Methods to stimulate flowering and seed production in spruce seed orchards

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Outline

- Flower stimulation with $GA_{4/7}$
  - Background
  - Effect
  - $GA_{4/7}$ products available
  - Application techniques
  - Profitability
- Cultivation techniques to combine with $GA_{4/7}$
  - Root pruning
- Cultivation techniques to avoid in S.O.s
  - Girdling
Flower stimulation with GA$_{4/7}$

- First reports in mid 1970s
- Has shown effect in many conifer species e.g.
  - *Pinus sylvestris*
  - *Picea abies*
  - *Pinus contorta*
  - *Picea mariana*
  - *Pinus radiata*
  - *Pseudotsuga menziesii*
- Generally more effective in promoting female than male flowering
- Effect of GA treatment are often increased if combined with cultivation techniques (e.g. heat, drought, girdling)
Flower stimulation with $\text{GA}_4/7$

**Picea mariana**

- **Control**
- **EtOH**
- **GA**

Cone per tree graph,
- Control: 100
- EtOH: 200
- GA: 300

*Source: Bockerhoff & Ho, 1997*

**Pinus sylvestris**

- **Control**
- **GA**

Filled seed per tree graph,
- Control: 4000
- GA: 8000

*Source: Eriksson et al. 1998*
Norway spruce – Female strobili scores

<table>
<thead>
<tr>
<th>Class</th>
<th>Control</th>
<th>GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>49 %</td>
<td>30 %</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>50 %</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>46 %</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>41 %</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>39 %</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>37 %</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>35 %</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>30 %</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>27 %</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>23 %</td>
</tr>
</tbody>
</table>

504 Ålbrunna

Control 14 %
GA 31 %

Norway spruce – Female strobili scores

Class

Percent
Flower stimulation with GA$_{4/7}$ are today routinely used in conifer breeding programs.

BUT, at least in Europe,

No use of GA$_{4/7}$ in seed production in operational scale in Seed Orchards.

Main reason

No product registered and approved for use in conifer Seed Orchards.
In Sweden this problem is now solved!

- In 2012 the Swedish Chemicals Agency approved Gibb Plus Forest for use in conifer S.O’s until 2019

- Gibb Plus Forest is the same product as Gibb Plus that is used to
  * Stimulate fruit set on apples and pears
  * Reduce tree russetting on apples
Application equipment

- Breeders make their own GA solution from powder diluted in ethanol (~ 150 mg/ml)
- Injection with a micropipette in drilled holes
Application equipment

- Gibb Plus Forest has a concentration of 10 mg/ml

- Injection volume > 10 times greater → Drilling holes are not an option!

Alternative injection technique is needed
Our choice
Picea abies

Rosenberg et al., 2012
Economic calculations

Based on data from 504 Ålbrunna

Assumptions

- Spacing 7 x 4 m, 80 % survival => 286 st/ha
- 75 % of the cones contains filled seed, 115 per cone
- Control grafts 170 cones/graft
  GA-treated 287 cones/graft
- 1000-grain weight: 7.6 gram
- GA cost 130 Kr/gram
  GA dose 50 mg/graft => 6.50 Kr/graft
- Labour cost 2100 Kr/day
  600 grafts/day => 3.50 Kr/graft
## Economic calculations
Based on data from 504 Ålbrunna

### Result

<table>
<thead>
<tr>
<th>GA treatment cost:</th>
<th>2 857 Kr/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra production:</td>
<td>22 kg seed/ha</td>
</tr>
<tr>
<td>Cost for extra production:</td>
<td>130 Kr/kg</td>
</tr>
</tbody>
</table>

### Success rate

<table>
<thead>
<tr>
<th>Every time</th>
<th>Cost for extra production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 out of 3</td>
<td>389 Kr/kg</td>
</tr>
<tr>
<td>1 out of 5</td>
<td>648 Kr/kg</td>
</tr>
<tr>
<td>1 out of 7</td>
<td>908 Kr/kg</td>
</tr>
</tbody>
</table>
Cultivation techniques to combine with $\text{GA}_{4/7}$ – Root pruning
Root pruning (cont.)
Root pruning (cont.)
Root pruning (cont.)
Cultivation techniques to **AVOID** in S.O.s – Girdling
Cultivation techniques to AVOID in S.O.s – Girdling
Take home message

- $\text{GA}_{4/7}$ treatment is a cheap way to increase seed production in Norway spruce S.O.s – but it’s not a magic wand
- Root pruning is a cultivation technique that can enhance the effect of $\text{GA}_{4/7}$
- Don’t use girdling in seed orchards!