The prospects and reality of GM crops in Russia

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Legal acts of Russian Federation in the area of GM crops regulations

- the Technical regulations of the Customs Union
- Federal law № 86-FZ "State regulation in the field of genetic engineering" from 5 July 1996
- Federal law № 2300-1 "Protection of consumer rights" from 7 February 1992
- Federal law № 7-FZ "Environmental protection" from 10 January 2002

Legal acts of Russian Federation in the area of GM crops regulations

Governmental order of the Russian Federation of 23 September 2013 № 839 "On state registration of genetically modified organisms intended for release into the environment and products obtained using such organisms or containing such organisms"

The entry into force of the Governmental order of the Russian Federation of 23 September 2013 № 839 from 1 July 2017. (Decree of the RF Government of 16 June 2014 No. 548)Мораторий

The international regulatory framework

1

- The Russian Federation ratified only the Convention on biological diversity

2

- Cartagena Protocol, the Aarhus Convention and the Nagoya Protocol has not been ratified

The prospects of the Russian system of regulation of GM crops

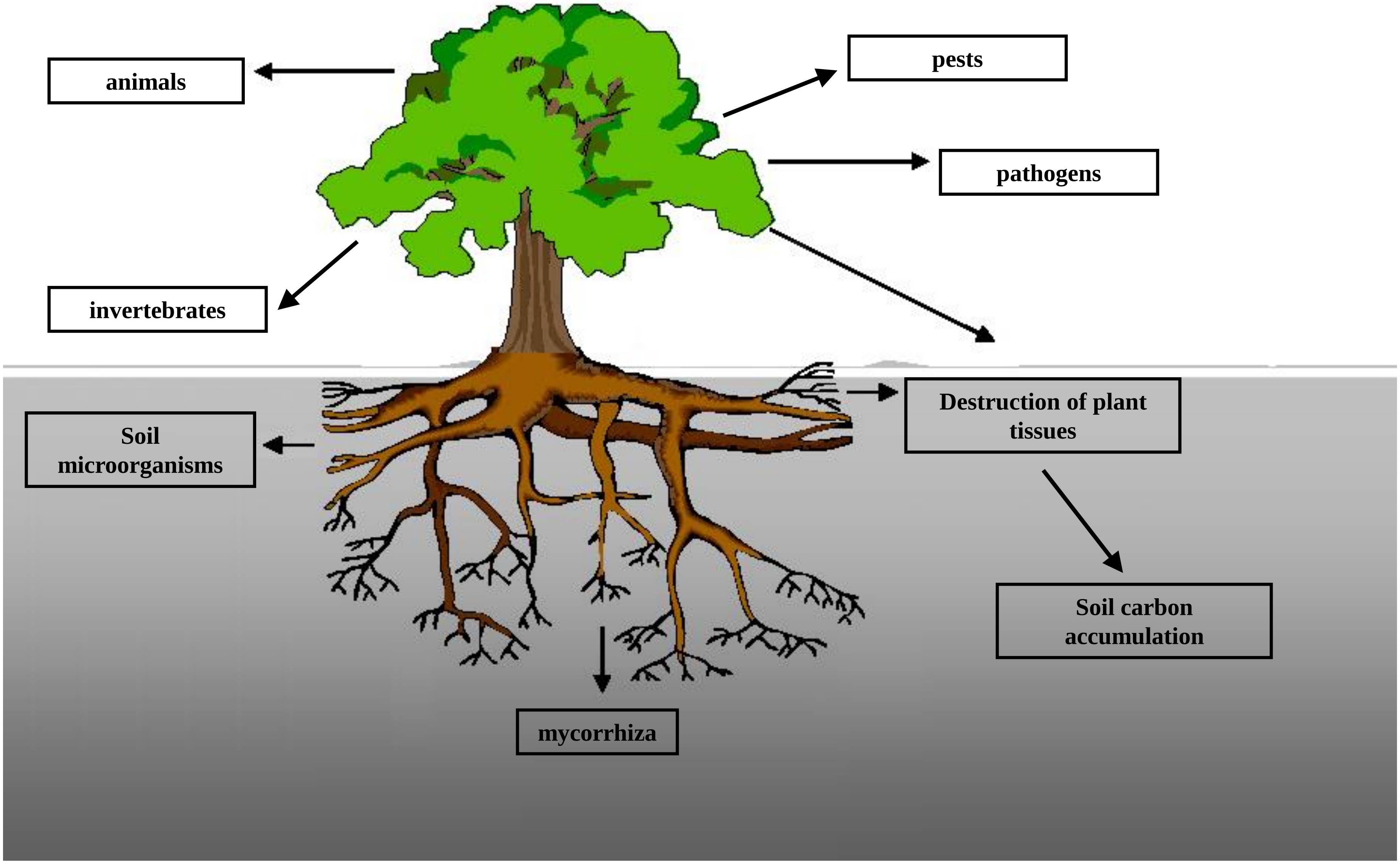
1

- The ratification of the Cartagena Protocol and harmonization with the international legal framework

2

- The creation of a system of Biosafety in the framework of the Customs Union

Possible effects of transgenic trees on the environment



Forest plantations in the world

5-7% of the forest area

25-35% of global wood production

30-40 m^3/h/year (deciduous)

10-15 m3/h/year (conifers)

Transgenic poplar with Bt-toxin (China)

- Produced at 2003
- The first country approved commercial usage of GM trees is China.
- It was transgenic poplar with Bt-toxin. First plantation was established at 2008.

GM trees approved for commercialization (ISAAA GM Approval Database)

Tree	GM Events	Countries
Poplar	2	China
Apple	2	Canada, USA
Eucalyptus	1	Brazil
Papaya	4	Canada, China, Japan, USA
Plum	1	USA
--	0	Russia

GM trees properties:

