Plant Growth Regulators – Growth Retardants

Joyce Latimer
Virginia Tech
Blacksburg VA

Growth Retardants
- Cell elongation inhibitors
- Retard growth by inhibiting the production of the plant hormones Gibberellins
- Gibberellins cause cell expansion
- Therefore, plants are shorter

GA (Gibberelic Acid) Metabolic Pathway

Brain Whipker, NCSU

GA Metabolic Pathway
- Chemical chain of events, which leads to the production of GA
- Knowing the pathway provides a better understanding of how PGRs work.

Cell Elongation Inhibitors
- Group A
  - Cycocel (chloromequat)
- Group B (N– containing heterocyclic compounds)
  - A-Rest/Abide (ancymidol) [pyrimidine]
  - Topflor (flurprimidol) [pyrimidine]
  - “Paclo” (paclobutrazol) [triazole]
  - “Unicon” (uniconazole) [triazole]
- Group C
  - B-Nine (daminozide)
Problems

GA Pathway

Isopentyl pyrophosphate
Farnesyl pyrophosphate
Geranylgeranyl pyrophosphate

ent-kaurene
ent-kaurenol
ent-kaurenal
ent-kaurenoic acid
GA13-aldehyde
Gibberellins

Less Growth: Shoots Leaves Roots

GA Pathway

Isopentyl pyrophosphate
Farnesyl pyrophosphate
Geranylgeranyl pyrophosphate

ent-kaurene
ent-kaurenol
ent-kaurenal
ent-kaurenoic acid
GA13-aldehyde
Gibberellins

Less Growth: Shoots Leaves Roots

Group A
Cycocel

Group B
Ancymidol Paclo Unicon Topflor

Group C
B-Nine

Gibberellins

Tank Mix: Synergy?

Control
Cycocel 1000 ppm
Cycocel 2000 ppm
Cycocel 3000 ppm
Cycocel 4000 ppm

Rudbeckia triloba

☐ 4 WAT, moderate response to Cycocel alone

Joyce Latimer
February 2011
Other Effects of PGRs

Brian Whipker, NCSU

Greener Leaves

PGR treated leaves are darker green
Suggests a higher chlorophyll content
- Cells smaller, so chlorophyll more concentrated
- Increased chlorophyll production because of blocked pathway

Why greener leaves?

PGR Pathway

Isopentyl pyrophosphate
Farnesyl pyrophosphate
Geranylgeranyl pyrophosphate
ent-kaurene
ent-kaurenal
ent-kaurenoic acid
GA12-aldehyde
Gibberellins

Why greener leaves?

X = blocked steps

Greener Leaves

Robust Latimer
February 2011
Reduced Water Stress

- Blocked GA pathway increases abscisic acid production...
- Interferes with the breakdown of abscisic acid

Abscisic Acid

Stomatal Closure

Reduced Water Loss

Disease Suppression

- Applying paclobutrazol to trees reduced the incidence of fungal diseases.
- Thought due to the inhibition of sterol production in fungi.
  - Sterols essential constituents of membranes.
  - Same mode of action as sterol biosynthesis inhibitor class of fungicides.

GA Pathway

Isopentyl pyrophosphate

Farnesyl pyrophosphate

Geranylgeranyl pyrophosphate

t-kaurene

t-kaurenol

t-kaurenal

t-kaurenoic acid

GA12-aldehyde

Gibberellins

Why less disease?

Paclobutrazol blocked steps

Verticillium dahliae Growth Inhibition

Source: Jacobs and Berg, 2000.

Mean Daily Water Use

Colt Cherry Rootstocks


Joyce Latimer
February 2011
Benefits of Growth Retardants

- Control plant height/size
  - Less space used per plant
  - Buffer period of growth control
  - Can meet shipping height reqmnt
  - Can ship more plants per load

Benefits of Growth Retardants

- Improve plant quality
  - Deeper color
  - Strengthen stems
  - Plant height impacts perceived quality (balance)
### Benefits of Growth Retardants
- May increase disease resistance
- Increase stress resistance
  - Have less shrinkage (production losses)
  - Have longer shelf life (production and retail)

### Benefits of Using PGRs
- Growers using PGRs:
  - Reduce cost of production
  - Reduce shrinkage
  - Can ship more plants per load
- PGRs: higher quality and more saleable plants

