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MEETING REPORT

Plant Growth Regulation Society of America 2006 Annual Meeting Summary

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INTRODUCTION

The 33rd Annual Meeting of the Plant Growth Regulation Society of America (PGRSA) was held from July 9–13 at the Hilton Quebec, in Quebec City. Over 100 scientists from 10 different countries presented 34 oral presentations and 33 posters. Abstracts were published in the conference agenda as well as on-line on the PGRSA webpage (see Annual Meeting at http://www.griffin.peachnet.edu/pgrsa/homepage.shtml).

The PGRSA has evolved into a unique and specialized group that includes a well-balanced number of scientists from university, government and industry backgrounds. The Annual Conference routinely covers a wide range of issues pertaining to both fundamental and applied research in plant growth regulation. Due to the interaction of these three scientific groups, presentations often focus on short and medium-term benefits to the horticultural sector, with a smaller number of presentations addressing longer-term research projects. Attention is often drawn to practical application of plant growth regulators and plant growth regulatory techniques due to industry participation. The 2006 meeting included pre- and post-conference tours, a keynote address, four symposia featuring invited speakers, contributed oral presentations, a poster session and an Industry Update session to highlight advances in commercial research and product development.

In the keynote address, Dr. Andre Gosselin, past Dean of the Faculty of Agriculture and Food Science at Laval University (Quebec City) and current Professor at the Horticultural Research Center (CRH), opened the conference with insight on how to effectively foster industry-government-university research ties. Dr. Gosselin recounted difficulties and benefits from such relationships. He elaborated on past successes at Laval that hinged on patience, practicality and willingness by all to work in the best interests of developing mutually beneficial projects. Such collaboration led to the creation of the Envirotron research center, a private-public success story that is home to the CRH on the Laval University campus. This research center continues to be a centerpiece for horticultural research in Quebec and has produced dozens of PhD and M.Sc graduates since its creation in 1993.

The four invited-speakers symposia were held on PGR-Producing Microorganisms (moderator: Dr. Jeff

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Norrie, Acadian Seaplants Limited), Advances in Hormone Mode-of-Action Research (Dr. Ron Smith, VarFor Ltd.), PGR Use in Turf and Ornamental Horticulture (Dr. Gary Custis, PBI Gordon) as well as in Tree and Vine Crops (Dr. Thomas Chao, University of California). The contributed papers and poster sessions highlighted a wide variety of topics in plant growth and developmental regulation. The Industry Update session (Dr. John Immaraju, AMVAC Corp.) was well attended and bridged fundamental research with commercial research interests.

Symposium 1: PGR-Producing Microorganisms

The opening symposium focused on PGR-Producing Microorganisms. Dr. Sylvie Devos (University of Antwerp), winner of the 2006 PGRSA Young Scientist Award, opened with a talk titled 'A Hormone and Proteome Approach to Picturing the Initial Metabolic Events During Clubroot Disease on *Arabidopsis*'

Given that clubroot disease causes gall formation on *Brassica* roots, Dr. Devos discussed a holistic approach in understanding the role of plant hormones in early clubroot symptom development in *Arabidopsis*. Their team used the *CYCB1;1*::GUS, DR5::GUS and ARR5::GUS constructs to assess clubroot initiation. She also discussed how hormone concentrations between control and infected plants were screened using different hormone mutants for resistance and auxin transport. Also, a differential proteome study was performed using two dimensional gel electrophoresis coupled to MALDI-TOF. Combining the hormone and proteome data, Dr. Devos postulated that at the first stages of clubroot disease, cytokinins are produced by the pathogen, triggering 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 (see Figure 1).

The second speaker, Dr. Chantal Hamel (Agriculture and Agri-Food Canada, Saskatchewan) discussed how arbuscular mycorrhizae improve input efficiency in cropping systems. Dr. Hamel pointed out that since 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) can play a major role in this management. She discussed how these fungi have evolved as excellent ''sun-powered resource managers'' in successful ecosystems. As a heterogeneous group of soil fungi with requirements of their own, AMFs present a picture contrasting with our initial understanding of these organisms. She argued that 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 under reduced input systems may help improve farming profitability at a time of increasing resource costs.

