

RESULTS OF 50 YEARS OF SELECTION AND BREEDING OF POPLARS IN THE NETHERLANDS

by

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SUMMARY

Key words: Breeding-Selection-Comperative trials-relative Volume production.

Before worldwar II selection within existing Poplar material was commonly used in The Netherlands. Since 1948 breeding was added. Collections all over the world took place and material was gathered either through colleagues or by own expeditions. Variability was created through artificial and natural crossings. A total of 500.000 seedlings were produced from which about 10.000 survived selection criterea concerning healthyness and growth.

Many comperative trials were established with these 10.000 clones and many of those showed their significance for practical use through the years. Relative productions of 11 clones in 13 trials were compared. The trials were located in east and central Holland, near the coast and in the IJsselmeerpolders (reclaimed areas). Wind proved to be of levelling influence on differences in growth between clones. Change of relative productions with time are discussed with 18 clones belonging to 3 groups in a trial at Ochten (Central Holland) as an example.

INTRODUCTION

Poplars are common in The Netherlands, both in roadside plantations and in afforestation. A present production of poplar wood of approx. 245.000 m³ is derived from an area of approx. 16.000 ha poplar-forest and approx. 15.000 ha of roadside-and borderline-plantations. National schemes and agricultural overproductions schould make it possible to increase poplar-wood production with more than 100% before the year 2050.

This can only be possible when good producing and healthy clones are available that are totally adapted to our climate and circumstances.

BREEDING AND SELECTION

Through history some pure species of Poplar (P. nigra, P. tremula) as well as some more or less natural hybrids (P. x euramericana, P. canescens) were used with satisfactory results.

Some fifty years ago the awareness of the different imported species and their hybrids began to take place. From then on selection for specific use was a fact.

After World War II breeding was added by means of artificial crossings and since 1948 selection and breeding of poplars has played an important part in the yearly programme of the Forest Research Institute "De Dorschkamp" at Wageningen, Netherlands. After the outbreak of Marssonina leaf disease this work was intensified.

The main part of the work has been the hybridizing by artificial crosses of pure species, primarily ♀ P. deltoides x ♂ P. nigra and/or ♂ P. trichocarpa. To a smaller extent crosses have been made between ♀ and ♂ P. deltoides. Occasionally other poplar species like P. maximowiczii or hybrids were used. In addition to the crossing programme, open pollinated progenies from selected mother trees in pure P. deltoides stands or in mixed stands of P. deltoides and P. trichocarpa have been bred. Combinations between ♀ P. nigra and ♂ P. deltoides never gave any seed at all. To succeed with crosses of this type, apparently some barrier must be overcome, the nature of which is not yet known. So far earlier performed radiation experiments to eliminate this barrier have not been effective.

A lot of the hybrid material that resulted from the first series of crosses was used for back-crosses with either one of the parents or it was used to cross with other individuals. Among these individuals hybrids were used as well as pure species.

Specifically with P. deltoides also provenance hybrids were used.

Many clones of P. deltoides show a high level of resistance to leaf diseases but they seldom show a high level of resistance to bacterial canker (Xanthomonas

populi).

Though P. nigra occurs naturally in the Netherlands, it has become rather scarce because for a long time the farmers have methodically replaced nigra poplars with faster growing hybrids.

However, a few hundred P. nigra clones have been collected, some of them of remarkable form.

Also clones have been imported from other countries, such as Italy and France.

Provenance hybrids of P. nigra are also made and used in further breeding work. Most Dutch P. nigra clones seem to be resistant to bacterial canker, while they seem to have a tendency to be more or less sensitive to rust (Melampsora larici populina).

Method of crossing and breeding

Flower branches with cut ends placed in water are forced in the greenhouse in February and early March. The pollen is collected in glass tubes and stored dry in the refrigerator at about 0° C. The next step is to graft branches with female flowerbuds. Normally bottle grafts are made on one- year old stocks of P. 'Robusta'. These stocks are rooted cuttings potted in November or December (after the end of the first growing season) and then immediately brought into the greenhouse. Each artificial cross of one male and one female clone is made on three separate female scions (belonging to the same clone) grafted on three different stocks to ensure a reasonable number of seed per cross.

