EXCHANGE OF GENETIC MATERIAL

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ABSTRACT

The exchange of genetic material activity of the I.E.A/B.A. involved three countries in the period 1986-1988 and seven in the period 1989-1991. During this time, many poplar clones and seed, obtained from the Belgian breeding program and demonstrating a potential use for biomass production, were sent to other countries. Willow seed häs also been exchanged among participants. The emphasis bas gradually shifted from the exchange of clones which could be of immediate use in the new environment to the collection of informations about the exchanged clones in their new environment to permit enhanced exchanges in the future and subsequently to the exchange of seed and pollen which could be of use in own breeding programs of the participants.

KEYWORDS : poplars, biomass production, selection and breeding.

INTRODUCTION

In 1986 two IEAIBA activities were initiated in Taskll for the exchange of genetic material: one for the collection and distribution of poplar species, hybrids and clones; and another for the hybridization, clonal selection and distribution of willow clones. With the extension of the Agreement in 1989, exchange of material was co-ordinated by tllis activity for the following three years.

The objectives for the exchange of poplars were:

(1) the exchange of clones which may be of immediate use in a new environment;
(2) the exchange of control-pollinated seed for the production of new populations which can then enter clonal selection programmes in a new environment;
(3) the exchange of clones or seeds which will be useful in any long term breeding programmes existing or being initiated in a new environment; and
(4) the feedback of information to gain a better understanding of clonal reactions to various diseases in different environments, permitting enhanced exchanges of genetic material in the future.

In the period 1986-1988, three countries participated: Belgium, Canada, and the U.S.A. 195 clones were shipped as cuttings from Belgium to Canada. Also, some ten clones were sent as tissue culture plantlets to Iowa State University in Ames, lowa, U.S.A.

In the period 1989-1991, seven countries participated : Austria, Belgium, Canada, Finland, Sweden, the United Kingdom and the U.S.A. 146 clones were sent as cuttings from Belgium to other countries. Also, an amount of 99.600 half-sib seeds were sent. Each country received the basic collection that was deemed suitable for its specific environment.

As the project went on, the emphasis gradually shifted from short term objectives (the exchange of clones which may be of immediate use in a new environment) to long term objectives, namely the feedback of informations (to improve future exchanges) and the exchange of seeds which can be used in ones own, long-term breeding programme.

EXCHANGE OF POPLAR CUTIINGS

1986-1988.

In this period, the objective focused on the exchange of clones for the immediate use in new environments and on the collection of information on clonal reactions to various diseases in different environments. During the whole period, 195 clones were sent as cuttings to Canada. Table 1 presents an overview of this exchange. 10 Clones were sent as tissue culture plantlets to the U.S.A.

TabIe 1: Clones sent to Canada.

		No. of Clones Sent		
		1986	1987	1988
Pure species	m			
	txt		28	
Fl hybrids	dxm			5
	dxn	10	16	
	dxt	18	30	
	nxt		8	
	txm			10
Backcrosses	(txd)xd	9	43	
	(txd)xt		10	
	(txm)xt			5
F2 backcrosses	(txrn)x(txm)			2
Total : (195)		37	135	23

m = *Populus maximowiczii*, d = *P.de/toiäes*, t = *P.trichocarpa*, n = *P.nigra*.

These clones represent second and third generations of improvement in the Belgian breeding programme. As such, they combine good form, growth and vigour with disease resistance (to the main diseases in Belgium), good rooting capacity, photoperiodical adaptation to the growing season, adaptation to a range of soit types, and good wood quality. The main Belgian diseases are bacterial canker *(Xanthomonas popu/i)*, rust *(Melampsora /arici-populina* and *M allii-popu/ina)* and *Dothichiza populea*. The clones sent abroad are all field resistant to *Xanthomonas populi* and have a low degree of susceptibility to *M larici-populina* and *M allii-populina*. There is also a good resistance gainst *Dothichiza popu/ea* (the European physiological races can however be supposed to be different from the American ones). This resistance of the Belgian clones sent abroad is very important in that it reduces the risks of introducing European pests in the North American environment.

