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FEM growth and yield data – Poplar roadside plantations - tree level.csv FEM growth and yield data – Poplar roadside plantations - plot level.csv

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Key words

Growth and yield, Roadside plantation, Line plantation, Tree diameter in row, Tree diameter (perpendicular) on row, Growing space, Variation in systematically thinning, Variation in initial spacing, Tree height, Distance dependent tree data, Populus x candensis, Netherlands

Historical overview

The growth and yield research on poplar roadside and other line plantation was initiated by prof. dr. J.H. Becking in 1951. The project was part of a much larger series of growth and yield trials in the Netherlands with about 400 plots.

During almost five decades the project was supervised by A. van Laar, P.G. de Vries, J.H. Hildebrand and H.H. Bartelink. The project stopped after measuring the last remaining stands in 1997. Two articles were published using this data:

- <u>Vries</u>, P.G. de, 1962. Een onderzoek naar de invloed van de boomafstand op de massaproduktie en op de vorm van de stamdoorsnede bij eenrijge populierenbeplantingen. Nederlands Bosbouwtijdschrift 34, 238-248.
- Jansen, J.J., 1990. Diameterbijgroei en boomafstand bij lijnvormige beplantingen van populier. In: P. Schmidt (red.), De Populier - Verslag Studiekring 1990 Koninklijke Nederlandse Bosbouw Vereniging, Nederlands Bosbouwtijdschrift 62, 231-235.

Brief characteristics

<u>Species</u>: Populus x canadensis 'Forndorf', P. x canadensis 'Gelrica', P. x canadensis 'Heidemij', P. x canadensis 'Marilandica', P. x canadensis 'Robusta' and P. x canadensis 'Serotina'

Location: Netherlands in the South (3 sub-regions Zuid Limburg, de Kempen, Midden Brabant/Noord Limburg), Central (2 sub-regions Achterhoek, Rivierenland) and North (1 sub-region, Noordoostpolder)

Number of plots: 34

Number of recordings: 305 Number of trees: 2517 Number of tree measurements: 20988

Explanation of variables and labels

See the info in the tables 1, 2 and 3.

Some variables are calculated, whether a certain value of a variable is measured or calculated is given with a separate variable. Other variables are complete measured or complete calculated. The way of calculation is given in the next paragraph.

			Measurement	Write
Variable	Position	Label	Level	Format
plotnr	1	Plot number	Scale	F3
plotcode	2	Plot code	Nominal	A6
name	3	Plot name	Nominal	A30
region	4	region	Nominal	F1
subregion	5	sub-region	Ordinal	F1
yog	6	year of sprouting	Scale	F4
уор	7	year of planting	Scale	F4
Length	8	plot length in m	Scale	F6.1
NO	9	initial number of stems per km	Scale	F4
spacing	10	initial spacing in m	Scale	F4.1
nrec	11	number of recordings	Scale	F2
tree	12	tree number	Scale	F3
tree_old	13	tree number in field book	Scale	F3
var	14	polar cultivar	Nominal	F1
х	15	x coordinate in m	Scale	F5.1
rec	16	record number	Nominal	F4
space	17	growing space in m	Scale	F4.1
DOR	18	date of recording	Scale	DATE11
age	19	age	Scale	F4.1
d_ir	20	diameter in row in cm	Scale	F3.1
d_or	21	diameter on row in cm	Scale	F3.1
h	22	height in m	Scale	F3.1
g	23	tree basal area in m2	Scale	F5.2
v	24	tree volume in m3	Scale	F5.3
ch	25	Measurement code for height	Nominal	A1
cd	26	Measurement code for diameter	Nominal	A1
md	27	Felling code for tree	Nominal	A1

Table 1. Variable Information in 'FEM growth and yield data - Roadside plantations - tree level.csv'

			Measurement	Write
Variable	Position	Label	Level	Format
plotnr	1	Plot number	Scale	F3
plotcode	2	Plot code	Nominal	A6
plotname	3	Plot name	Nominal	A30
nrec	4	Number of recordings	Scale	F2
region	5	Region	Nominal	F1
subregion	6	Sub-region	Nominal	F1
var	7	main poplar cultivar	Nominal	F1
length	8	Plot length in m	Scale	F6.1
NO	9	Initial number of trees per km	Scale	F4
spacing	10	Initial spacing in m	Scale	F4.1
yog	11	Year of germination/sprouting	Scale	F4
уор	12	Year of planting	Scale	F4
rec	13	record number	Scale	F3
DOR	14	Date of recording	Scale	DATE11
age	15	Age in yr	Scale	F4.1
hm	16	Mean height in m	Scale	F4.1
N_bt	17	Plot number of trees per km before thinning	Scale	F6
G_bt	18	Plot basal area before thinning in m2/km	Scale	F5.2
dg_bt	19	Diameter of mean basal area tree in cm before thinning	Scale	F4.2
V_bt	20	Plot volume before thinning in m3/km	Scale	F5
N_th	21	Plot number of trees per km of thinning	Scale	F6
G_th	22	Plot basal area of thinning in m2/km	Scale	F5.2
dg_th	23	Diameter of mean basal area tree in cm of thinning	Scale	F4.2
V_th	24	Plot volume of thinning in m3/km	Scale	F5
N_at	25	Plot number of trees per km after thinning	Scale	F6
G_at	26	Plot basal area after thinning in m2/km	Scale	F5.2
dg_at	27	Diameter of mean basal area tree in cm after thinning	Scale	F4.2
V_at	28	Plot volume after thinning in m3/km	Scale	F5