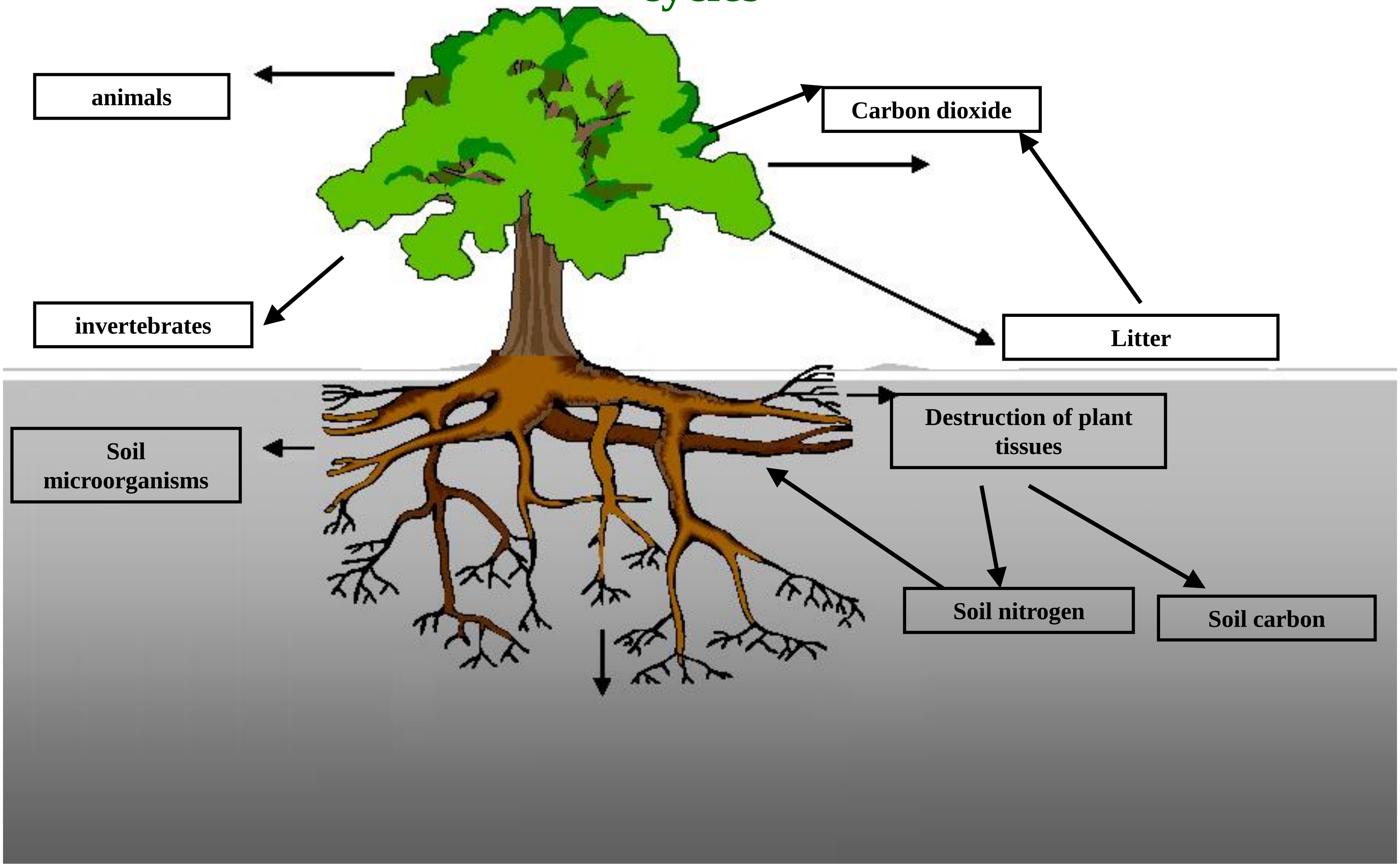
1 – Herbicides resistance

2 – Resistance against pests and diseases

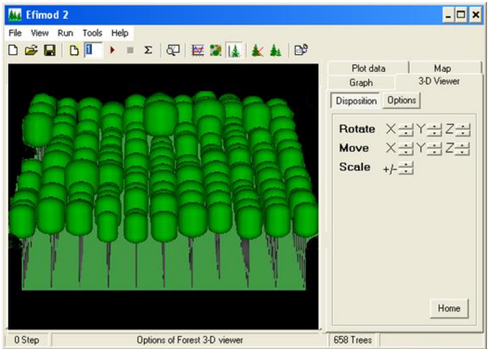
3 – Improved growth rate

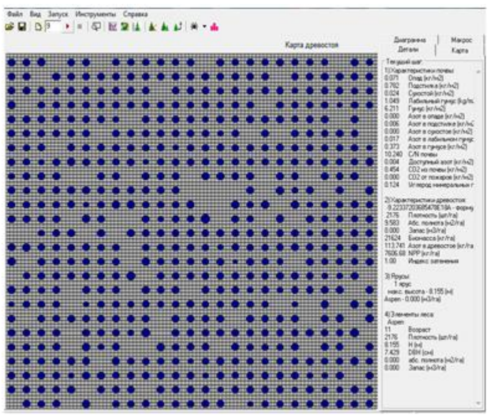
4 - Decreased/modified lignin content

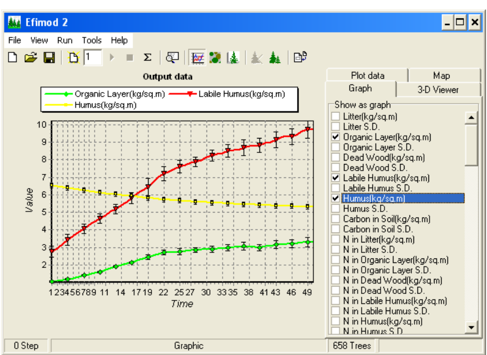
Possible effects of transgenic trees on carbon and nitrogen cycles



EFIMOD-fbp: input and output data, application







- **EFIMOD-fbp** – version of the system models of forest growth and biological cycle of carbon and nitrogen EFIMOD (Komarov et al., 2003).

- **Required input data:**
  1) The number of trees per hectare, age, the amount of the cross-section areas, timber, average height, etc.
  2) Contents (inventory) of organic matter and nitrogen in forest litter and mineral soil horizons.
  3) Time series of air temperature and precipitation, temperature and humidity of the soil and forest litter.
  4) Nitrogen input from external sources (fertilisers and atmospheric deposition).

