Validation of Plant Growth Regulator Products for the Enhancement of Germination, Growth and Development of Native Plants

Christina C. Small (Presenter); Dani Degenhardt; Tania McDonald

InnoTech Alberta, Edmonton, AB, Canada; Christina.Small@innotechalberta.ca

Introduction

All plants naturally produce hormones that regulate metabolism, growth, and development. A number of plant hormones were identified in the 1930's - by regulating these hormones, researchers found that they could control the loss of leaves, and formation and growth of roots, shoots, buds, flowers and fruits.

What are Plant Growth Regulators (PGRs)?

- Chemical stimulants (synthetic analogues) that promote existing hormonal activity
- Commonly used in agriculture, viticulture and horticulture to improve growth, yield and ease of harvest
- There are 5 major types of PGRs:
  - **Auxins** (increases cell growth & expansion)
  - **Gibberellins** (elongates stems & breaks seed dormancy)
  - **Cytokinins** (promotes cell division)
  - **Ethylene** (influences fruit ripening or aging)
  - **Abscisic Acid** (increases stress resiliency)

How are PGRs commonly regulated in Canada?

- Considered pesticides that do not pose significant risk to the environment (i.e., non-toxic) (*Pest Control Products Act*)
- Reviewed as a fertilizer if products supplement plant growth (*Fertilizer Act*)

How can PGRs Apply to Restoration?

- Opportunities in seed development, plant propagation and bioengineering in both greenhouse-based and field-based revegetation and restoration applications
- May improve the ecological recovery of disturbed lands by reducing the time frame for reclamation and aid industry in achieving ecological goals and objectives

Research Questions

- Which of the 5 major PGR products have been identified to improve seed germination and early growth and development?
- What is the impact of PGR application to native grass and forb germination and early development?

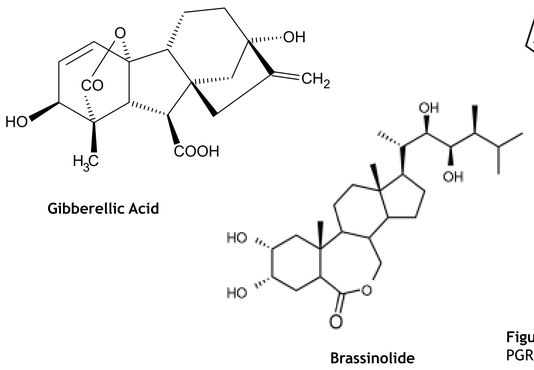


Figure 1: Chemical structure of those PGRs selected for the study.

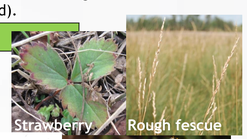
Methods

Germination Experiment

- 5 PGR Treatments – GA_3 (40% and 90%; 500 mg/L), $GA_{A4/A7}$ (500 mg/L), kinetin (5 mg/L), brassinolide (0.1 mg/L)

Table 1: Alberta native plant species used in the trial. Plants were selected from the following different Natural Regions: Grassland, Boreal Forest, Foothills, Rocky Mountain, and Parkland).

Grasses	Forbs
• Western Wheatgrass • Hairy Wild Rye • Junegrass • Foul Bluegrass • Ticklegrass • Rough Fescue • Rocky Mountain Fescue	• Yarrow • Strawberry



Petri Plate Preparation:

- 20 treated seeds per plate saturated with ultrapure water

Germination Cabinet Conditions:

- 21°C day/18°C night; 10/14 h light/day
- 80% humidity

Figure 2: Seeds soaked for 24 hours in PGRs prior to germination.

Measurement Endpoints:

- Germination rate (day 7 and day 14)
- Shoot length (day 14)
- Root length (day 14)
- Vigor index

$$= \%\ Germination \times (Root\ Length_{Mean} + Shoot\ Length_{Mean})$$

Results

Table 2: Effect of PGR treatments on germination rate on day 7. The results solely indicate those species that were measured to have significant increase in germination rate over the control (p=0.05; n = 100) and the magnitude of the improvement in germination rate.