Our third speaker on PGR-producing microorganisms, Dr. Bernard Glick (University of Waterloo), discussed how plant growth can be promoted by soil bacteria that regulate plant ethylene levels. He pointed out that the mechanism used by many soil bacteria to promote plant growth is the production of the enzyme 1-aminocyclopropane-1-carboxylate (ACC) deaminase which cleaves the plant-produced ethylene-intermediary 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 *Rhizobia* 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 were discussed in the context of a model for the functioning of ACC deaminase-containing bacteria. In addition, Dr. Glick discussed the role of plant gene expression resulting from the interaction with ACC deaminase-containing soil bacteria, and other bacterial regulatory factors.

The fourth symposium speaker, Dr. Wilhelm Rademacher (BASF, Limburgerhof, Germany), the 2005 American Society for Horticultural Science Outstanding Industry Scientist of the Year, presented a talk titled 'Biosynthesis of Plant Hormones by Microorganisms'. Dr. Rademacher emphasized that 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. He discussed the role of bacteria and fungi and their capacity to produce auxins, cytokinins or ethylene. Although he argued that the ability to form gibberellins or abscisic acid is much less common, *Gibberella fujikuroi* predominantly produces GA_3, GA_4 and GA_7 as active GAs. It is well known that the fermentations of high-yielding strains provide these GAs for commercial use. Dr. Rademacher also mentioned that although the fungi *Sphaceloma manihoticola* and *Phaeosphaeria sp.* produce primar-