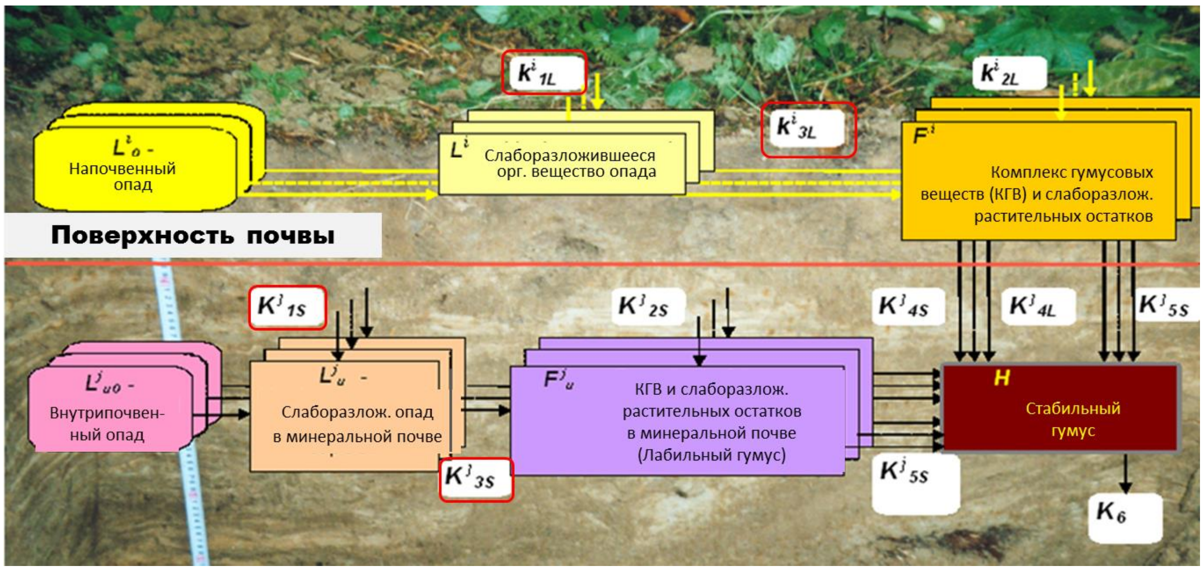
- **Output parameters:**
  1) The average diameter and height, the amount of the cross-section areas, timber reserves, the number of trees per hectare.
  2) Biomass, carbon and nitrogen in each tree.
  3) The amount of carbon and nitrogen of the soil, including woody debris (dead trees and deadfall).

- Simulation step to stand - 1 year for soil - 1 month.

- **Simulated forest management activities:**
  The application of fertilizers.
  Thinning

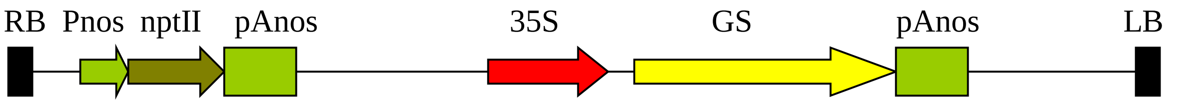
ROMUL-fbp: input and output data, application

- **ROMUL-fbp** - version of the soil model ROMUL (Chertov et al., 2001), developed for describing the dynamics of organic matter and nitrogen in soils of forest plantations and taking into account the specificity of plant debris formed under biotechnological forms of trees (increased nitrogen and cellulose, lower lignin content).



- **Input data**:
  - Biomass and nitrogen content in different cohorts of litter (leaves, branches, roots).
  - The stock of organic matter and nitrogen in organic and mineral horizons. The temperature and humidity of the soil and forest litter. Nitrogen input from atmospheric deposition.
- **Output data**:
  - The amount of carbon and nitrogen in different fractions of forest litter and mineral soil horizons.

Transgenic plants with modified nitrogen metabolism

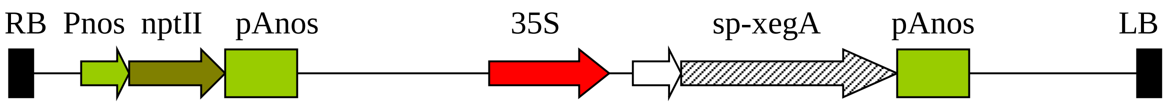


T-DNA with glutamine synthetase gene GS from *Pinus sylvestris*

Species	Line
Aspen	Wild-type
	6(8)
	8(1)
Birch	Wild-type
	8b
	9b

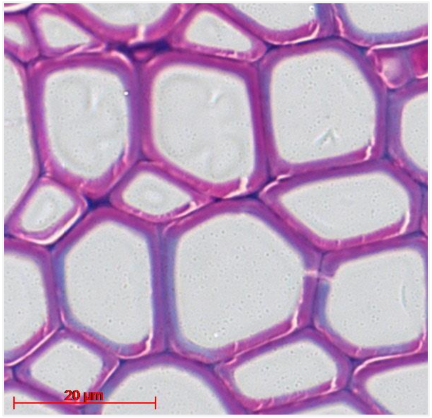
GS-trees Wild-type

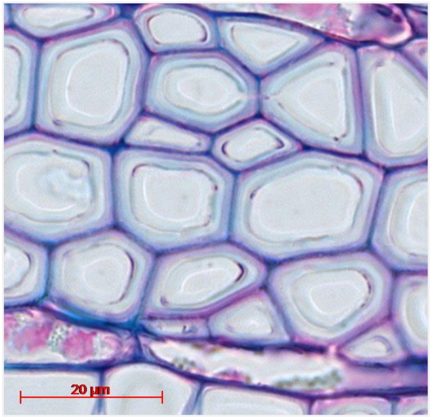
Transgenic plants with modified wood, harboring xylogluconase gene sp-xegA



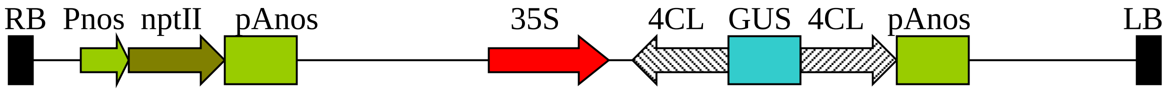
T-DNA with recombinant gene sp-xegA coding xylogluconase from Penicillium canescenes with signal peptyde from Populus alba

Species	Line
Aspen	Wild-type
	X1b
	X3b





Transgenic plants with decreased lignin content



T-DNA with inverted repeats of 4CL gene fragment from P. tomentosa (RNA interference construct) under 35S promoter