PGR	Increase in Germination Rate Over Control Treatment (Day 7)				
	Strawberry	Junegrass	Foul bluegrass	Ticklegrass	Rough Fescue
$GA_3$40%	130%	36%	123%	44%	-
$GA_3$90%	131%	-	98%	51%	-
$GA_{A4/A7}$	132%	-	115%	42%	-
Kinetin	113%	-	118%	56%	85%
Brassinolide	149%	-	121%	49%	93%

Table 3: Effect of PGR treatments on germination rate on day 14. The results solely indicate those species that were measured to have significant increase in germination rate over the control (p=0.05; n = 100) and the magnitude of the improvement in germination rate.

PGR	Increase in Germination Rate Over Control Treatment (Day 14)	
	Ticklegrass	Rough Fescue
$GA_3$40%	-	-
$GA_3$90%	68%	-
$GA_{A4/A7}$	-	-
Kinetin	77%	40%
Brassinolide	-	-

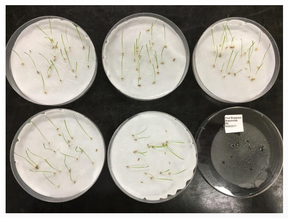


Figure 3: Foul bluegrass growth and development at day 14 after seed treatment with brassinolide.

Table 4: Effect of PGR treatments on shoot (S) and root (R) length for the individual tested plant species on day 14. Highlighted boxes (green for shoot length and brown for root length) indicate significant increases in shoot and root length over the control (p=0.05; n = 100).

Plant Species	Product									
	$GA_3$40%		$GA_3$90%		$GA_{A4/A7}$		Kinetin		Brass*	
	S	R	S	R	S	R	S	R	S	R
Yarrow	■	■	■	■	■	■		■		■
Strawberry	■				■		■	■		■
Ticklegrass	■	■	■	■	■	■		■		■
Western wheatgrass	■		■		■					
Junegrass	■	■	■		■	■		■		■
Hairy wild rye	■		■	■	■					
Rough fescue	■				■			■		■
Rocky mountain fescue	■				■			■		■
Foul bluegrass								■		■

*Brassinolide

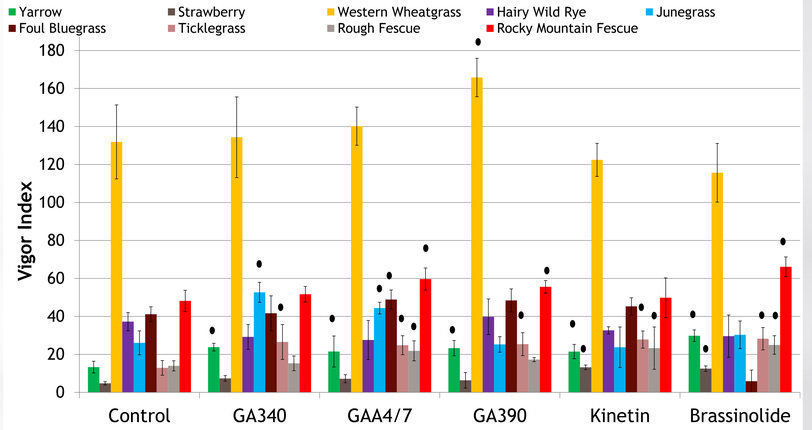


Figure 4: Effect of PGR treatments on vigor index for the species used in the trial. Values are an average ± standard deviation (n = 100). The dot above the bars indicate a significant difference at p = 0.05 for each treatment in comparison to the associated control.

Conclusions

- PGRs have the potential to break dormancy and improve emergence
- A one-time seed soak did not increase the total number of germinable seeds for most species tested in the trial
- Gibberellins significantly improved shoot length for the majority of species
- Kinetin and brassinolide significantly improved root length for the majority of species
- PGRs having the greatest impact on overall seed development included $GA_{A4/A7}$ and brassinolide

Significance:

- Improving early emergence and shoot length may improve competition with weeds and non-desirable species
- Enhancing belowground biomass development may assist in erosion control and improve plant establishment
- Enhancing aboveground biomass development may reduce bare ground by increasing litter