It was feit that priority should be given to the screening for rust resistance and *Marsonnina brunnea* resistance. More precise identification of the rust species and possibly of rust races will be extremely useful for the selection. Reliable artificial inoculation techniques with *S.musiva* on young plants can shorten the risk of spreading too sensitive clones. Common methodologies for screening should be developed.

To have a realistic idea of the frost hardiness, clones should be kept in the nursery for several winters.

Some of the Belgian clones have been observed to be sensitive to North American rusts *(M medusae)* and to *Septoria musiva canker*. In general the DxN hybrids carne out as the more promising ones.

Observations made on nursery plants will have the greatest value in tenns of providing an important feedback mecbanism which will enable the refinement of selection criteria to choose clones for subsequent exchanges. Waiting for such feedback, the programme will be concentrated on the exchange of seeds of selected parents of the different species and hybrids. The recent occurence of diseases typical of one continent in another continent also suggests that the export of new material be limited to seeds and pollen as a precaution measure.

1989-1991.

In tbis period, 146 clones were sent as cuttings from Belgium to the other countries. Each country received a 'basic collection' from which to select individuals for propagation or parents for future generations. The U.S.A. received only seed due to import restrictions.

As such, the emphasis shifted more towards the long-tenn aim of the establishment of own local (or national) breeding programmes. Also, instructions were sent out on which characteristics to observe and how, in order to obtain feedback information pennitting mapping of the areas for which certain clones were suitable, as well as informations on which to base future exchanges of poplar material. Tuis second aim, also a long-term one, will be treated in more detail later.

Table 2 presents an overview of the exchange of clones in the second period.

Table 2: Exchange of clones with Austria (AUS), Canada (CAN), Finland (FIN), Sweden (SW=L.Christerson, SWF=B.Falk) and United Kingdom (U.K.).

		No. of Clones Sent							
		1989		1990					
		CAN	SW	UK	AUS	FIN	SW	SWF	UK
Pure species	txt	61	61	63	30	53	65	14	60
	m		1						1
Fl hybrids	txm	6	10	10					10
	dxm		1	1					
	nxt		6	8					
Backcross	tx(txm)		11	11					
Double backcross	tx(dxt)xt		5	5					
Trispecies cross	dx(txm)	2	3	3					
Total :	145	72	98	101	30	53	65	14	71

m = *Populus maximowiczii*, d = *P.deltoides*, t = *P.trichocarpa*, n = *P.nigra*.

EXCHANGE OF POPLAR SEED

As mentioned before, the U.S.A. could receive only seeds due to import restrictions. The import of cuttings is being greatly inhibited by quarantine measures also in Canada. But even inside Europe it is better to avoid the exchange of cuttings because of the risks it implies for the import of diseases.

Open pollinated seedlots were sent to the participating countries, to be used for selection as well as for breeding later on.

Table 3: Exchange of open pollinated (halfsib) seed with Austria (AUS), Canada (CAN), Finland (FIN), Sweden (SW=L.Christerson, SWF=B.Falk), United Kingdom (UK) and the United States of America (USA) : number of halfsib families (A) and number of seeds (B).

		No. of Clones Sent						
(A)	Mother	AUS	CAN	FIN	SW	SWE	UK	USA
1990	txt	11		11	11	11	11	9
1991	t	10		10	10		10	
	d		2	1			1	2
	n			1			1	
	dxt		4					4
	nxt		3					3
total :	30	21	9	21	21	11	21	18

(B)	Total	AUS	CAN	FIN	SW	SWE	UK	USA
1990	62300	10500	-	10500	10500	10500	10400	9000
1991	illQQ	6300	7300	6300	6300		6300	4800
	99600							

FEEDBACK OF INFORMATION

All the clones which have been exchanged should be kept for several years in a nursery and closely observed. These observations concern mainly the resistance to local diseases and the suitability for the local climate.

To facilitate the interpretation of data it is useful to :

1. Establish trials by means of cuttings in different locations with different climatological and pathological circumstances .
2. To collect, at each of these places, and also in the original nursery, weather data concerning temperature, air moisture and rainfall, especially rainfall during the growing season, using a weather station that is Iocated in the trial itself. These data can be useful to interpret observations on frost resistance and resistance to diseases.

