollinated Japanese chestnut (*Castanea crenata* S. et Z.) was studied. Two types of explants were exposed for four weeks to cool white (control), red, blue, red+blue and red+far-red radiation from a light-emitting-diode system. While zygotic embryos showed positive photoblastic behaviour, their germination was inhibited under blue radiation. Both hypocotyl elongation and root development were positively correlated with red radiation. The emergence of primary leaves and their expansion were faster in blue than red condition. In plantlet explants, red and red+far-red radiation significantly increased formation and growth of roots, whereas blue light reduced rooting. Therefore, radiation quality appears to influence some steps in the development of zygotic embryos and plantlets in chestnut.

(43)

**HORMONAL BALANCE AND PHYSIOLOGICAL BACKGROUND FOR  
DECISION SUPPORT ON FRUIT SET IMPROVEMENT ON PEAR TREES**

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Since the growth regulator chlormequat chloride (CCC) was removed in Belgium in 1998, pear growing in intensive training systems has become more difficult and fruit growers are looking for alternative ways to control the vegetative growth of the pear trees. Prohexadione-Ca, a new growth regulator with good results on apple trees, is much less effective on pear trees and can have a negative effect on return bloom. The best way to control the vegetative vigour of a fruit tree is a regularity in the productivity, which can be achieved by a treatment with gibberellins, but the results of these treatments are not consistent. In this study, we investigate the effect of treatments of 'Conference' pear trees with Prohexadione-Ca and different gibberellins on proteome and gene expression, in order to obtain a better understanding of the physiological background of the process of flower initiation and fruit set on 'Conference' pear.

<sup>s</sup> Graduate student

(44)

**BOTH PROHEXADIONE-CA AND GA<sub>4+7</sub> REDUCE RUSSET  
AND SCARF SKIN IN APPLE?**

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Russet and scarf skin are cosmetic defects of some commercially important apple cultivars that result from aberrant patterns of development in the hypodermal cell layer of the fruit. The severity of both russet and scarf skin is reduced by multiple (3-4) applications of 15-20 ppm GA<sub>4+7</sub> ten days apart beginning at petal fall. In field studies over three years it was shown that a single application of the gibberellin biosynthesis inhibitor prohexadione-Ca at petal fall also reduced the severity of both cosmetic defects. Combining GA<sub>4+7</sub> and prohexadione-Ca had an additive effect on russet and scarf skin severity. Reductions in russet and scarf skin following prohexadione-Ca treatment are discussed in relation to its effects on gibberellin biosynthesis and metabolism.

(45)

**EFFECTS OF ALTERED GROWTH ON THE LEVELS OF THE PLANT HORMONES AUXIN AND GIBBERELLIN IN *ARABIDOPSIS THALIANA*.**

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Hormone homeostasis and interactions are critical for normal growth and development. In plants, the two hormones auxins and gibberellins (GAs) promote germination, increase growth, induce flowering and fruit development, and can be used commercially to affect the yield of crop plants, flowering time or fruit size. Recently, we demonstrated that seedlings of *Arabidopsis thaliana*, treated with paclobutrazol (an inhibitor of GA biosynthesis) or naphthylphthalamic acid (an auxin transport inhibitor, ATI), showed an up-regulation of the stem-expressed isoform of the GA biosynthetic enzyme GA 20-oxidase (GA20ox1). Since both of these treatments caused stunted growth, we proposed to examine the effect of altering growth on the levels of auxin and GA20ox1 to define if the up-regulation of genes in the GA biosynthetic pathway is a direct consequence of altered polar auxin transport or if it is a global consequence of reduced growth. We first determined different media composition that gave us reduced growth. We then examined the expression of two GUS reporter gene constructs: one for the GA20ox1, and the other for a synthetic auxin response element which gives an indication of auxin levels and distribution. We showed that neither GA20ox1 or auxin levels were increased by treatments that retarded growth. Therefore, we conclude that the up-regulation of the GA20ox1 following treatment with ATIs is specific to an altered auxin transport and not due to stunted growth. The mechanism(s) by which auxin status affects transcriptional regulation of GA biosynthetic genes are still under investigation. This work is supported by the MBRS-RISE GM60655 and the NSF 0080934.