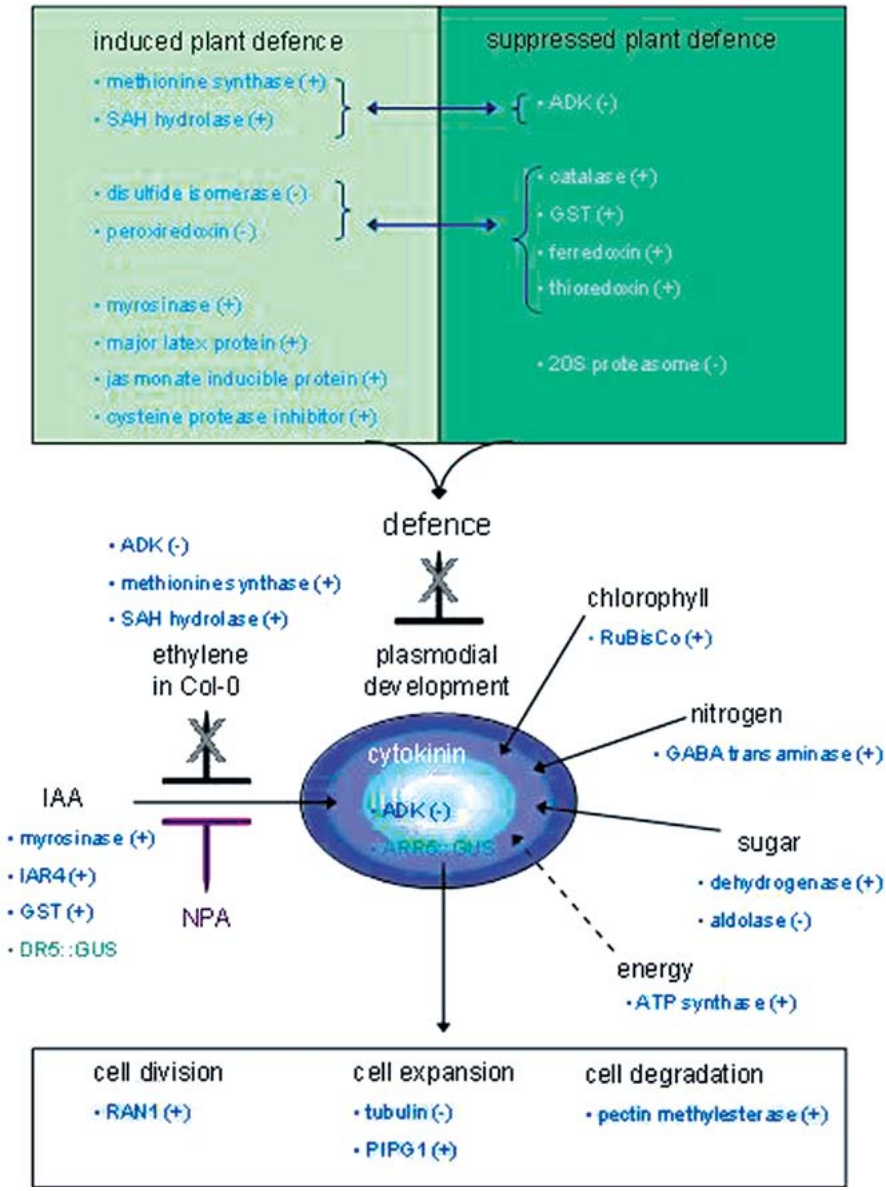

Figure 1. Hypothesis of plant processes upon *Plasmodiophora brassicae* infection of *Arabidopsis thaliana* Columbia-0. Proteins that indicate plant defence (see light box) and proteins that point to a suppression of plant defence (see dark box) control the defence against *P. brassicae*. The plant is unable to defend itself and plasmodial development proceeds (see circle). The plasmodia synthesize cytokinins that induce a sink for chlorophyll, nitrogen, sugar and IAA. This process requires energy (dashed arrow). IAA transport that is necessary for accurate plasmodial development is not blocked by ethylene, but when NPA is added, host IAA transport might be blocked and clubroot development is impaired. Upon a susceptible interaction, the newly formed plasmodial sink induces cell division, cell expansion and eventually cell degradation. The proteins that correspond to each process are presented (up regulated (+) and down regulated (−) upon clubroot infection). The promoter-GUS constructs (Devos) are also shown.

ily GA_4 and GA_1, respectively, *Cercospora rosicola* and *Botrytis cinerea* are fungi that synthesize abscisic acid. It is also possible for strains of the latter organism to produce this hormone on a commercial scale.

Symposium 2: Advances in Hormone Mode-of-Action Research

The second symposium, 'Advances in PGR Mode-of-Action Research' included talks from several of the world's leading researchers in the field. The first speaker, Dr. Angus Murphy (Purdue University) presented a talk titled 'Interactions of PIN and PGP Efflux Mechanisms on Polar Auxin Transport'. He first discussed how the directional transport of auxin is required for the establishment and maintenance of plant polarity. This 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 recently been shown to mediate auxin export: members of the plant-specific pin-formed (PIN) subfamily of major facilitator proteins, and phosphoglycoprotein (PGP) ABC transporters. Using findings from a number of studies, Dr. Murphy discussed auxin transport mechanisms and described the various roles of PIN and PGP proteins in intercellular auxin transport

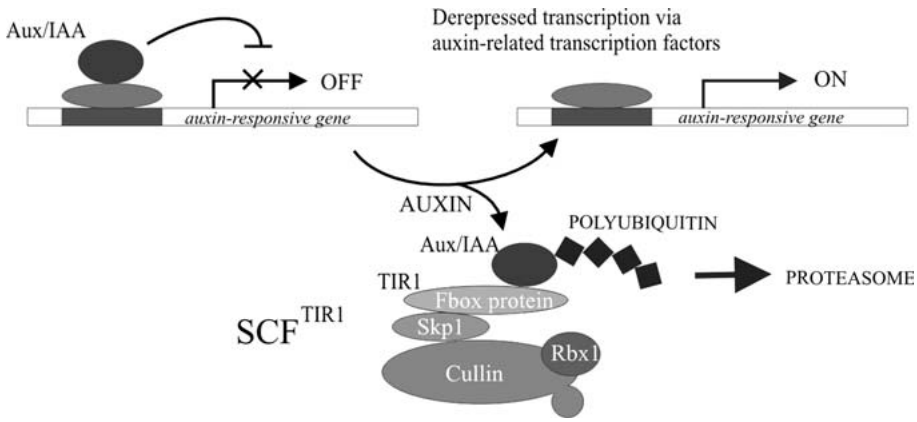

Figure 2. Auxin-induced gene expression proceeds via the degradation of Aux/IAA proteins and thus transcriptional derepression in response to auxin. Components of the E3 ubiquitin ligase SCF^{TIR1} collaborate with ubiquitin activating and conjugating enzymes to form a polyubiquitin chain on the target marking it for destruction in the proteasome. The F-box protein TIR1 is responsible for the specific selection of Aux/IAA proteins (Kepinski).