Species	Line
Aspen	Wild-type
	C2c
	C4a

Plant tissue decomposition experiments

Leaves
Stems
Roots

The mass loss

300 mg + 50 g
tissue sand

T = 22°C
H = 80, 50, 20%

0.5, 1, 2, 3.5, 5, 7,
9, 12-th month

CO_2 emission

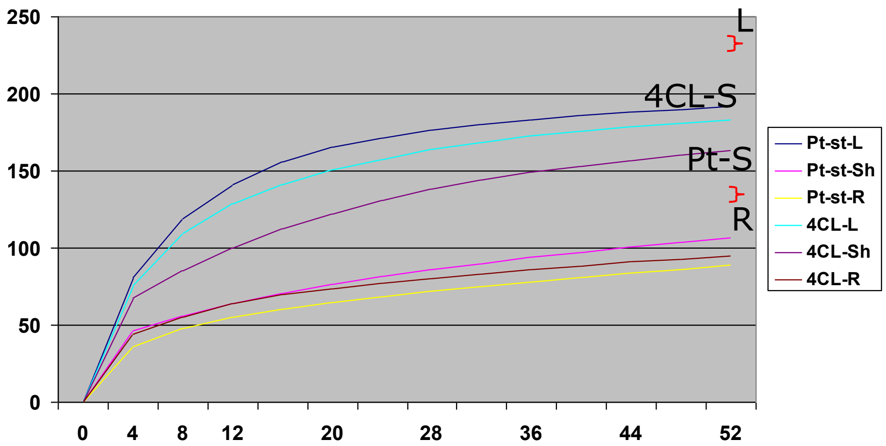
100 mg + 2 g
tissue sand

T = 22, 12, 2°C
H = 80, 50, 20%

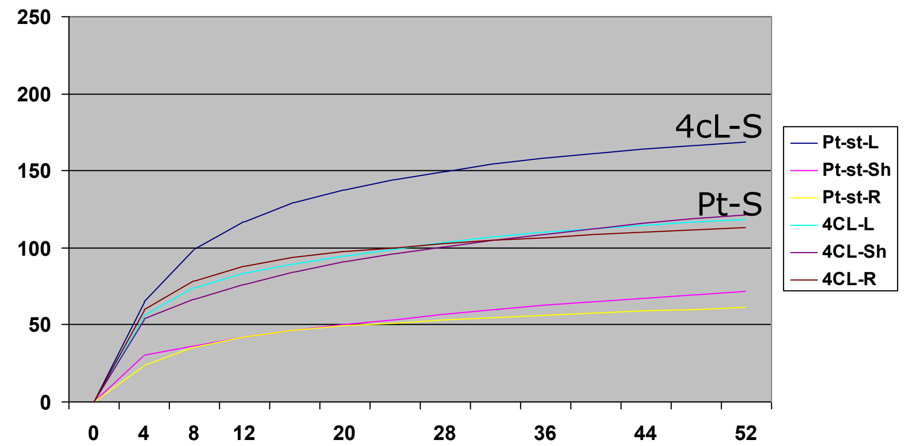
21 samples during
365 days

Effect of temperature on cumulative CO_2 emission - plant residues of transgenic aspen with decreased lignin content (μg C-CO_2/g plant tissue)

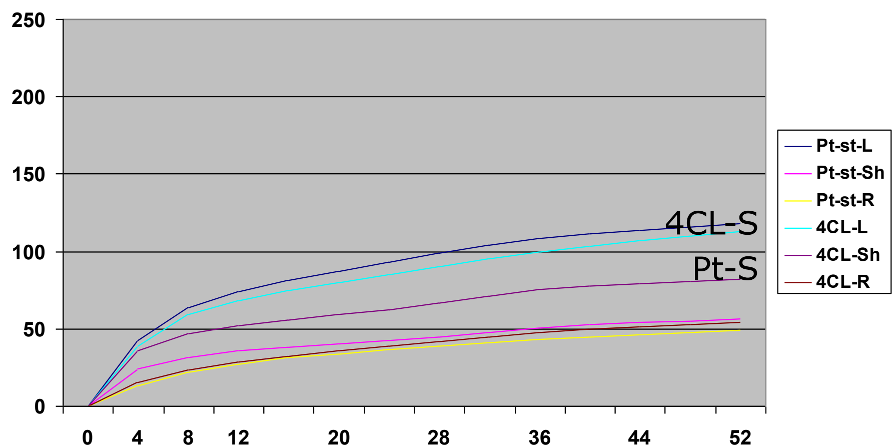
22°C



12°C

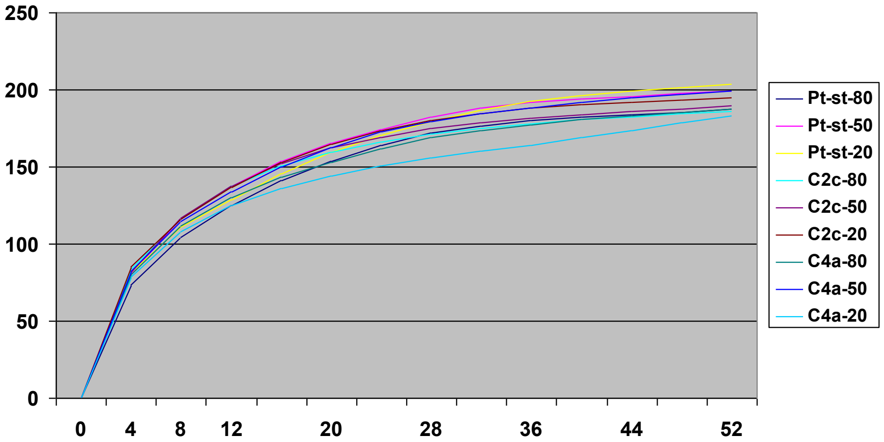


2°C

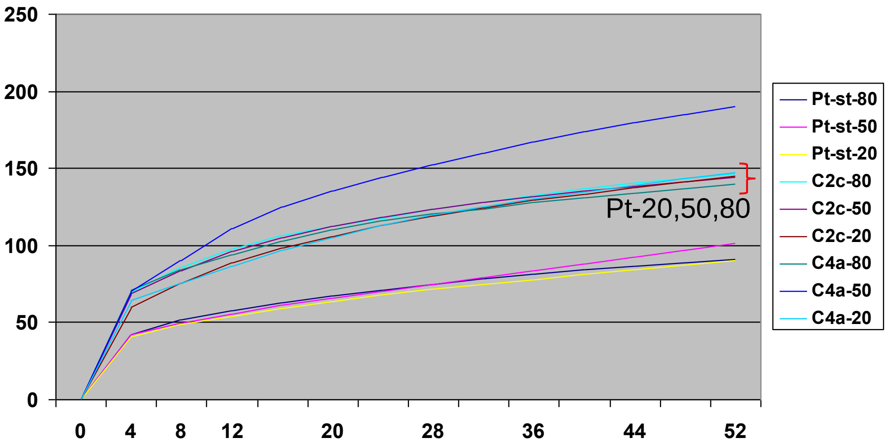


Effect of moisture on cumulative CO_2 emission – plant residues of transgenic aspen with decreased lignin content (μg C-CO_2/g plant tissue)