<sup>s</sup> Graduate student

(46)

**ETHEPHON DELAYS BLOSSOMING, REDUCES FRUIT SET, AND INCREASES FRUIT SIZE OF 'BABY GOLD 5' PEACHES**

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Methods to delay the time of blossoming of *Prunus* species would reduce the inherent risk of crop lost associated with late spring frosts. A two-year orchard study was conducted to assess the effectiveness of ethephon on delaying bloom of 'Baby Gold 5' peach trees. Foliar ethephon sprays were applied to whole trees at the 25-50% leaf drop stage. Field and laboratory tests were used to monitor blossom development. Fall-applied ethephon treatments delayed bloom by as much as six and eight days in 2004 and 2005 respectively. Significant reductions in fruit set were also observed in both years of the study, translating into a reduced need for hand thinning. Fruit size was significantly increased in both years. Results of this study indicate autumn ethephon applications can be used successfully to delay bloom in peaches, while reducing the need for hand thinning, providing an increase in fruit size, and an improvement in fruit quality.

(47)

**GUAVA CALLUS PRODUCTION UNDER DIFFERENT CULTURE MEDIUM  
AND PLANT GROWTH REGULATOR CONDITIONS**

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The goal of this research was to develop an efficient *in vitro* callus regeneration protocol for guava (*Psidium guajava* L.). The specific research objective was to evaluate particular culture media and plant growth regulators for their influences on callus initiation. Guava is an important tropical fruit species that is rich in vitamins and vitamin precursors, minerals, organic acids, and pectins. Different concentrations of various plant growth regulators (PGR), such as 6-benzyladenine (BA), kinetin, or 2,4-dichlorophenoxyacetic acid (2,4-D), and naphthaleneacetic acid (NAA) were added to basic Murashige and Skoog (MS) and woody plant medium (WPM) and tested for their influences. Differences in callus initiation and morphology were noticed between MS and WPM, and among PGR concentration treatments.

(48)

**THE EFFECT OF SALICYLIC ACID ON THE FLOWERING OF *CAPSICUM  
CHINENSE* JACQ.**

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The effect of salicylic acid (SA) on the flowering process of a solanaceae was studied using *Capsicum chinense* as a model, since previous work in this laboratory had demonstrated its effects on species of ornamental plants. Two independent experiments were conducted: one under greenhouse conditions and the other one in open conditions. Seedlings arranged in a random experimental design were sprayed in two occasions with SA. The concentrations of SA tested were  $10^{-6}$  to  $10^{-10}$  M. Results showed that SA induced early flowering from 3-5 days and 5-8 days under greenhouse conditions and open growing conditions respectively.

(49)

**ETHYLENE AS AN ALTERNATIVE METHOD IN PEACH FRUIT THINNING**

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Fruit thinning is one of the major management practices in a peach orchard. Hand-thinning is presently the only method to adjust the number of fruits. This study was conducted to determine whether ethylene can be used as a chemical thinning agent in peach orchards. Ethrel applications at 200 and 400 mg/L resulted in significant fruitlet thinning and increased fruit size and weight. It also enhanced fruit maturity thereby enabling growers to sell their product sooner than normal harvest time. Ethrel can be used even after bloom and as a result, the remaining fruits have more chance to absorb carbohydrates and increase their size. Aminoethoxyvinylglycine (AVG) is an inhibitor of ethylene biosynthesis and its application at 500 mg/L resulted in retaining more fruits per trees. It shows that AVG can be used as an anti-abscission agent in those varieties with high rate of fruit drop.

<sup>s</sup> Graduate student

(50)

**POST HARVEST PERFORMANCE AND DISPLAY LIFE OF CUT PHLOX  
FLOWER HEADS: EFFECT OF PROHEXADIONE-Ca**

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Prohexadione-Ca (PROHEX), an inhibitor of dioxygenases involved in late steps of GA biosynthesis and flavonoid metabolism, effectively controls and protects pome fruit trees from diseases such as fire blight and scab, and insect pests. In this report, we present our results related to the effect of PROHEX on quality and post harvest display life of cut flower heads of *Phlox paniculata* 'John Fanick'. Addition of PROHEX in the vase solution inhibited growth of flowers and strongly prevented development of petal color by affecting anthocyanin production. In sucrose (SUC) +PROHEX, the flowers were larger than normal, but the newly opened flower buds remained light blue or bluish white. In SUC+PROHEX+GA, most of the flowers did not develop anthocyanins at all and remained a pure white color, although they attained enlarged size and exhibited enhanced longevity and extended vase life. These results indicate that the post harvest performance and display life of cut phlox flowers can be substantially modulated by regulating the level of growth regulators and SUC in the holding solution.