Table 2. Variable Information in 'FEM growth and yield data - Roadside plantations - plot level.csv'

Variable	File	Value	Label
region	tree level & plot level	1	North
		2	Middle
		3	South
subregion	tree level & plot level	1	Noordoostpolder
		2	Rivierengebied
		3	Achterhoek
		4	Midden-Limburg
		5	Zuid Limburg
		6	de Kempen
var tree level & plot level 0 unknown		unknown	
		1	Populus x canadensis 'Gelrica'
		2	Populus x canadensis 'Heidemij'
		3	Populus x canadensis 'Forndorf'
		4	Populus x canadensis 'Robusta'
		5	Populus x canadensis 'Serotina'
		6	Populus x canadensis 'Marilandica'
ch	tree level		measured value
		*	estimated value
cd	tree level	evel diameters measured	
		*	diameters estimated
		g	girth measured, diameters
			estimated
md	tree level		not felled
		F	felled after this recording

Table 3. Variable Values in both files

Calculated variables on tree level

Missing diameter and height measurements are estimated as follow:

For diameter in 2 steps.

Step 1. Estimating mean diameter for missing observations

$$\widehat{d}_{ij} = \overline{d_j} \cdot \sum_{j=1}^{m} \frac{d_{ij}}{m^* \cdot \overline{d_j}}$$
where $\overline{d_j} = \sum_{i=1}^{n^*} \frac{d_{ij}}{n^*}$

 m^* = number of measurements of d_{ij} at the i^{th} tree in *m* recordings (1)

 n^* = number of measurements of d_{ij} at the j^{th} recording for n trees

$$d_{ij} = \sqrt{dir_{ij} \cdot dor_{ij}}$$

Step2. Estimating diameter in row and on row

 $d\hat{o}r_{ij} = q_j \cdot \hat{d}_{ij}$ (missing values) and $d\hat{o}r_{ij} = q_j \cdot d_{ij}$ (for girth measurement) $d\hat{i}r_{ij} = \hat{d}_{ij} / q_j$ (missing values) and $d\hat{i}r_{ij} = d_{ij} / q_j$ (for girth measurement)

where
$$q_{j} = \sqrt{\frac{1}{m^{*}} \sum_{j=1}^{m^{*}} \frac{dor_{ij}}{dir_{ij}}}$$
 (2)

 m^* = number of measurements of d_{ij} at the i^{th} tree in *m* recordings

In the following table some quantitave figures are given about estimation and measurement of the diameters.

Table 4. diameter measurement	Frequency	Percent
diameters measured	20624	98.3
diameters estimated	53	.3
girth measured, diameters estimated	311	1.5
Total	20988	100.0

The <u>height</u> (*h*) is calculated with the following linear regression model:

$$h_{ij} = \sum_{j=1}^{m} a_j \cdot x_j + \sum_{i=1}^{n} b_i \cdot y_i + c \cdot d_{ij}$$
where $x_j = \begin{cases} 1 \text{ for } j^{th} \text{ recording} \\ 0 \text{ else} \end{cases}$

$$y_i = \begin{cases} 1 \text{ for } i^{th} \text{ tree} \\ 0 \text{ else} \end{cases}$$
(3)

The standard deviation for the model was 0.56 m.

For recordings without height measurements an interpolated value for *a* was calculated and missing values were calculated with:

$$\hat{h}_{ij} = \hat{a} + \hat{b}_i + \hat{c} \cdot d_{ij} \tag{4}$$

$$\hat{h}_{ij} = \hat{a} + \hat{b}_i + \hat{c} \cdot d_{ij}$$

In the following table some quantitave figures are given about estimation and measurement of the height.

Table 5. height measurement	Frequency	Percent
height measured	5478	26.1
height estimated	15510	73.9
Total	20988	100.0

The tree basal area was calculated with:

$$g_{ij} = \pi \cdot \frac{dir_{ij} \cdot dor_{ij}}{4}$$
(5)

The tree volume (over bark stem volume) was estimated with the volume table function:

$$v = e^{-3.0719171} \cdot dbh^{1.788649} \cdot h^{1.105970} \text{ with } dbh \text{ in cm, } h \text{ in m en } v \text{ in dm}^3$$
(6)

The tree volume was afterwards transformed to m³

The <u>age</u> was calcutated using the DOR (date of recoring) and the yog (year of germinating/sprouting) with

$$age = \begin{cases} year of recording - yog & \text{for } day \leq 92\\ year of recording + (1 - e^{-0.03111 \cdot (day - 91.25)})^{7.075} - yog & \text{for } day > 92\\ where day is the number of the day within a year (counting from 1 tot 365). \end{cases}$$
(7)

By thinning the <u>growing space</u> (variable 17 in table 1) can change from time to time. See the example in next Figure.



NOP 6 growing space tree number 15 in time

Wageningen, 25 October 2013