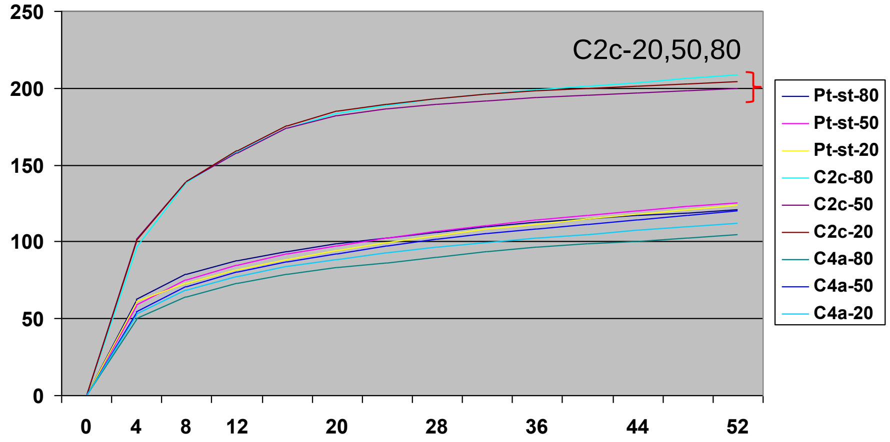
leaves



stems

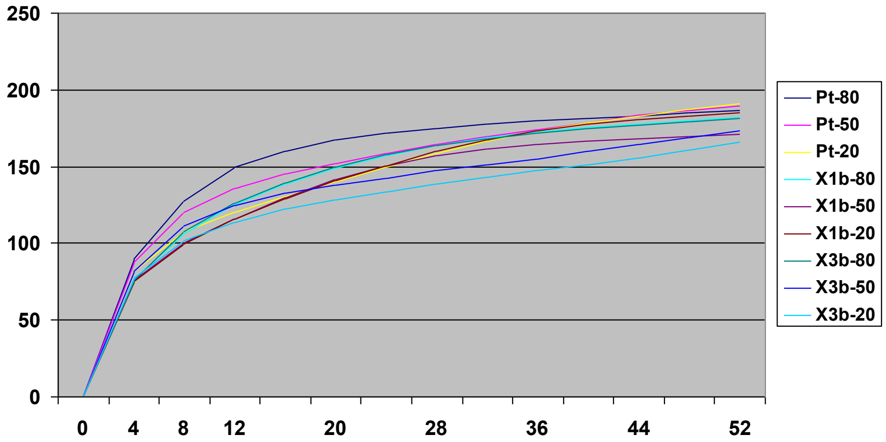


roots

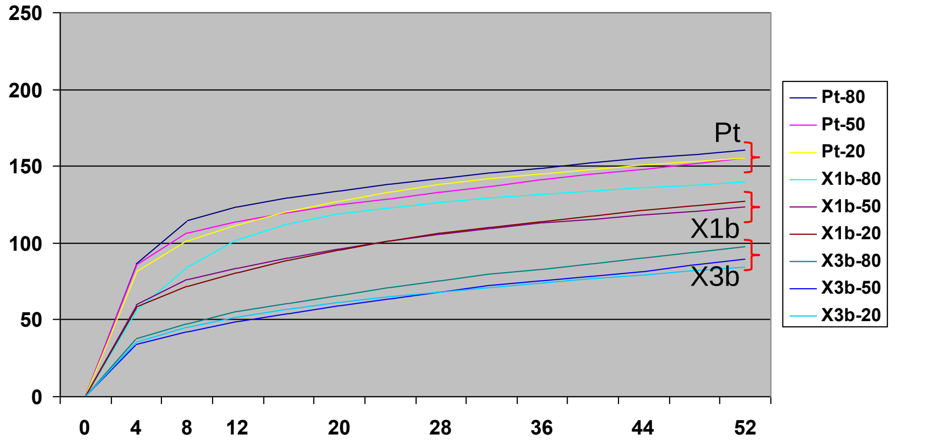


Effect of moisture on cumulative CO_2 emission – transgenic aspen with modified wood, harboring xyloglucanase Xeg gene (µg C-CO_2/g plant tissue)

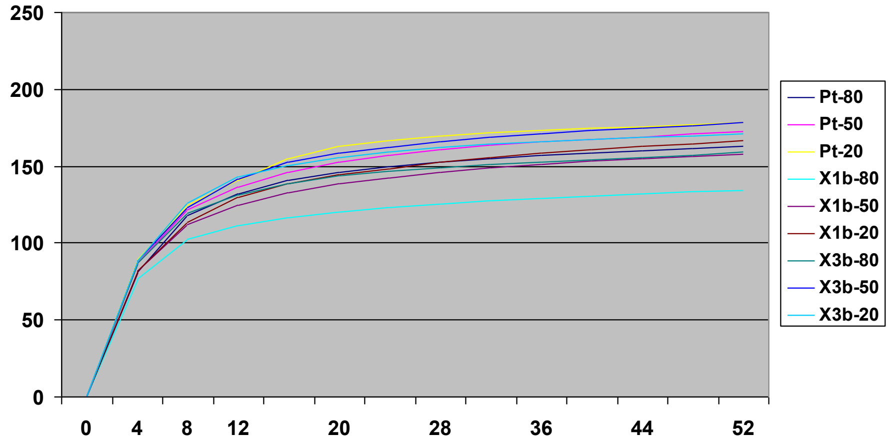
leaves



stems



roots

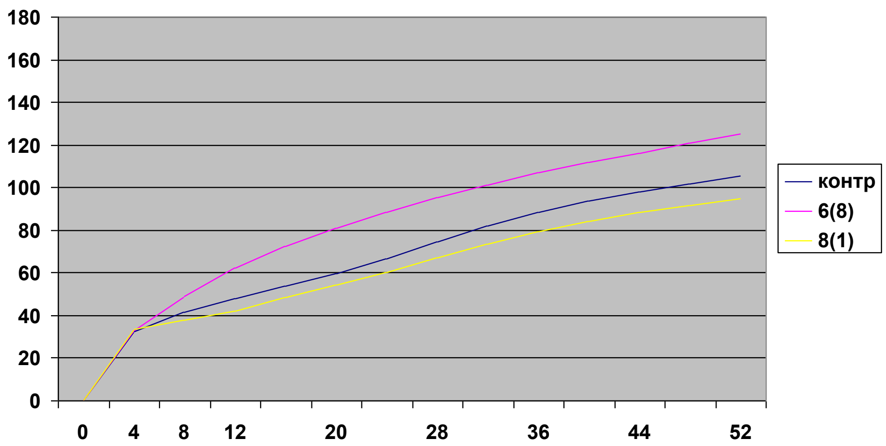


Nitrogen and carbon content in stems of aspen and birch plants with modified nitrogen metabolism

