A few basics on genetically engineered trees

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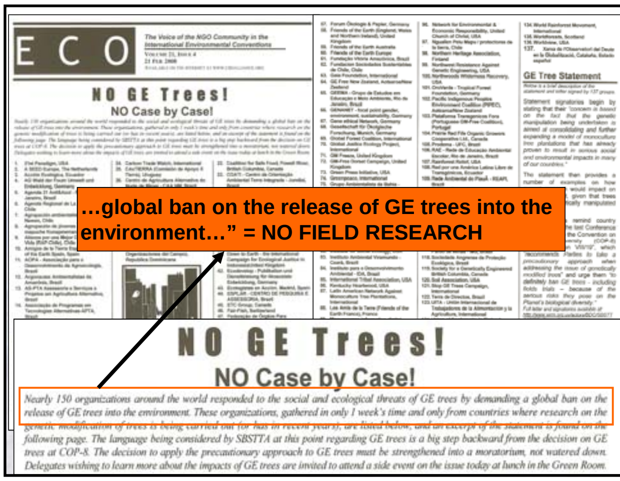
E C O

NO GE Trees!

NO Case by Case!

Nearly 150 organizations around the world responded to the social and ecological threats of GE trees by demanding a global ban on the release of GE trees into the environment. These organizations, gathered in only 1 week's time and only from countries where research on the genetic modification of trees is being carried out (or has in recent years), are listed below, and an excerpt of the statement is found on the following page. The language being considered by SBSTTA at this point regarding GE trees is a big step backward from the decision on GE trees at COP-8. The decision to apply the precautionary approach to GE trees must be strengthened into a moratorium, not watered down. Delegates wishing to learn more about the impacts of GE trees are invited to attend a side event on the issue today at lunch in the Green Room.



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Rationale for GM tree research

- Powerful basic science tool
- Extend limits of conventional breeding
  - Needed solutions for critical problems (e.g., new forms of pest resistance genes)
  - Fast, compared to slow and inefficient breeding due to long generation time of trees
  - Can mitigate risks of exotic invasive species
- GM provides options for new kinds of high value, sustainably produced bioproducts
- GM can aid intensification of production, itself often an environmental benefit

Forests and Wood

Need for genetic improvement

Plantation forests occupy 5% of all forests and deliver 35% of industrial roundwood. More yield = less potential impact on wild/conservation forests.

FAO: ⇒ higher wood yield / ha
⇒ improved wood quality

Poplar in Oregon an example

Rationale for public GM tree research

- Products that do not meet financial objectives of corporations
- Public benefit goals such as restoration of threatened wild species – biodiversity
- High level of transparency so value and biosafety and value elements scrutinized
- Can do basic research that does not guarantee financial benefits
  - Long time scales, beyond financial cycles
- Can address wide range of social and environmental values

Examples of ongoing, promising research

- Resistance to pests and diseases
- Tolerance to salinity and high temperature stresses
- Phytoremediation of environmental toxins
- Modified properties to improve processing of wood for biofuels, paper, or solid wood
- Tolerance to herbicides to reduce the environmental impacts, improve efficiency, or reduce costs of weed control treatments

Examples of ongoing, promising research

- Flowering control for reduced spread and growth rate
- Improved growth, yield, and nutrient usage
- Synthesis of new, renewable bioproducts such as plastics and enzymes

Stability of expression and flowering control studies

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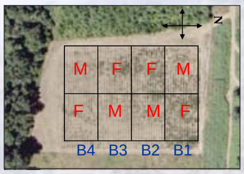
Oregon State UNIVERSITY OSU

High field stability of transgene expression and suppression

No losses of expression or loss of gene suppression seen over 3 years of study with 2,256 GM poplars

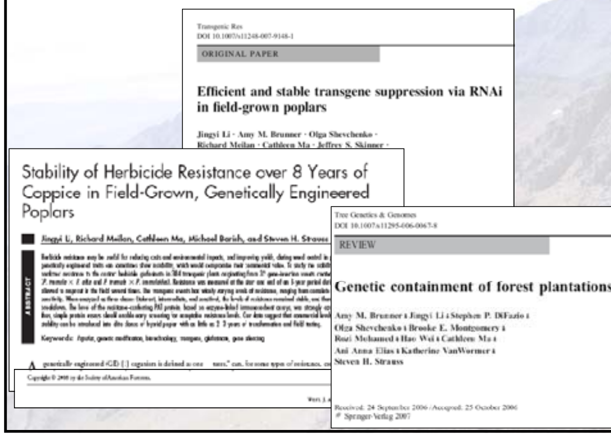
Strauss, Oregon, USA



Aerial photo of four blocks, clones in sub-blocks

Second growing season

Peer-reviewed, published papers


Transgenic Res
DOI 10.1007/s11248-007-9148-1

ORIGINAL PAPER

Efficient and stable transgene suppression via RNAi in field-grown poplars

Jingyi Li · Amy M. Brunner · Olga Shevchenko · Richard Meilan · Cathleen Ma · Jeffrey S. Skinner ·