and the corresponding developmental processes in plants they affect. He concluded by outlining that PIN proteins characterize polar efflux complexes and that they align with auxin transport vectors, they are required for polar auxin transport, and are required for developmental polarity. He also noted that the activity of specific PINs and PGPs overlap at both the cellular and subcellular levels, and that the coexpression of specific PIN and PGP pairings can result in increased or decreased activity. There is also evidence of direct protein-protein interactions. The results suggest that PINs and PGPs can function as both independent and interactive efflux mechanisms.

The second speaker, Dr. Joe Ogas, also from Purdue, spoke on the role of gibberellin and an ATP-dependent chromatin remodeling factor, PICKLE (PKL) that acts during seed germination to repress genes that promote embryonic identity and thus facilitate the developmental transition from seed to seedling. The ability of gibberellins (GAs) 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 the expression of a new suite of genes that typify that state. In addition to its influence during germination, PKL appears to mediate a branch of the GA response pathway. Dr. Ogas' studies suggest that GA promotes developmental transitions in part by acting through both PKL-dependent and PKL-independent pathways to repress gene expression.

The third speaker on Mode-of-Action Research was Dr. Stefan Kepinski from the University of York, UK and Umeå Plant Science Centre, Sweden. Dr. Kepinski spoke on how auxins affect gene expression and how regulated gene destruction is at the heart of auxin's influence on plant signaling mechanisms. Central to the response(s) to auxin 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*. Kepinski's group previously showed that auxin prompts the expression of auxin-regulated genes by causing the ubiquitin-dependent proteolysis of Aux/IAA proteins and that this is catalyzed by an SCF-type ubiquitin-ligase complex called SCF^{TIR1}. More recently they showed that the regulation of the interaction between SCF^{TIR1} and Aux/IAAs depends on the direct binding of auxin to the F-box protein TIR1, and hence that TIR1 is a receptor for transcriptional responses to auxin (see Figure 2).

The final speaker on hormone research, Dr. Peter McCourt from the University of Toronto, spoke on 'Chemical Genetic Approaches to Plant Growth Regulation'. He discussed how the use of both genetic and genomic analyses, particularly in *Arabidopsis*, has greatly improved the molecular understanding of mechanisms of plant growth regulation. He pointed out that over the past ten years the major hormone receptors in *Arabidopsis* and rice have been identified, which may lead us to believe that genetic screens are no longer useful for dissecting problems in plant growth regulation. Dr. McCourt pointed out, however, that mutational analysis in combination with other new tools such as chemical biology will

allow new insights into how plant growth is regulated. Using ABA as an example, he demonstrated that by combining chemical biology with genetic analysis, a better understanding can be obtained of how abscisic acid may function. This combined approach can also be used as a way to identify other molecules with growth regulator properties.

Symposium 3: PGR Use in Turf and Ornamental Horticulture

The third Symposium focused on PGR Use in Turf and Ornamental Horticulture. Three speakers outlined research on turf. Dr. Ron Calhoun from Michigan State discussed the effectiveness of mefluidide or ethephon applications at limiting the expression of seedheads. He described how difficult it can be to determine application timing. He also found that linking application timing to developmental models such as growing degree days can provide much more consistent results. Tracking 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. Dr. Calhoun used this information to identify which application timings provided the highest level of seedhead control while minimizing turfgrass injury.

The second speaker in this session, Dr. Bingru Huang (Rutgers), spoke on the genetic transformation of creeping bentgrass with the IPT gene controlling cytokinin synthesis. Dr. Huang's group investigated 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. They 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 above 35°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. Some transgenic plants from *Psag12-ipt* and *Phsp18-ipt* clone groups had higher cytokinin in the leaves and the roots after stress treatments, suggesting a role for this hormone in delaying leaf senescence and improving heat stress tolerance in mature turfgrass leaves.