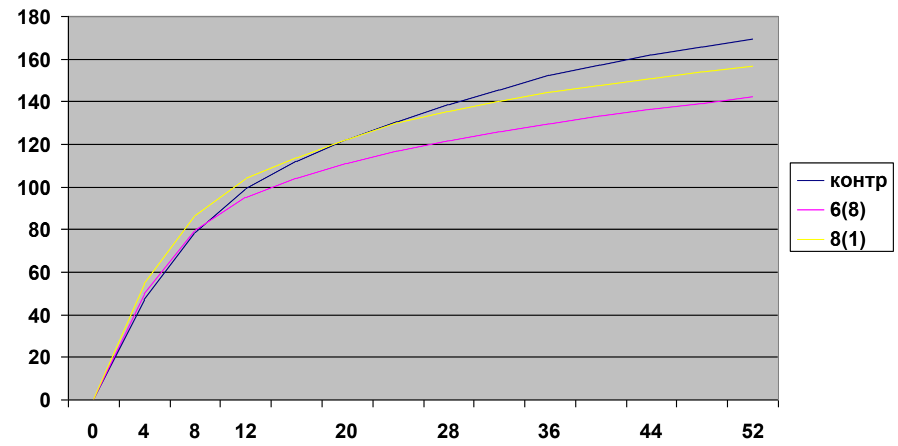
Species	Lines	N, %	C, %	N:C
Aspen	Wild-type	0,98	48,1	1:49
	6(8)	0,99	44,6	1:45
	8(1)	1,09	48,1	1:44
Birch	Wild-type	0,93	48,6	1:52
	8b	1,16	49,1	1:42
	9b	1,39	49,8	1:36

Cumulative CO_2 emission during decomposition of stem residues of transgenic aspen with modified nitrogen metabolism (µg C-CO_2/g plant tissue)

80% WHC



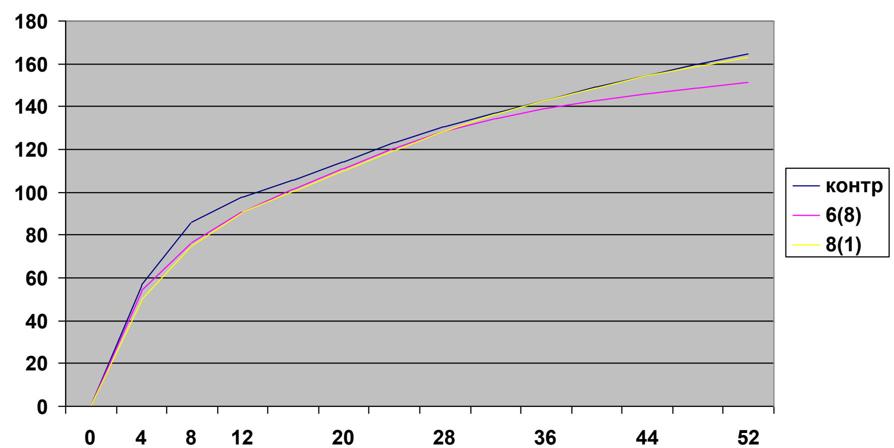
50% WHC



WHC -

water holding

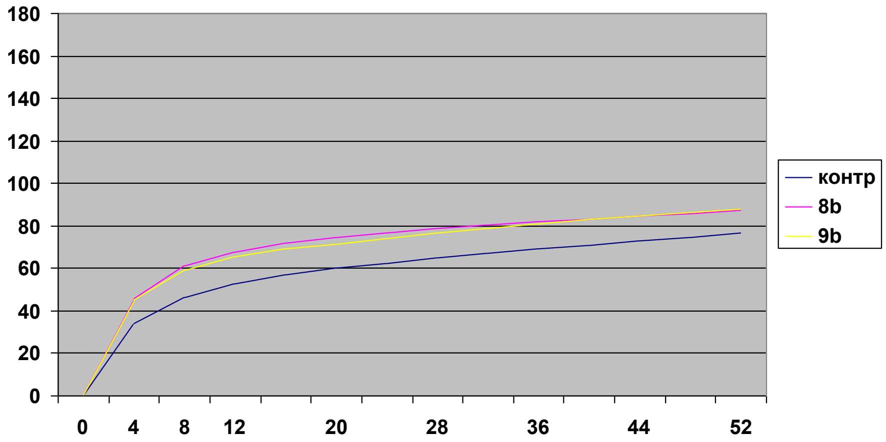
capacity



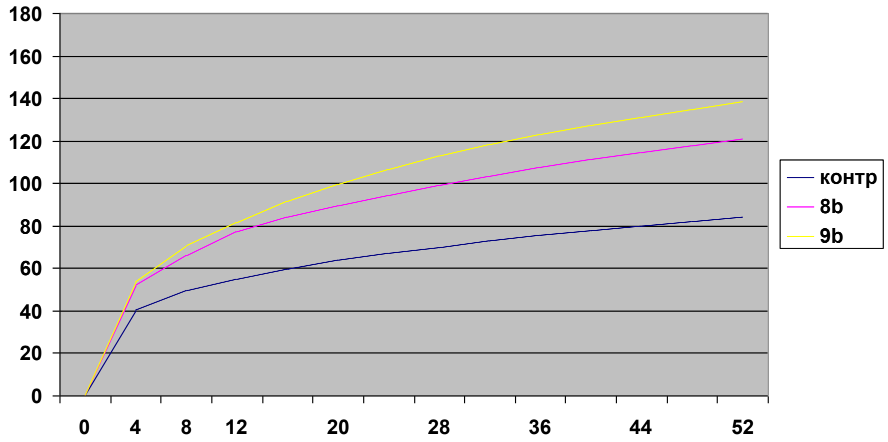
% WHC

Cumulative CO_2 emission during decomposition of stem residues of transgenic birch with modified nitrogen metabolism (µg C-CO_2/g plant tissue)