Stability of Herbicide Resistance over 8 Years of Coppice in Field-Grown, Genetically Engineered Poplars

Jingyi Li, Richard Meilan, Cathleen Ma, Michael Barish, and Steven H. Strauss

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Tree Genetics & Genomes
DOI 10.1007/s11295-006-0067-8

REVIEW

Genetic containment of forest plantations

Amy M. Brunner · Jingyi Li · Stephen P. DiFazio · Olga Shevchenko · Brooke E. Montgomery · Rozi Mohamed · Hao Wei · Cathleen Ma · Ani Anna Elias · Katherine VanWormer · Steven H. Strauss

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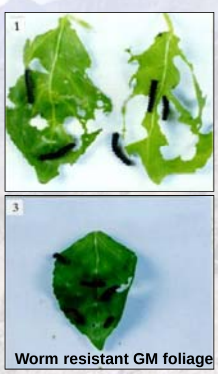
Rationale for GM poplar in China

- **<u>Insect tolerance</u> for very hard to control defoliators and borers**
  - **"Tree North" forest belt**
- **<u>Salt tolerance</u> for damaged agricultural land**
  - **Large area (70 mio hm)**
- **<u>Wood properties</u>**
  - **Pulp and paper demand**



Worm resistant GM foliage

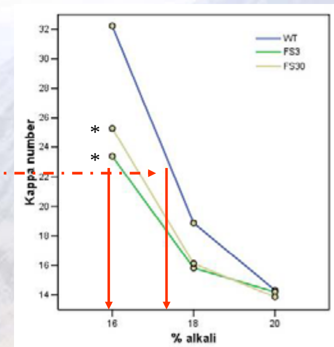
Research plantations of insect tolerant poplars in China

Field trial of lignin-modified poplar

Orléans, France (4-year-old)

4 lines + WT; 5 blocks; 2 plants/line/block = 10 plants per line

Pulping lignin-modified poplars = potential chemical savings

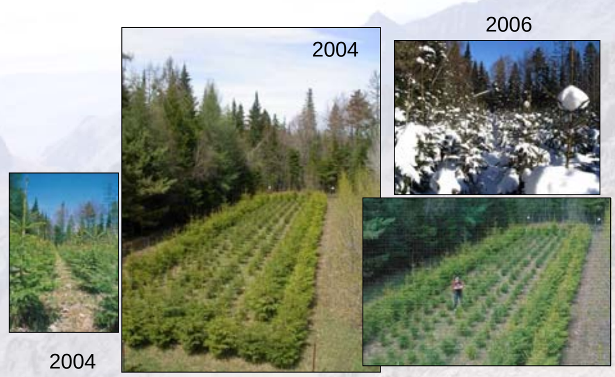


Armand Séguin
Centre de foresterie des Laurentides
CANADA

Ressources naturelles Canada | Natural Resources Canada
Service canadien des forêts | Canadian Forest Service

Biosafety studies of GM poplar and spruce

GM spruce field trial



Abiotic stress tolerance screening of GM Eucalypts - Univ. of Tsukuba, Japan

M. Watanabe, Tsukuba

Fighting an exotic tree disease with gene suppression

Plum Pox Virus (PPV)

Ralph Scorza
USDA-ARS
Appalachian Fruit Research Station
Kearneysville, West Virginia
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Enhanced phytoremediation using GM trees

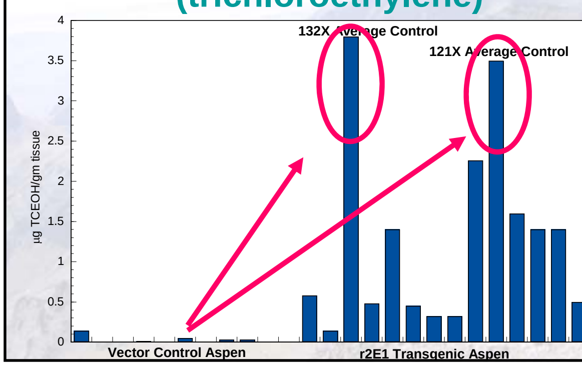
Plant based removal of environmental toxins

Prof. Sharon L. Doty

College of Forest Resources,
University of Washington, USA

UNIVERSITY OF WASHINGTON

GM poplar have much more rapid breakdown of TCE (trichloroethylene)



American Chestnut & Elm Research & Restoration

W.A. Powell, S.A. Merkle, and C.A. Maynard

College of Environmental Science & Forestry
State University of New York
Syracuse, NY