The pollinations are made with a small brush. The greenhouse contains a series of small glass-panelled rooms. Each room is reserved exclusively for the application of the pollen of one male clone. These rooms are cooled by sucking air through them. The entering air passes through filters which prevent the passage of pollen. Flowerin female clones are pollinated 3-4 times, a few hours to half a day apart, because different parts of the catkin flower successively.

Fruits ripen about six weeks to four months after pollination, depending upon the clone. The usual time is eight weeks. The seed is extracted from the embedding cotton mass with tweezers and put on wet slides of peat to germinate under cover of a glass plate or plastic sheet in the greenhouse. A few days later when the plants are about half an inch high they are transplanted into big, square pots filled with garden soil. About six weeks later each plant is potted separately and transferred to cold frames, where they stay during the remaining part of the summer.

Selection in the cold frames

At the end of their first season, the plants are still in the cold frames. Those which show more than the lightest degree of leaf diseases are rejected. This selection should be timed as late as possible because within the last 2-3 weeks before leaf fall, rust and Marssonina may develop on hitherto disease-free plants.

A first selection on leaf diseases in the cold frames just before leaf fall is an effective, acceptable and practical way of rejecting the majority of the plants with high susceptibility to these diseases.

Subsequent selection: vegetative propagation

During the first three years of their life, selected seedlings are examined yearly, especially shortly before leaf fall, for symptoms of leaf diseases. If their resistance is considered sufficient and other properties (growth, form etc.) are satisfactory, they are propagated vegetatively through cuttings.

Plants, thus obtained from a new clone, serve two purposes: 1) tests for susceptibility to bacterial canker; 2) further observations concerning leaf diseases, growth, form and other characteristics, e.g. time of flushing and leaf fall, resistance to drought, wind, insects, etc.

Bacterial canker

Susceptibility to bacterial canker is tested by the phytopathological section of the Research Institute for Forestry and Urban Ecology "De

Dorschkamp". Whereas until quite recently all trees were inoculated by leafscar inoculation with a suspension of Xanthomonas populi, the stipule-scar method seemed to reflect the field susceptibility of the moderately susceptible clones better than the leaf-scar method (de Kam and Heisterkamp 1986).

Clones which have successfully passed the canker test are grown in comparative trials on different sites. One should bear in mind that these clones were selected in their seedling stage. Their capacity to grow from ripened wood cuttings might be different in comparison to their seedling growth. This capacity should be tried as soon as material for these cuttings can be obtained without harm to the selection programme.

Further observations

As a result from all the crosses that have been made since 1948 a grand total of 500.000 seedlings were initially raised. After the selections in cold frames for leaf-diseases and the canker- inoculations not less than 10.000 clones resulted to be planted out in trial plots all over the country. Clones should be tested for a long time before they can be released for use in practice (Koster 1972, de Vries 1987, 1989). Whether this practice is forestry or amenity-plantations or other purposes, every user has the right to be informed about the material that he plants with the purpose of longevity.

Nowadays this user has the right moreover because he has to pay a certain amount of money per plant in order to give the breeder the possibility to continue his work also in economical stress-situations or periods (de Vries 1987, 1989). Breedersrights enable the breeder to do so.

COMPARATIVE TRIALS WITH NEW POPLAR CLONES

As volume production is one of the important characters of selection, this is being studied in comparative trials, where P. 'Robusta' or sometimes P. 'Rochester' is used as standard.

Many poplar plantations have been planted in our reclaimed areas, the IJsselmeer polders, on marine soils, with a lutum content between 8 and 25%, pH-KCl around 8, organic matter content of about 3% and a C:N ratio of 10-15. Also many trials have been established in this area.

The question arose whether the new clones produced as well in the IJsselmeer polders as in other parts of the country.