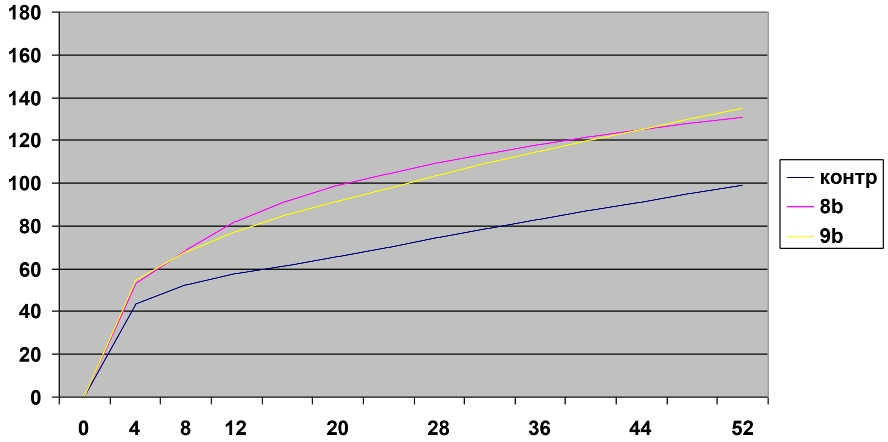
80% WHC



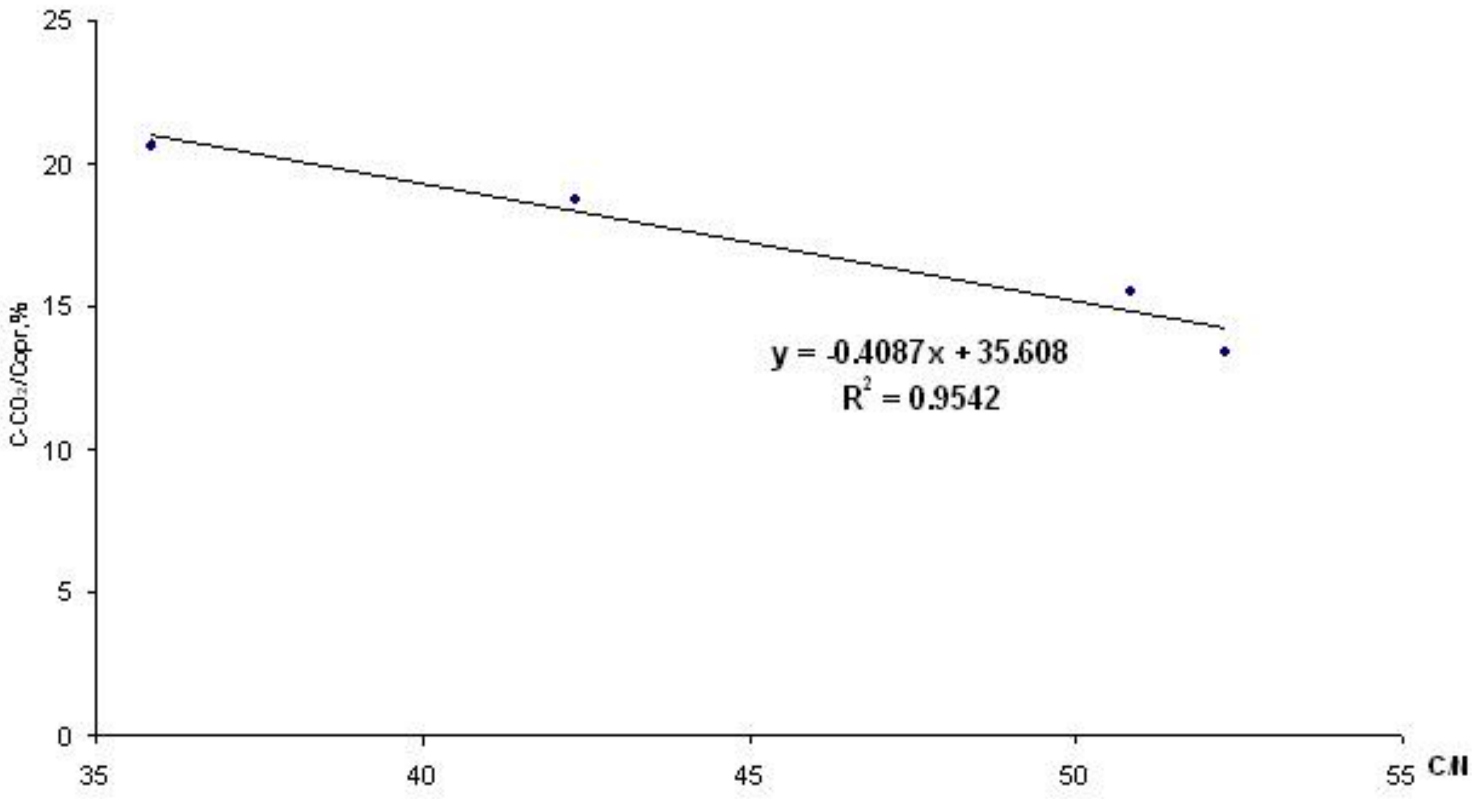
50% WHC



20% WHC



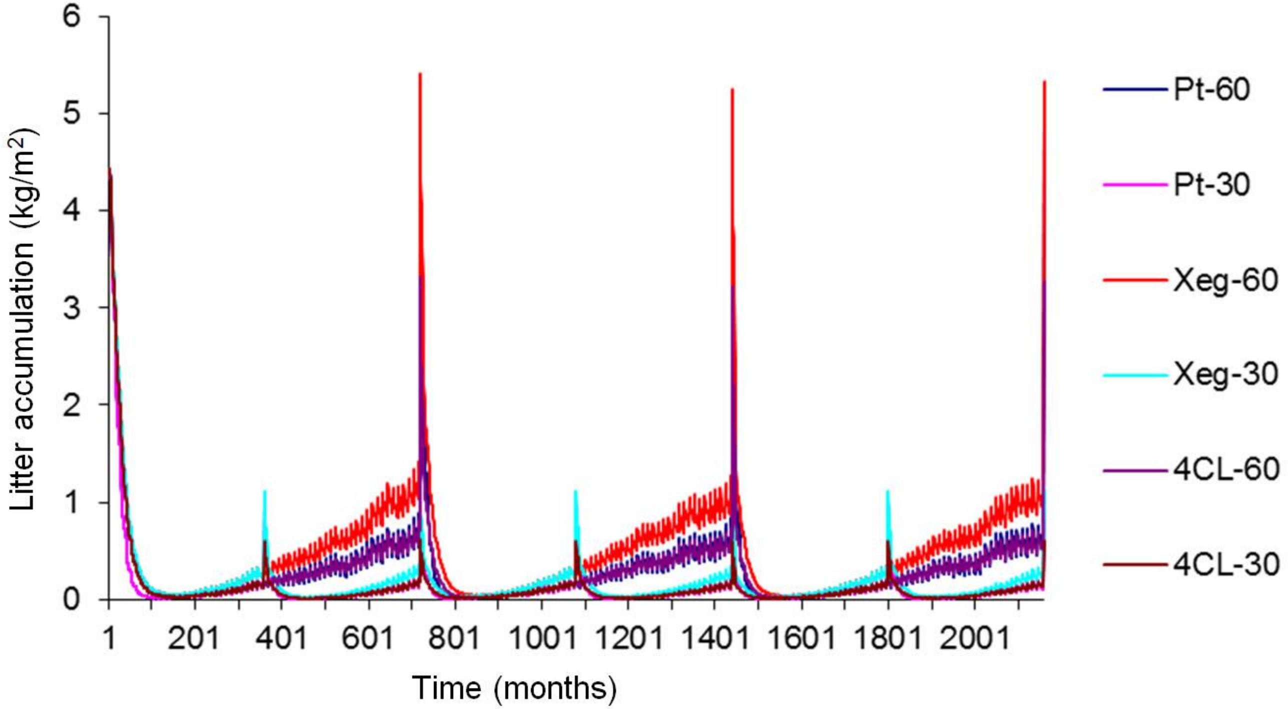
Correlation between C/N ratio and the Rate of decomposition of stem residues from transgenic birch with modified nitrogen metabolism



Organ biomass portion in whole plant of transgenic aspen

Plant	Organ biomass portion in whole plant		
	leaves	stems	roots
Wild-type	0.43	0.37	0.21
Xeg	0.35	0.45	0.20
4CL	0.52	0.34	0.14