Dr. Erik Ervin (Virginia Polytechnical University) discussed the impact of seaweed extract-based cytokinins and zeatin riboside on heat tolerance in creeping bentgrass. His team found that differing seaweed extraction procedures results in varying concentrations of cytokinins. Whereas previous research has demonstrated improved abiotic stress resistance of cool-season turfgrasses due to foliar seaweed extract (SWE) applications, their objective was to compare the effects of two differentially-processed SWEs to synthetic zeatin riboside when applied at equivalent cytokinin concentrations on the heat tolerance of creeping bentgrass. They concluded that natural and synthetic cytokinin treatments resulted in greater visual quality, photochemical efficiency, chlorophyll content, superoxide dismutase activity, less lipid peroxidation, and higher zeatin riboside levels from seaweed extract treatments, when compared to the controls.

The final speaker in the PGR Uses in Turf and Ornamental Horticulture section was Dr. Wayne Mackay (Texas A&M) with a presentation titled 'Current and Potential Uses of Plant Growth Regulators in Floriculture and Ornamental Plants'. Dr. Mackay indicated 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. He argued that ''on site'' trials at the grower level are required to determine specific limitations which may 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. His talk highlighted current, potential and unrealized opportunities related to use of PGRs in ornamental and floricultural crops including examples for ethylene synthesis and function controlling substances such as ReTain®, STS, and 1-MCP.

Symposium 4: PGR Applications in Fruit and Vine Crops

The fourth and final invited-speakers forum centered around PGR applications in fruit and vine crops. The symposium was opened with a talk from Dr. Don Elfving (Washington State University) on mechanical harvesting of sweet cherries. He pointed out that a successful mechanical harvest depends on loosening the fruit so they can be easily removed

Table 1. Production Area and Commercial Value for Washington Sweet Cherry Industry

Year	Bearing area (ha)	Production (1000MT)	F.O.B. Crop value ($\$\times 10^6$)
1995	6640	64	107
2004	11700	122	237
Increase	(+76%)	(+91%)	(+121%)

Table 2. Effect of Ethephon and Smart Fresh (SF) MCP 17 Formulation Applied Days before Harvest on Fruit Removal Force and Flesh Firmness at Harvest (2003)

Treatment	Fruit removal force (%)	Flesh firmness (%)
Control	100a	100b
SF only	109a	106a
Ethephon	48b	92c
Ethephon + SF	52b	99b

Smart Fresh (SF) is the commercial formulation of 1-MCP, an ethylene-action inhibitor for post-harvest apples.

with shake-and-catch machines. Although ethephon is the only bioregulator product that is both effective for loosening cherries and registered for that use, ethephon-loosened cherries soften more rapidly and have a shorter postharvest life. Preharvest spray applications of the C_2H_4-action inhibitor 1-MCP (as SmartFresh, the commercial formulation of 1-MCP used to treat apples postharvest) 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 and did not improve flesh firmness. The 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 (see Tables 1 and 2).

The second speaker, Dr. Esmaeil Fallahi (University of Idaho) spoke on the application of blossom thinners for cropload management in apples and stone fruit. His talk discussed the use of hydrogen cyanamide (Dormex), sulfcarbamide (Wilthin), pelargonic acid (Thinex), endothalic acid (Endothal), and ammonium thiosulfate (ATS) as blossom thinners over the past 17 years. Dr. Fallahi also pointed out that Tergitol TMN-6 at 0.75% to 1.25% reduced blossoms in apples, peaches, nectarines, and plums in the US Pacific Northwest. Lime sulfur and fish oil, alone and in combination, can be effective organic blossom thinners for apples and peaches. Dr. Fallahi also discussed the impact of fruit quality and load, as well as effects of these products on the cost of fruit production.

Dr. Vito Polito (University of California) presented the third talk in this session on ethylene and pistillate flower abortion in walnut (*Juglans regia*). His research focused on the abortion of pistillate flowers shortly after bloom and the resultant impact on productivity in susceptible cultivars. High pollen loads induced the abortion of pistillate flowers due to a burst of ethylene production within 24 hours of pollination. Ethylene levels are highest in the most susceptible cultivars. Dr. Polito presented information on the application of inhibitors of ethylene synthesis and ethylene reception such as aminoethoxyvinyl-glycine (ReTain®, Valent Biosciences) and 1-methylcyclopropene (SmartFresh®, Agrofresh, Inc.) to control pistillate flower abortion in walnut orchards.