To answer this question a comparison was made (See Table I) of the production of 11 new clones in a series of 13 trials of which three are situated in E. Flevoland (reclaimed before and developed since 1957). Of the other 10 trials nine are situated in Central or Eastern Holland and one on the coast of NW Holland (10 km from the North Sea). As indicated in Table I, the trials vary in age between 13 and 6 years, counting from the time of planting the cuttings in the nursery. They were generally planted with 1-year-old rooted plants, in some cases with 1-year-old plants on 2-years-old roots. The planting distances are generally 4x4 m, in two trials 7x7 m and in one trial 4x8 m. The 13-year-old trial was thinned once and the results refer to its present situation: distances 8x5.7 m.

Relative volume production in % of 'Robusta'

Volume production is assessed as $\bar{d}_{1.30}^2 \times h$ for all clones in a trial and expressed as a percentage of the volume production of the standard clone. Basically the volume of the standard clone is always 100% but corrections may be made when differences in fertility occur in the various replications and in the numbers of trees per clone. In the trials an overwhelming majority of these clones show a relative volume production higher than 100% (more than 100% of the volume production of the standard clone 'Robusta'; in a few trials where 'Robusta' is absent, 'Rochester' is used as standard). See Table I.

Out of 87 assessed volume productions not less than 81 are higher than 'Robusta'; of these 61 are statistically significant (75%).

As a group the deltoides-trichocarpa hybrids consistently show the highest production. The pure trichocarpa clones grow fast in some trials (C,F,J,M) but slower or even poorly in some other trials.

The best Euramerican clone 'Dorskamp' equals in production the delto-tricho hybrids; its brother 'Flevo' on the other hand does not grow faster than 'Robusta'. The other 4 Euramerican clones rank in production between 'Dorskamp' and 'Robusta'.

Table 1. New clones: relative productions (1) in % of standard clones

Region	E. and C. Holland									Coast	E.Flevoland former seabottom		
Columns	A	B	C	D	E	F	G	H	J	K	L	M	N
Local names	Hees 15 ^B	Vledder 1	Vledder 2	Leerdam	Doetinchem	Hees 29A	Middachten	Ochten	Doetinchem	Schoorl	C 31 ^E	X 23 ^E	W 53 ^G
Age in years from cutting	13	11	10	10	9	8	7	7	6	11	10	9	6
Distance in m	4x4	4x4	4x4	4x4	4x4	4x4	4x4	7x7	4x4	4x4	4x4	4x8	7x7
<u>hybrids:</u>													
Delto x tricho (and VV)													
'Donk'	204*		162	188*	192*	250*	206*	248*	240*	102		296*	203*
'Rap'	174*	295*	370*	217*	211*	271*	221*	203*	341*	160*		344*	208*
'Barn'	156			222*	147	255*		185*	177*	149*	134*	200*	115
<u>trichocarpa:</u>													
'Fritzi Pauley'		133	211*	160	191*	266*	130*		279*			173*	64
'Blom'		140			137	218*		169*	190*	63		236*	
<u>Euramericans:</u>													
'Dorskamp'				226*	157*		230*		178*	141	189*	316*	
'Flevo'				156	98		95			101	100		
'Spijk'	204*				114	162	125		158*	149*	141*	237*	186*
'Agathe F'						117	184*	210*	140			299*	203*
'Florence Biondi'						151	107	191*	114			226*	129
2223						221*		181*	301*			275*	164*
<u>Standard clones:</u>													
'Robusta' %	104			108		102	102	102	101	101		103	102
'Robusta' $\bar{h}$ (in m)	22.0			17.0		10.3	12.5	9.8	11.4	13.1		9.2	6.9
'Rochester' %		103	103		100	165			100		100	162	84
'Rochester' $\bar{h}$ (in m)		12.8	11.5		16.0	13.0			13.1		10.1	10.7	6.5
lsd	62	38- 70	55- 86	61- 73	38- 54	65- 75	75	29- 30	50- 60	45- 50	14- 32	58- 67	47- 52

* statistically significant

(1) relative productions are calculated as $\bar{d}^2_{1.30} \times \bar{h}$ and expressed in % of 'Robusta' (or 'Rochester' if 'Robusta' is absent)

Influence of wind

On the whole, relative growth in E. Flevoland is at least comparable with if not better than growth in Eastern and Central Holland with the possible exception of the trial under L (lot C 31^E) on the Western fringe of the polder, about 4 km from the dike.