### Growth Retardants

#### PGRs – NO Soil Activity
- Typically short-term responses
- Uptake by leaves; good coverage required
- Daminozide
  - **B-Nine WSG** (OHP)
  - **Dazide** (Fine Americas)

#### PGRs – LIMITED Soil Activity
- Some root uptake
- Primarily foliar applications; good coverage required
- Chlormequat Cl (not labeled for chemigation)
  - **Cycocel** (OHP)
  - **Chlormequat E-Pro** (Etigra LLC)
  - **Citadel** (Fine Americas)
Cycocel

- Labeling includes outdoor use.
- Guidelines
  - Sprays only
  - Limited to 3 applications per crop
  - 12 hour REI (same as greenhouse use)
  - Mechanical (tractor) multi-nozzle sprayer applications on gravel/landscaped fabric cannot exceed 1 acre of plants per mixer/loader/applicator/day.

Veronica x ‘Sunny Border Blue’

- B-Nine effective on a wide variety of perennials
- Multiple applications required at 7 to 14 day intervals

Coreopsis grandiflora ‘Sunray’

- Crop specific responses
- B-Nine 5000 ppm x 2

Cycocel Phytotoxicity

- Chlorotic halos on geranium
- Minimal with rates below 750 ppm

B-Nine/Cycocel Tank Mix on ‘Tango’

- Significant reductions in stem height
- Improved plant form

Helenium ‘Coppelia’

- B-Nine or B-Nine/Cycocel (5000/1500 ppm) tank mix sprays, 6WAT
**Perovskia atriplicifolia**

- B-Nine: 5000 x3, good control
- B-Nine/ Cycocel Tank mix, multiple applications

**Gaura lindheimeri ‘Siskiyou Pink’**

- For many plants, width more important than height

**PGRs – Soil ACTIVE**

- Taken up by shoot and root tissues
- Typically more potent than foliar only
- Ancymidol (labeled for chemigation)
  - A-Rest (SePRO)
  - Abide (Fine Americas)
- Topflor (flurprimidol) (SePRO)
  - (labeled for chemigation)

**Veronica ‘Icicle’**

- Abide drenches at 2 fl.oz per quart pot
- Plant ht: Control 10 inches vs. 8 ppm drench 4 inches

**Delphinium ‘Blue Bird’**

- Abide drenches 10 fl.oz per trade gallon pot
- Control 13 inches vs. 8 ppm drench 7 inches

**Delphinium elatum ‘Blue Bird’**

- Topflor foliar spray, 4 WAT, linear response
<table>
<thead>
<tr>
<th>Plant</th>
<th>PGRs – Soil ACTIVE</th>
<th>PGRs – Soil ACTIVE</th>
</tr>
</thead>
</table>
| Erysimum linifolium | - Topflor foliar spray, 6 WAT, persistent | - Paclobutrazols  
  - labeled for chemigation  
  - much more potent than ancymidol & daminozide  
  - Uniconazoles  
  - not labeled for chemigation  
  - 8-10x more potent than paclobutrazols  
  - Primary uptake by stems and roots | - Paclobutrazols  
  - Paczol (OHP)  
  - Bonzi (Syngenta Professional Products)  
  - Piccolo (Fine Americas, Inc.)  
  - Florazol (Prokoz)  
  - Downsize (Greenleaf Chemical) | - Uniconazoles  
  - Sumagic (Valent USA)  
  - Concise (Fine Americas, Inc.) |
| Phlox subulata 'Apple Blossom' | - Paclo, 6 WAT, moderate control of plant width | - Alcea ‘Chaters Double’  
  - Paclo sprays, 2 WAT, multiple applications necessary for long term control |
**Veronica repens ‘Sunshine’**

- Paclo, 6 WAT, excessive control

**Veronica x ‘Sunny Border Blue’**

- Paclo overdose
- Tank Mix excellent control, 1x

**Rudbeckia ‘Herbstonne’**

- Sumagic: ~45 ppm
- B-Nine: good control, 5000x3

**PGR Relative Activity**

- Ancymidol
- Daminozide
- Chlormequat
- Daminoz + Chlormeq
- Paclo
- Unicon
- Topflor

- Less

**Sedum ‘Matrona’**

- 6 WAT
- Width control
- NR to B-Nine or tank mix

For more information

Joyce Latimer
540-231-7906; jlatime@vt.edu
http://www.hort.vt.edu/floriculture
http://www.gpnmag.com