The final invited speaker, Dr. Mark Fidelibus (University of California) spoke on the use of abscisic acid as a potential tool for improving color in table grapes. He outlined that because poor color is a common problem in red grapes growing in warmer climates, poor color is related to a deficiency in endogenous abscisic acid (ABA). Dr. Fidelibus argued that exogenous application of ABA can improve color and a recent breakthrough in ABA synthesis may reduce its cost, thus enabling more widespread use by growers. Their work on 'Crimson Seedless' grapes (*Vitis vinifera* L.) found that application timing and PGR treatments interacted to affect color and firmness. Applied at veraison, ABA and Ethrel treatments increased red skin color compared to the non-treated fruit. ABA worked better than Ethrel at veraison but applied a month after veraison, ethrel was superior. He also noted that the PGR treatments that enhanced color also caused softening (see Table 3).

Poster Session

The regular poster reception was well attended with over 80 people participating in the event. The session showcased a wide range of basic and applied research with a total of 33 posters being presented.

Table 3. Effect of Different ABA and Ethephon Application Times and Concentrations on Berry Hue

	Berry skin hue angle				
	Abscisic Acid				
	Concentration (mg/L)				Ethephon
Application time	0	75	150	300	250
Veraison	63.5 a[z]	33.5 b	24.1 c	18.3 c	35.0 b
Post-veraison I	54.7 a	47.7 ab	38.8 b	35.3 b	39.7 b
Post-veraison II	62.2	55.9	51.1	51.5	52.2
LSD (0.05)	11.2	13.5	13.8	14.0	14.8

[z]*Values are treatments means, n=18. Means followed by a different letter within rows are significantly different according to Duncan's Multiple Range Test, α = 0.05. Means within columns are significantly different according to LSD.*

Topics were wide-ranging and included several posters on prohexidione-Ca (pears, apples, phlox) and aminolevulinic acid (amaranth, ornamental pepper, vegetable seedlings). More wide-ranging PGR effects were also presented on the following: auxin inhibitors (apples), brassinosteroid biosynthesis (*Arabadopsis*), cytokinin isomers (tobacco), ethephon and ethrel (peaches and apples), NAA, BA and 3,5,6-TPA (apples). Other posters discussed hormone balance in such diverse species as pears, guava and *Arabidopsis*. More specific posters presented results on salicylic acid effects on flowering in *Capsicum chinense*, alcohol and sucrose effects on *Lupinus*, 1-MCP effects on *Ziziphus*, and immunosensors for GA detection. Dynamac Corporation (Florida) presented research on ethanol effects on germination and growth of lettuce, radish, soybean and wheat seedlings as well as work on hydroponic production of salad crops under differing CO_2 concentrations.

Other studies highlighted work on the mediation of oxidative stress in maize using seaweed extracts. Morales-Payan presented several posters ranging from effects of *Ascophyllum* seaweed extracts on *Zoysia* turfgrass and potato tubers, to others such as GABA, humic acids, amino acids and peptides, betaines and saponins on potato and triadimefon effects on corn.

Other posters presented work on emulsified oil adjuvants and ethephon on peach thinning and bud break response to exogenous BA applications in apple.

In short, the poster session presented a good blend of applied and basic science, while providing valuable insight into how PGRs can benefit different crop species.

Industry Session

The Industry Update session at the 2006 PGRSA meeting was moderated by John Immaraju, (AMVAC Chemical Corporation). It included six presentations from various companies that manufacture plant growth regulators.

Kevin Forney (Fine Americas) discussed Concise ™ and Piccolo®, two new PGR formulations. Concise (0.55% uniconazole-p) is an effective growth retardant recently approved by the US EPA for use on ornamental crops. Concise is labeled for use on a wide range of annual and perennial containerized plants grown in commercial greenhouses, glasshouses and shade structures and can be applied as a foliar spray, soil drench, bulb dip, liner dip or pre-plant media spray. University field trials have demonstrated that Concise is highly effective at low use rates and can be used to produce more compact and marketable plants.