(51)

**EFFECT OF ALCOHOL AND SUCROSE ON DISPLAY LIFE OF CUT RACEMES  
OF *LUPINUS HAVARDII***

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By recurrent selection and breeding, we have developed blue, white and pink colored genotypes of *Lupinus havardii* Wats. having great potential as specialty cut flower crops. Our current improved genotypes show very little flower abscission, although some flowers do senesce during vase life. This investigation forms a part of our ongoing studies related to evaluation of post harvest performance of cut racemes, and reports the results of the effect of ethyl alcohol (1-10%), alone and in combination with sucrose (SUC), on flower senescence and vase life of cut racemes. Increasing concentrations of alcohol (up to 4%) reduced the senescence of flowers and greatly enhanced their display life. Alcohol (>4%), depending upon the genotype, induced moderate to severe collapse of inflorescence axis above the vase solution, although the flowers remained fresh for a long time. SUC and alcohol, in combination, acted synergistically, and further extended the vase life. Experiments using ethylene inhibitors/promoters revealed that the effects of alcohol are partially mediated via inhibition of ethylene production and ethylene sensitivity.

(52)

**POSTHARVEST RIPENING OF *ZIZIPHUS MAURITIANA* FRUITS: EFFECT OF  
1-METHYLCYCLOPROPENE**

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*Ziziphus* spp. constitute an important source of low cost, nutritive, fresh edible fruits in arid regions of India. Superior cultivars (*Ziziphus mauritiana* cv. Seb) produce big plum sized fruits which are highly prized for fresh consumption. However, fully ripe fruits often become brown, loose their firmness and organoleptic qualities. This study was initiated to monitor changes in certain chemical constituents and quality of fruits of cultivar 'Seb' following pretreatment with 1-methylcyclopropene (1-MCP). Treatment with 1-MCP considerably prevented the decrease in fruit firmness and vitamin C content. 1-MCP treated fruits remained much greener than the control as evidenced by their higher chlorophyll content and exhibited a much lower level of lipid peroxidation. These results indicate the potentials of 1-MCP in delaying fruit ripening and extending the shelf life of *Ziziphus* fruits.

(53)

**A NEW IMMUNOSENSOR FOR RAPID DETECTION OF GIBBERELIC ACID**

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Gibberellins are phytohormones essential for normal plant growth while gibberellic acid (GA<sub>3</sub>) is one of the most active forms among more than 120 naturally occurring gibberellins. Accurate analysis of gibberellins is important for crop production. Based on immunosensor technology, a rapid, selective, sensitive, accurate, and inexpensive immunosensor for gibberellic acid detection was designed by coupling immunoassay with the square wave anodic stripping voltammetry (SWASV) technique involving copper ion labeled antigen in the competitive immunoreaction. The response signal expressed as the percentage of current reduction (CR %) (y) is linearly related to the concentration of GA<sub>3</sub> (x) in the 1µg/mL to 150µg/mL range with a regression equation of the form  $y=0.44x + 15.59$  and a correlation coefficient of 0.99. The results of the immunosensor assay for GA<sub>3</sub> in rice grains showed similar sensitivity with traditional HPLC and ELISA assays.