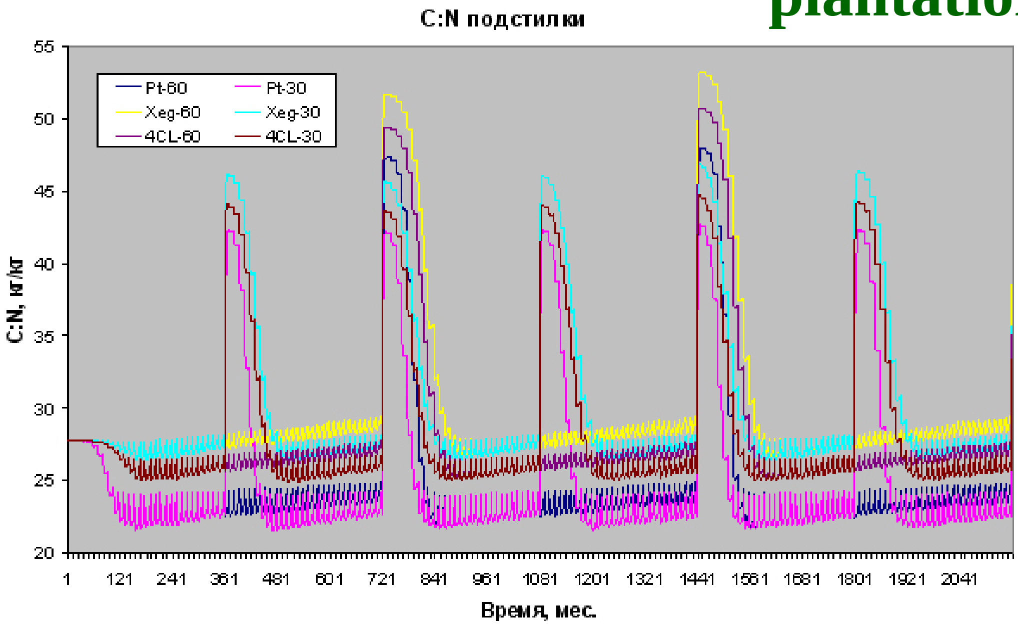
Mathematical model of the litter accumulation in the forest plantations from transgenic (with 4CL or Xeg modification) or wild type aspen.



Lines Pt-60, Xeg-60, 4Cl-60 are the litter accumulation in wild type, PtXeg1b, Pt4CL2c aspen plantations at 60-year rotation, respectively.

Lines Pt-30, Xeg-30, 4Cl-30 are the litter accumulation in wild type, PtXeg1b, Pt4CL2c aspen plantations at 30-year rotation, respectively.

Mathematic model of C/N ratio of forest litter in transgenic plantation

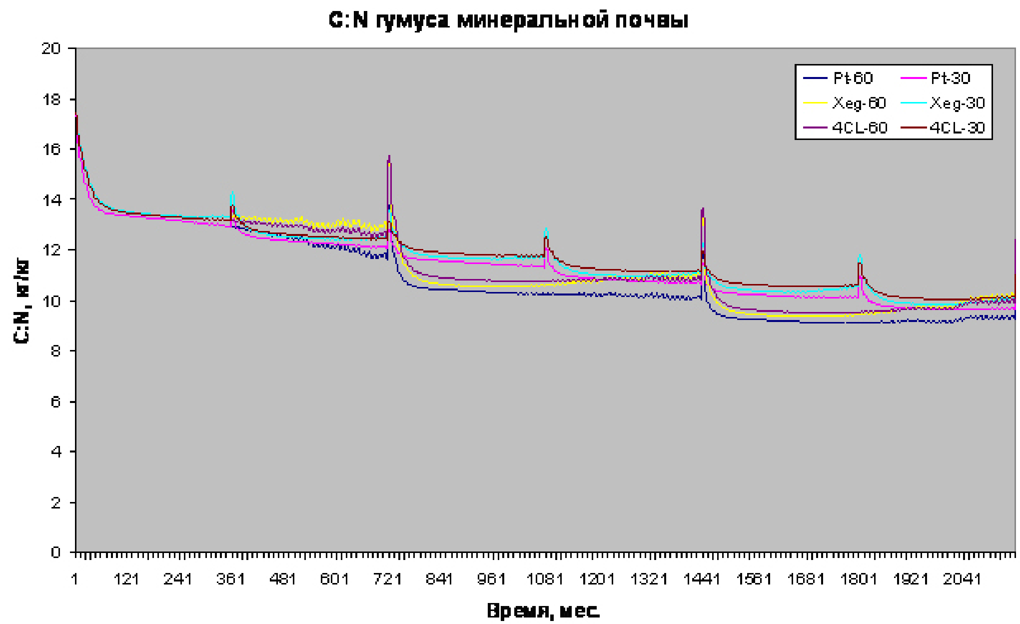


Pt – wild-type aspen

Xeg – transgenic aspen with xylogluconase Xeg gene

4CL – transgenic aspen with 4CL construct

30 and 60-year rotation



European Journal of Forest Research

New procedure for the simulation of belowground competition can improve the performance of forest simulation models

Shanin et al., submitted in April 2015

CONCLUSIONS

1. There are two main ways of national biosafety system development. The first is the ratification of the Cartagena Protocol and harmonization with the international legal framework. The second is the creation of a Biosafety system in the framework of the Customs Union.

2. GM trees have potential value for forest plantations , however possible effects on environment are least studied.

3. It is experimentally shown that genotypes differ by the following characteristics of importance to the ecosystem level, changing habitat conditions:

a) there are differences in the rates of conversion of organic matter in organic and mineral soil horizons, due to differences in the content of lignin and cellulose, as well as the nitrogen content;

b) it is shown that transgenic plants change productivity, which leads to changes in the biological cycle;

c) changes in the redistribution of increments found in organs of plants, which also leads to changes in the biological cycle.

4. To eliminate possible negative effects of transgenic plantations it is need to develop special program of attendance and exploitation, for example soil fertilization.

Acknowledgements

This work is supported by the Ministry of Education and Science of The Russian Federation (Project № 14.616.21.0013 from 17.09.2014).

Branch of Shemyakin and Ovchinnikov Institute of Bioorganic Chemistry RAS

Vadim Lebedev,
Mikhail Filippov,
Juliy Kovalitskaya,
Vitaliy Nemashkalov,
Elena Vidjagina,
Slava Faskhiev,

Konstantin Shestibratov

Institute of Physicochemical and Biological Problems of Soil Science RAS

Alla Larionova,
Sergey Bykhovets,
Vladimir Shanin,

Irina Priputina

THANK YOU FOR ATTENTION!