University of Georgia
Athens, GA

Many exotic diseases have ravaged North American forests

Examples

- 1892 - White pine blister rust
- 1904 - Chestnut blight
- 1923 - Port-Orford-cedar root disease
- 1920s - Beech scale complex
- 1930 - Dutch elm disease
- 1967 - Butternut canker
- 1976 - Dogwood anthracnose
- 2000s - Sudden oak death

American elm

American chestnut in the Great Smokey Mountains of North Carolina, c. 1900

Loss of the American elm – a highly valued street tree

Provides urban shade, climate mitigation, wildlife habitat

Before blight

The same street after blight

Field trials of GM American Elm underway

Planted June 2006

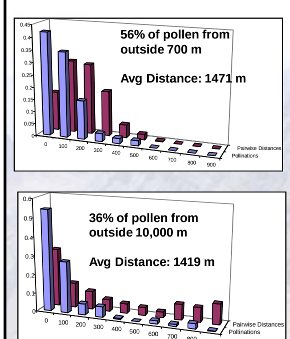
Field research essential for science, value and safety studies

- Physiology and ecology of plants differs greatly between lab/greenhouse and field environments
  - Greater intensity and diversity of stresses and diseases/insects in the field
- Trees interact strongly with environment over many years, thus of particular importance
  - Many cases where promising laboratory results did not hold up in the field
- Breeders depend on many field trials on many sites, over many years, for progress
  - GM no different in this basic requirement for progress

Key biosafety, ethical, and regulatory issues for GE trees

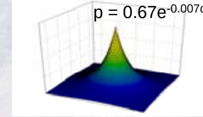
- Gene flow from plantation to wild lands and species
  - Long distance, pollen and often seed
    - Ethical issue, especially for native species
  - Science: Very difficult to predict all possible consequences, and irreversible
- Trees as keystone species, support a lot of other organisms
  - Are more or less fit trees the goal or the fear?
  - Can GE traits affect fitness enough to be a significant concern?
  - Will new toxins put into trees to increase their pest resistance or stress tolerance harm biodiversity or help it?
- Current regulatory environment: Guilty until proven innocent

Long-distance gene flow by pollen



Probability Density Function

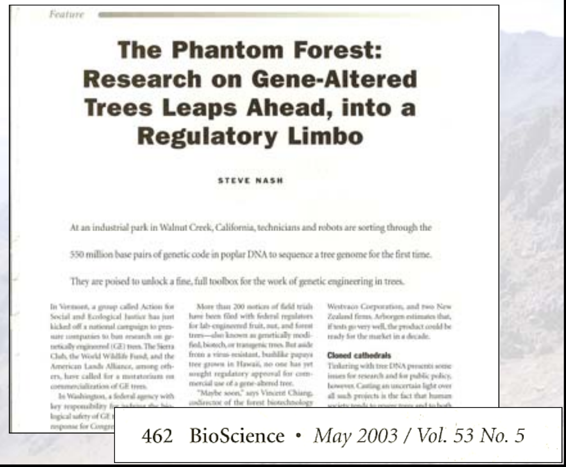
$p = 0.67e^{-0.007d}$



◆ **Long-distance gene flow prevalent**

Discussion questions

- Should outdoor plantings be allowed?
- Should any gene flow to wild species be allowed?
- What should research priorities be?



Feature

The Phantom Forest: Research on Gene-Altered Trees Leaps Ahead, into a Regulatory Limbo

STEVE NASH

At an industrial park in Walnut Creek, California, technicians and robots are sorting through the 550 million base pairs of genetic code in poplar DNA to sequence a tree genome for the first time. They are poised to unlock a fine, full toolbox for the work of genetic engineering in trees.

In Vermont, a group called Action for Social and Ecological Justice has just kicked off a national campaign to pressure companies to ban research on genetically engineered (GE) trees. The Sierra Club, the World Wildlife Fund, and the American Lands Alliance, among others, have called for a moratorium on commercialization of GE trees.

In Washington, a federal agency with key responsibility ... logical safety of GE ... response for Congr...

More than 200 notices of field trials have been filed with federal regulators for lab-engineered fruit, nut, and forest trees—also known as genetically modified, biotech, or transgenic trees. But aside from a virus-resistant, bushlike papaya tree grown in Hawaii, no one has yet sought regulatory approval for commercial use of a gene-altered tree.

"Maybe soon," says Vincent Chiang, codirector of the forest biotechnology

Westvaco Corporation, and two New Zealand firms. Arborgen estimates that, if tests go very well, the product could be ready for the market in a decade.

Cloned cathedrals

Tinkering with tree DNA presents some issues for research and for public policy, however. Casting an uncertain light over all such projects is the fact that human

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