(54)

**VOLATILE ETHANOL AFFECTS GERMINATION AND GROWTH OF LET-  
TUCE, RADISH, SOYBEAN AND WHEAT SEEDS**

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Ethanol (EtOH) from biogenic and anthropogenic sources can contaminate atmospheres in closed environments such as spacecraft, growth chambers, and greenhouses. An EtOH exposure limits 1000 ppm has been established by NASA, OSHA, and ACGIH to protect human health. Similar limits have not been established for plants. Seeds of six radish cultivars (*Raphanus sativus* L. cv. Cherriette, Cherry Bomb, Reggae, Sora, Sparkler White, and White Globe) were exposed to 0, 50, 100, 250 and 500 ppm EtOH for 5 days and germination, shoot length measured, and threshold limits (T<sub>10</sub>, T<sub>50</sub>, and T<sub>90</sub>) determined. Threshold values were also established for *Lactuca sativa* L. cv. Red Romaine; *Glycine max* (L.) Merr cv. Hoyt, and *Triticum aestivum* L. cv. USU Apogee. Threshold analysis indicated that radish was the most sensitive crop, and soybean the most tolerant, However, germination was completely inhibited at 500 ppm EtOH (1/2 regulatory limit) in all seeds tested. These results highlight the need to develop specific VOC guidelines for plant growth facilities.

(55)

**MIXED VS. MONOCULTURE HYDROPONIC PRODUCTION OF SALAD  
CROPS AT THREE CO<sub>2</sub> CONCENTRATIONS**

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Development of cropping systems for use on the International Space Station, long duration transit missions, and lunar or Mars habitats has been a part of NASA's Advanced Life Support (ALS) research efforts for many years. Growth of multiple crops on a common solution will increase efficiency, but may result in allelopathic responses being induced. Three candidate ALS salad crops, radish (*Raphanus sativus* L. cv. Cherry Bomb II), lettuce (*Lactuca sativa* L. cv. Flandria) and bunching onion (*Allium fistulosum* L. cv. Kinka) were grown hydroponically as either monoculture (control) or mixed-crop within a walk-in growth chamber at three CO<sub>2</sub> concentrations (400, 1200 and 4000 μmol mol<sup>-1</sup>) to determine if allelopathic responses were occurring. The chambers were maintained at 22°C, 50% RH, and 300 μmol m<sup>-2</sup> s<sup>-1</sup> PPF with a 16-h light/8-h dark photoperiod using cool-white fluorescent lamps (17.2 mol m<sup>-2</sup> d<sup>-1</sup> PAR). Results showed no negative effects of mixed-cropping under these CO<sub>2</sub> concentrations.

(56)

**IN VITRO SHOOT PROLIFERATION OF *ENCYCLIA TAMPENSIS* (LINDL.)  
ORCHIDS**

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*Encyclia* is a genus of orchids with four members native to Florida that are endangered or commercially exploited. If a commercial orchid tissue culture media was found that could be used to propagate *Encyclia*, the resulting plants could be introduced into protected habitats to increase the wild populations or could be grown commercially to lessen the demand for collected plants. Six month *Encyclia tampensis* (Lindl.) seedlings were grown in Orchid Maintenance/Replate Medium w/ Banana and Charcoal with 6g/L agar (C), ½ strength Orchid Multiplication Medium with 6g/L agar and 10g/L charcoal (OM), Knudson C Orchid Medium – Morel Modification with 6g/L agar and 10g/L charcoal (K), or Vacin & Went Modified Orchid Medium w/ Agar and Sucrose with 10g/L charcoal (VW) for seven weeks. Plants grown in OM and VW media both produced more shoots and roots (7.56 leaves, 1.92 shoots and 6.55 leaves, 1.73 shoots respectively) than the control medium (5.68 leaves, 1.64 shoots) with OM producing the highest averages. Plants grown in the K medium averaged significantly less shoots and leaves than the other three media (4.48 leaves, 1.32 shoots).

(57)

**EXPERIENCE WITH CONTINUOUS USE OF PROHEXADIONE-CA OVER SEVERAL YEARS IN APPLES AND PEARS**

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Prohexadione-Ca (ProCa) has been continuously used over four seasons on apples (cvs. Elstar and Summerred - both on M.9) and pears (cv. Conference on Quince C) grown at different locations in The Netherlands. Using the product REGALIS® (10% ProCa), dosages of 120 g/ha of active ingredient have been applied twice per season: at the beginning of shoot growth and approximately four weeks later. Significant reductions in shoot elongation resulted in average labor savings for dormant pruning of approximately 35% in both apple varieties. There were no indications for negative impacts on tree performance or fruit yield and fruit quality. As an average of the four seasons, dormant pruning in pears could be reduced by about 15%. This resulted from 10% less shoots and a reduction in shoot length by 30%. The effect of ProCa on return bloom varied between -20% and +25%. Reductions in flower intensity had no negative impact on fruit set. Over the years, fruit production per tree was rather increased by approximately 7%.