Piccolo – Liner Dip (0.4% paclobutrazol) was recently approved by the US EPA for pre-transplant soak, that is, 'liner dip' applications on plugs or rooted cuttings of bedding plant and herbaceous flowering/foliage plants. University trials have demonstrated that the Piccolo liner dip treatment is highly effective in reducing the height of very vigorous plants that tend to grow rapidly, following transplant. Recommended rates for the Piccolo liner dip treatment range from 0.5 to 8 ppm depending on plant species, desired level of activity and geographical location.

Jeff Norrie (Acadian Seaplants) discussed links between fundamental and applied research. Acadian Seaplants, a leader in marine plant products for agriculture and food markets, has developed an extensive research program to complement its world-wide field trial program. This program is exploring the chemical and biological nature of marine-plant products through a series of projects with university and government partners. The actual research uses NMR, HPLC, GC/MS and a number of bioassay and molecular biological tech-

niques to identify specific active ingredients, molecular profiles, plant genetic responses to treatments and overall effects on plant growth and development. By determining the links between basic research and specific effects on plant growth, the results of this research are expected to allow Acadian Seaplants to develop new products and crop recommendations for use on a wide range of crops around the world.

David Barcel of Chemtura Crop Protection discussed using ultra-low dose Paczol applications to manage poinsettia crop height. Paczol (0.4% Paclobutrazol) is a common PGR used for reducing plant height by inhibiting gibberellin production within the plant. Typical application rates for a poinsettia crop are 20–30 ppm sprayed or 2–4 ppm when drenched, depending on variety, growing conditions, and so on. A trial was conducted to evaluate Paczol drench at 0.1 ppm followed by 0.1 ppm drench as needed or 0.15 ppm drench, followed by 0.15 ppm drench as needed to maintain crop height. Control was based on the University of New Hampshire poinsettia growth model. Other treatments tested were B-Nine+Cycocel at 2500+1000 ppm respectively, followed by 0.1 ppm Paczol as needed. All three treatments were successful in controlling crop height to a commercial height of 16–19'' when compared to an untreated control. The ''low-dose'' Paczol method appears to be a viable option for growers, because it can reduce the probability of overstunting from an excess application.

John Immaraju spoke on two new NAA formulations and AMV-1017, a new post harvest potato sprout inhibitor. Two new 1-NAA formulations in development include a liquid version of the sodium salt of 1-NAA (Fruitone® L) and Tre-Hold® A112. Tre-Hold A112 is being developed to prevent the development of tree sprouts after heavy pruning of limbs on bearing avocados. Pruning is an essential practice of avocado production systems to manage tree architecture. Three years of trials have shown good results and IR-4 is currently conducting residue trials for establishing a NAA tolerance on avocados.

A new product, coded AMV-1017 is being developed for use as a post-harvest treatment to inhibit potato sprouting in storage. AMV-1017 is a 9-carbon unsaturated ketone which is already approved for food use by the FDA. The technology and patent was licensed by AMVAC from Washington State University in 2005 and the product is currently undergoing field testing and development. Trial results from two years show excellent efficacy at 100 ppm on a broad range of potato varieties. The common potato variety, Russet Burbank can be held in cold storage (45 deg F) without sprouting for up to 3.5 months (one treatment) to around 5 months (2 treatments). The mode of action is unknown but the compound appears to destroy the internal meristematic tissue of the developing potato sprouts.

Gary Custis of PBI Gordon presented research on dikegulac-sodium and medfluidide—two PGRs for tree injection and bark-banding. PBI Gordon manufactures two plant growth regulators, Atrimec (dikegulac-sodium) and Embark (medfluidide). PBI has been doing research on a more efficient delivery system for Atrimmec that provides longer residual activity as well as limiting the environmental exposure compared to foliar applications. When Atrimmec is foliarly applied, timing is critical and one of the major problems is that the fruit does not mature at the same rate on all sides of the tree, which results in inconsistent fruit suppression. However, by either injecting or bark-banding, the active ingredient penetrates into the vascular tissue and is directly translocated to the flowers thereby suppressing the fruit production more uniformly. Injecting requires separate expensive equipment, while the bark-banding application requires only an inexpensive hydraulic sprayer.