Here, relative production is low, probably because this part of the polder is more exposed to wind than the trials under M and N (on lots X 23^E and W 53^G) in the extreme Eastern part of the polder near Harderwijk.

Similarly, relative productions are low in the trial under K near Schoorlham, 10 km from the North Sea coast. Clearly wind has a levelling influence on differences in growth when clones of different capacity for growth are compared in trials of this kind.

Absolute productions

As can be calculated from Table I the mean annual height growth of 'Robusta' varies from 1.90 m (trial under J at Doetinchem) to 1.02 m (trial under M in the IJsselmeer polders). Height growth is influenced by many factors: site quality, age of the stand, density, wind etc.

The 3 trials in the IJsselmeer polder all show a low mean annual height growth of 'Robusta' and 'Rochester'. It seems likely that this is indicative of growth of first generation poplars on these reclaimed soils.

CHANGE OF RELATIVE PRODUCTIONS WITH TIME

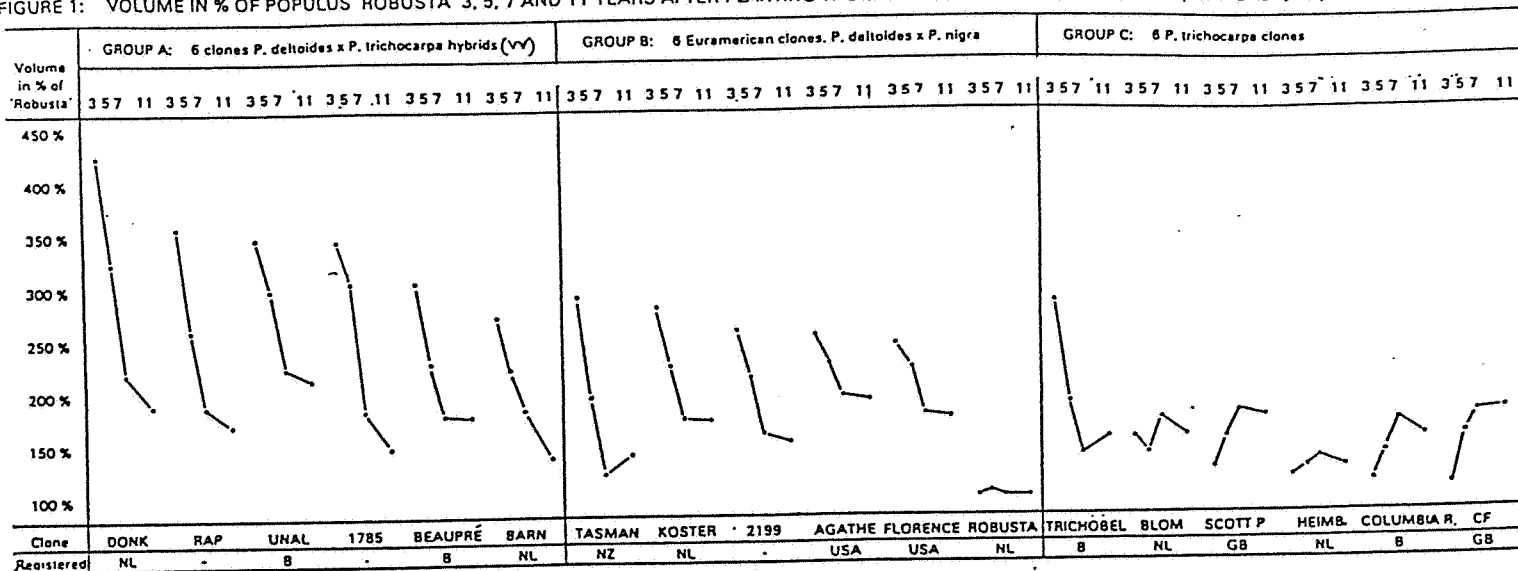
The trial at Ochten (mentioned under H) is planted 7x7 m on fertile clay. It comprises 18 clones x 2 plants per replication x 6 replications.