(58)

**IN VITRO REGENERATION *ATROPA BELLADONA* L. FROM LEAF DISCS**

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Multiple shoots were regenerated from calli induced from leaf discs of *Atropa belladonna* on Murashige and Skoog (MS) medium supplemented with various combinations and concentrations of naphthalene acetic acid (NAA) and either 6-benzyladenine (BA) or thidiazuron (TDZ). TDZ was more effective than BA. High numbers of adventitious shoots occurred at all levels of TDZ, especially in the presence of NAA. The maximum number of shoots (13.92 shoots/leaf disc) was obtained at 1.5 mg l<sup>-1</sup> TDZ and 0.5 mg l<sup>-1</sup> NAA, whereas BA gave the highest number of shoots (9.2 shoots/leaf disc) at 3.5 mg l<sup>-1</sup> alone. Regeneration were rooted easily (100%) and normally developed roots on auxin-free MS medium. Rooted plantlets were successfully acclimatized (94%) in 1 perlite: 2 sand (w/w). Some of the plants showed morphological and growth characteristics different from those of seed-derived plants.

(59)

**THE RELATIONSHIP BETWEEN ENHANCED CHILLING RESISTANCE  
IN MAIZE PRE-TREATED WITH SOLUBLE SEAWEED EXTRACT POWDER  
AND OXIDATIVE STRESS**

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The effects of seaweed extract application on plant development, metabolism and physiology are quite diverse, as is the range of potential compounds known to be present in seaweed extract formulations. Three week old maize pre-treated with soluble seaweed extract powder (SSEP) demonstrated enhanced chilling resistance as compared with untreated controls as measured by chlorophyll fluorescence ( $F_v/F_m$ ). Declines in photochemical efficiency ( $F_v/F_m$ ) have been associated with increased production of active oxygen species (AOS) through the process of photo-oxidation. The results of SSEP application on AOS production, antioxidant capacity and oxidative damage (malondialdehyde) will be presented

(60)

**EFFECTS OF A SOIL-APPLIED FORTIFIED *ASCOPHYLLUM NODOSUM* EX-  
TRACT ON THE VISUAL QUALITY OF ZOYSIA TURFGRASS**

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Experiments were conducted to determine the influence of soil applications of a fortified seaweed (*Ascophyllum nodosum*) extract (SWE) on the aesthetic quality of a residential zoysia turfgrass during the dry season in a tropical area. Aqueous solutions of a fortified SEW (regular extract + proprietary formulation of humic acid, carbohydrates, amino acids, peptides, saponins, betaines, GABA) (ATAN SoF® 0-8 L/ha) were drench-applied in February, when the turf was water-stressed. Aesthetic quality (AQ) was determined weekly for two months using a visual scale of 0 (dead turf) to 9 (excellent aesthetic quality) based on color and vigor. Significant differences in AQ were found for several SEW treatments three weeks after application, and effects were consistent throughout the dry season. Best results were obtained with rates of 4 to 8 L SEW/ha.

(61)

**POTATO TUBER YIELD AND SIZE AS AFFECTED BY A FORTIFIED SOIL-  
APPLIED ASCOPHYLLUM NODOSUM EXTRACT**

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The effect of a fortified seaweed (*Ascophyllum nodosum*) extract (SWE) (regular extract + proprietary formulation of humic acid, carbohydrates, amino acids, peptides, saponins, betaines, GABA) (ATAN SoF®) was on 'Atlantic' potato tuber yield and size was determined in greenhouse experiments. Aqueous solutions of the fortified extract were drench-applied at different rates (0-5 L/ha) and different times (from planting to mid-season). Total tuber yield tended to increase as the extract rate increased. Fewer but larger tubers were produced when the extract was applied during early tuber swelling, whereas more abundant but smaller tubers were produced as the extract was applied earlier in the season.