When barking-banding, dikegulac-sodium is combined with an organosilicone surfactant which aids movement across the bark of the tree into the vascular tissue of the plant. Additional research for the potential inclusion of a phosphite fertilizer, which appears to boost both the absorption and translocation of the PGRs to the flowers, is being undertaken. To date, results with prototype formulations have been promising, but have also been spotty. They continue to monitor environmental effects before and after application, as well as their impact on the plant's vascular structure. In addition to application timing, key environmental factors affecting whole-plant transpiration seem to have the greatest effect on translocation. Whereas foliar applications are restricted to a very narrow application window, bark-banding appears to have a much wider window of application.

The final speaker in the Industry Session, Dr. Jim Hansen of Valent Biosciences Corporation discussed work on ReTain® (aminoethoxyvinylglycine HCl (AVG)) on walnuts and their program on abscisic acid development. ReTain® is a potent ethylene biosynthesis inhibitor that prevents the abscission of pistillate flowers due to high pollen levels. VBC recently announced the approval of ReTain® in the US and Chile on walnuts for overcoming pistillate flower abscission (PFA). PFA is associated with high

Figure 3. About 55 of the 120 delegates at the PGRSA 2006 meeting participated in the post-conference tour, including a picnic lunch. Photo by S. Maki.

levels of pollen causing elevated ethylene production and abscission of pistillate flowers in walnut. This problem is most commonly associated with the Serr variety where losses due to PFA can be as high as 90%, but is also found to lesser extents in other walnut varieties. Application of 333g (50g AI) Re-Tain® at 5 to 30% pistillate bloom is recommended for overcoming PFA. VBC is currently developing abscisic acid (ABA) on a global basis with a focus on drought tolerance and promotion of coloring in grape.

Conclusion

The 2006 PGRSA meeting was an excellent mix of practical and fundamental science. As leaders in their fields of study, the invited speakers brought a wealth of information to the conference. In addition to the formal scientific agenda, the European-like charm and beauty of Quebec City served as a backdrop during a pre-conference tour of the Old City and the Festival d'Eté provided musical flavor for the duration of the conference. Over 80 persons attended the Opening PGRSA Reception in a panoramic setting at the top of the Hilton, overlooking Quebec City, the Plains of Abraham, L'Isle d'Orlean and the St-Lawrence River. The Sustaining Member's breakfast (sometimes referred to as the 'Industry' breakfast) was held for about 25 participants underscoring the valuable role industry partners play in the

Figure 4. The post-conference tour also included a visit to Les Chutes de la Chaudiere, a water falls and river gorge close to Quebec City.

sustainability of the PGRSA. The poster reception welcomed about 75 people on Tuesday night, after which many strolled through downtown Quebec and took in some of the festivities.

The Business Luncheon greeted about 80 persons while the closing event welcomed over 90 participants for a night-time dinner-cruise aboard the Louis Joliette along the St-Lawrence waterway. The following day, about 55 people took part in the post-conference tour of Laval's Horticultural Research Center (CRH), the Ven den Hende botanical gardens, and Quebec Multiplant's plant propagation

facilities and turfgrass fields. We ended our post-conference tour with a picnic lunch and walk-about at the touristy Les Chutes de la Chaudiere, on the east side of the St-Lawrence River, a short drive from Quebec City (Figures 3 and 4).

In short, it appeared that everyone had a special time in Quebec City with important and interesting science, as well as a splash of French Canadian culture. The Proceedings from the 2006 conference will include expanded abstracts or longer papers for each presentation. They will be available in the next few months on CD or, if necessary, hard copy. Next year's PGRSA meeting will be jointly held with the International Plant Growth Substances Association and the Japanese Society for the Chemical Regulation of Plant Growth in Puerto Vallarta, Mexico (July 21–25, 2007) and should provide another excellent gathering of scientific minds. The PGRSA contact for the 2007 meeting is Dr. Gary Custis (gcustis@pbigordon.com). Please visit the PGRSA website for details on the PGRSA and upcoming events (http://www.griffin.peachnet.edu/pgrsa/homepage.shtml).

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