The clones in this trial belong to 3 groups (See figure I)

- A. 6 clones of deltoides x trichocarpa hybrids
- B. 6 Euramerican clones
- C. 6 trichocarpa clones.

In figure I the relative productions of each clone expressed as $\bar{d}_{1.30}^{-2} \times \bar{h}$ in % of 'Robusta' are presented at 4 ages: 3,5,7 and 11 years after the cuttings were planted.

FIGURE 1: VOLUME IN % OF POPULUS 'ROBUSTA' 3, 5, 7 AND 11 YEARS AFTER PLANTING THE CUTTINGS, TRIAL 1975 AT OCHTEN (NETHERLANDS).



GROEP A: P. delt. x P. trich. (VV)

Kloon		1976	1978	1981	1985
4156	UNAL (B)	346	299	225	213
1647	Donk (NL)	428	325	220	190
1658	Rap (NL)	357	262	187	169
1623	Barn (NL)	282	247	184	139
1785	(NL)	343	306	183	147
4157	Beaupre (B)	304	229	179	178

TABLE 2. RELATIVE PRODUCTION IN % OF POPULUS 'ROBUSTA' AT 3, 5, 7 AND 11 YEARS AFTER PLANTING THE CUTTINGS. TRIAL 1975 AT OCHTEN (NETHERLANDS).

GROEP B: P. delt. x P. nigra (Euramericana)

Kloon		1976	1978	1981	1985
2136	Agathe F. (USA)	253	228	198	193
2135	F. Biondi (USA)	244	223	179	176
2223	Koster (NL)	280	225	175	172
2199	(NL)	258	215	160	152
2195	Tasman (NZ)	291	197	122	141
2098	Robusta (toets)	100	103	100	100

GROEP C: P. trichocarpa

Kloon		1976	1978	1981	1985
1237	ScottPauley (GB)	124	153	179	174
1255	Blom (NL)	153	141	173	155
1236	CF (UK)	105	153	173	175
1216	Columbia River (B)	111	137	168	151
4159	Trichobel (B)	283	191	140	153
1351	Heimbürger (NL)	114	125	133	124

After 3 years clones of group A show by far the highest production. After 7 years, all clones are decreasing, though 2 clones, 'Donk' and 'Unal' (both around 220%) still are clearly superior in production to the best Euramericans.

In group C only 'Trichobel' follows this pattern, whereas the other trichocarpa clones seem to be slower in starting. Some of them are now showing a slight but distinct increase in relative production.

After 11 years relative production compared to 'Robusta' is not as distinctive anymore as it was before. Only 'Unal' (at about 210%) in group A shows a better production than all other clones in any group. Next come 'Donk' from group A and 'Agathe F' from group B (both around 190%) and in third place all groups do have two representatives at about 170%.

These data show very clearly that huge differences in woodproduction and growth disappear with the age of the trees.

This makes it more difficult to predict what will be the best clones when you deal with large quantities of relative young material. Not only between the groups the ranking varies with the age, but also within the groups there are changes. Not all poplar plantations are felled within a period of 15 years, some stay until they are about 25 years of age and a few are getting even older than that.

Still, it is obvious that with the material that is created in the last decades we have gained enormous in wood production possibilities as well as in healthiness and adaptability of trees and plantations. This can still be improved of course, but one should never forget that with whatever method is used to enlarge variability there is always the next step of selection and after that a more or less time consuming period of testing.

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