(62)

**GROWTH OF AROMATIC COLEUS (*COLEUS AMBOINICUS* LOUR.) AS  
AFFECTED BY BIOSTIMULATORS**

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In the Caribbean, coleus is used as a medicinal and seasoning plant. Anecdotic information indicates coleus is responsive to exogenous growth substances (EGS), but little has been researched and published on the subject. Moreover, no information is available regarding the effect of EGS on the active principles of coleus. Experiments were conducted to determine the effect of the biostimulators acetylthioprolin (AP, 250 mg/L), gibberellic acid (GA 50 mg/L), triterpenic acid (TTA, 400 mg/L), a commercial glycine-rich complex of amino acid and peptides (ACP, 1500 mg/L), aminolevulinic acid (ALA, 30 mg/L), and two commercial *Ascophyllum nodosum* extracts with cytokinin-like activity (CST and CTR, 30 mg/L). Aqueous solutions of the biostimulators were sprayed on the leaves aromatic coleus when plants reached 20 cm height and again 21 d later. Crop fresh and dry weights were determined 60 d after the second biostimulator application. Crop fresh and dry weights were positively correlated, increasing approximately 18% with TTA, CST and CTR, 15% with ACP and ALA, and 12% with GA. No yield increase was detected with the AP treatment.

(63)

**AMINOLEVULINIC ACID EFFECTS ON THE YIELD OF WEED-FREE AND PIGWEED-INFESTED SALAD AMARANTH (*AMARANTHUS TRICOLOR*)**

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Greenhouse and field experiments were conducted to determine the effect of the exogenous biostimulant aminolevulinic acid (ALA) on the biomass accumulation of salad amaranth (*Amaranthus tricolor*) grown weed-free and infested by smooth pigweed (*Amaranthus hybridus*). Salad amaranth density was eight plants/m<sup>2</sup>. Pigweed density was 0 to 4 plants/m<sup>2</sup>. Pigweed and salad amaranth emerged the same day and grew alongside season-long (40 d). Aqueous solutions of ALA (0, 15, and 30 mg/L) were sprayed on the crop and crop/weed stands 14 d after emergence, mimicking the application of ALA on weed-free and weed-infested salad amaranth. Increasing ALA rates from 0 to 30 mg/L resulted in increased salad amaranth yield in weed-free stands. In pigweed-infested salad amaranth without ALA application, crop yield decreased as weed density increased. ALA application to the pigweed-infested crop favored pigweed, and the crop yield enhancement observed in weed-free salad amaranth was impaired by pigweed interference.

(64)

**CARIBBEAN CHERRY (*MALPIGHIA PUNICIFOLIA*) FRUIT GROWTH AS AFFECTED BY A SPRAYED SEAWEED (*ASCOPHYLLUM NODOSUM*) EXTRACT**

**J. Pablo Morales-Payan\***

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Experiments were conducted to determine the influence of a marine plant (*Ascophyllum nodosum*) extract (0-5 L/ha) on the fruit growth rate and size of Caribbean cherry. Aqueous solutions of the extract were sprayed on the fruitlets 2 d after anthesis. Fruit diameter and weight were determined daily until commercial maturity was reached. Fruit growth was sigmoidal in all the treatments. Fruit growth tended to be more rapid and fruit size and weight tended to be larger as the *Ascophyllum nodosum* extract rates increased. These results indicate that *Ascophyllum nodosum* extracts may be useful in enhancing fruit size and yield in Caribbean cherry.

(65)  
**EXOGENOUS AMINOLEVULINIC ACID EFFECTS ON  
ORNAMENTAL PEPPER**

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Greenhouse experiments were conducted to determine the effect of exogenous aminolevulinic acid rates (ALA, 0-45 mg/L) on shoot height, leaf area, stem diameter, chlorophyll and nitrogen in sap concentration, and fruit production in 'NuMex Centennial' ornamental pepper. ALA was sprayed on the leaves of plants approximately 13-cm tall and with five true leaves. ALA rates up to 15 mg/L did not significantly affect those variables. ALA rates >15 mg/L resulted in reduced plant height, leaf area, fruit production. Thus, exogenous ALA did not improve ornamental pepper growth and fruit yield, and rates >15 mg/L had toxic effects that may be related to its photodynamic activity.

(66)  
**TRIADIMEFON EFFECTS ON CORN (*ZEA MAYS*) GERMINATION,  
GROWTH, AND YIELD**

**J. Pablo Morales-Payan\***

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Greenhouse and field experiments were conducted to quantify the effect of seed treatment with the anti-gibberellin fungicide triadimefon on the germination, growth, and grain productivity of a tall corn variety ('Cesda 88'). Corn seeds were soaked for 24 h in aqueous triadimefon solutions (0-7.0%) and sown in loamy soil. Germination was reduced by 50% at the triadimefon rate of 0.70%, and completely inhibited at rates >3.50%. At the triadimefon rates of 0.15-1.25%, corn shoot height was temporarily reduced as compared to control plants. However, as the season progressed, triadimefon-treated plants resumed normal growth rates, and at harvest plants only plants treated with triadimefon rates >0.70% were shorter than control plants. Triadimefon rates of 0.15-1.25% did not significantly affect corn grain yield as compared to that of untreated plants.

(67)

**EFFECTS OF BIOSTIMULANTS ON NURSERY GROWTH OF ORANGE  
BUDED ON VOLKAMER LEMON (*CITRUS VOLKAMERIANA*) AND  
'SWINGLE' CITRUMELO (*C. PARADISI* x *PONCIRUS TRIFOLIATA*)**

**Luis Miguel Santana<sup>1</sup>, Raldolph Gabriel<sup>1</sup>, J. Pablo Morales-Payan<sup>2\*</sup>, <sup>3</sup>Casimiro H.  
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Nursery experiments were conducted to determine the effects of the growth stimulators (a) gibberellic acid 3, (b) acetylthioproline, (c) a commercial mixture of amino acids, indolacetic acid, gibberellic acid and zeatin [Biozyme®], (d) a commercial *Ascophyllum nodosum* extract [Stimplex®], and (e, f) two commercial mixtures of amino acids, peptides, proteins, humic acid, folic acid and vitamins [Maxiroot® and Biofert®] on the growth of 'Valencia' orange budded on the rootstocks volkamer lemon (*Citrus volkameriana*) and 'Swingle' citrumelo (*Citrus paradisi* x *Poncirus trifoliata*). The biostimulants were sprayed on the plant canopies every two weeks after orange buds started growing and until transplants reached the transplanting stage. Transplant growth was affected by all the stimulators. The best overall results were found with the *A. nodosum* extract (0.05-0.15%), which resulted in increased root, leaf, and stem dry weight by 22, 29, and 16%, respectively.

(68)

**ENDOGENOUS HORMONE CONCENTRATIONS AND BUD BREAK  
RESPONSE TO EXOGENOUS BA IN SHOOTS OF APPLE TREES WITH TWO  
GROWTH HABITS GROWN ON THREE ROOTSTOCKS**

**T. Tworkoski\* and S. Miller**

**USDA, ARS, Appalachian Fruit Research Station, 2217 Wiltshire Rd.,  
Kearneysville, WV 25430 USA**

Scion of two apple (*Malus xdomestica*) siblings were budded to three size-controlling rootstocks (M.9, M.7, and *Malus antanovka*) and planted in the field in 1997. The scion had two contrasting growth habits; one with narrow crotch angles, few proleptic branches, and an upright narrow canopy (UN) and the other with wide crotch angles, numerous branches, and a spreading round canopy (SR). Shoot tips were collected at time of bud break in April 2004 and analyzed for indole-3-acetic acid (IAA), cytokinins (CK), and abscisic acid (ABA). The UN growth habit had higher IAA, lower ABA, and equivalent CK as the SR growth habit. The synthetic cytokinin, 6-benzyl adenine (BA), was applied to 30 cm shoot explants of both growth habits in a greenhouse in March 2006. An 8.7 mM BA concentration stimulated bud break in both growth habits, compared with controls, and bud break was increased more in UN than SR growth habits. The results indicate that the auxin-to-cytokinin ratio may be a factor regulating bud break and development of growth habit of apple scions and that rootstock modified the hormone concentrations in shoot tips.

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