Djseases

Of great importance are close observations on the reaction of the clones to several local diseases. Since the occurence of diseases differs in the two continents (North America and Europe) the emphasis will sometimes be on other aspects.

For North America, the observations should include the following diseases:

* leaf diseases:
  - *Melampsora* species : use a rating system from 0 to 5.
  - *Marsonnina brunnea*
  - *Taphrina aurea*
  - *Septoria musiva*
  - others
* diseases of stem and twigs:
  - *Dothichiza populea*
  - *Septoria musiva:* we would like to know the reaction of different clones on this canker,

concerning its occurence in nature and also its reactions on artificial inoculations.

- *Hypoxy/011 mammatum*
- others

For :

- leaf diseases:
  - *Melampsora* species : use a rating system from 0 to 5. Belgium can assist in identifying which *Melampsora* species is present. For this, send infected and dried leaves of selected clones to our institute.
  - *Marsonnina brunnea*
  - othe "
- diseases of stem and twigs:
  - *Dothichiza populea*
  - *Xanthomonas populi:* all clones which have been exchanged have been tested and show high resistance to bacterial canker caused by *X popu/i* . However, if any suspect symptoms occur, our institute should be infonned.
  - others

These observations should be made on all the clones exchanged and later on also on the seedlings grown out of the exchanged seed.

Suitability to the local climate.

Another important feature is the suitability of the clones to the local climate, especially frost hardiness for spring, summer, auturnn and winter frosts.

The following observations help in detennining this suitability :

1 Bud burst. We propose a quotation of 0 to 5 for the stage of bud burst. Different clones and different trials can as such be compared. Bud burst is dependant on temperature and the link is a genetica! one. Late bud burst results in a loss of growth, early bud burst in frost damage. The selection of clones which are optimally adapted to the local climate is of great importance.

2. Frost resjstance to late sprin2 frosts. The damage to different clones caused by the late spring frosts in Belgium of 1991 was quantified with a number from 0 (no damage) to 5 (plant died). The observations were carried out on different locations, which enabled us to make some interesting comparisons.

3. Evolution of hei2ht 2rowth of some clones durin2 the win2 season. These observations were carried out in Belgium during the growing season of 1991 on one year old plants. Weeldy the height of the new sboot (of the second year) was measured with a precision of 1 cm. This was continued during the growing season. This absolute height can be transfonned into a relative height , namely by dividing it by the total height of the shoot at the end of the growing season. The evolution of this relative height, expressed as a %, as a function of time, shows in which period a clone concentrates its growth. These graphs are shown for a DxT clone, a (DxT)xD clone, and a DxN clone (Fig. 1).

From the height data one can also calculate the weeldy height growth. Putting this in a graph, next to the average temperature during the corresponding week, the specific behaviour of each clone emerges again. These graphs are given for a DxT clone, a (DxT)xD clone and a DxN clone (Fig. 2).

These few examples should not be considered complete. In Northem Europe the resistance to summer and winter frosts can be very important. This resistance must be tested on site.

Example : Iáal plots in Canada

Former expeáments have revealed that in Canada DxN clones are the most succesful among the clones exchanged.

In 1990 and 1991 a seáes of 35 DxN clones were outplanted as cuttings in five clone-site táals at different locations in Canada. Out of these, 15 clones are of Belgian oágin. The planting distance is 2.4 x 3.6 m.

The following 15 Belgian clones were used:

78.010/27 = DN230
78.010/28 = DN231
78.010/32 = DN232
78.010/33 = DN233
78.0161149 = DN234
78.016/155 = DN235
78.016/156 = DN236
78.018/192 = DN237
78.018/202 = DN238
78.018/203 = DN239
78.022/223 = DN240
78.022/226 = DN241
78.022/228 = DN242
81.001/30 = DN243
81.001/31 = DN244

Ibis strategy of plantations at different sites to be observed closely can serve as an example for otber countáes.

EXCHANGE OF WILLOW SEED

In the spáng of 1990, controlled hybridization of willows was undertaken by participants in Canada and Sweden, and open pollination was performed in Belgium. Seed from these crosses was then distributed amongst Canada, England, Northern Ireland and Sweden.

Ihis exchange was more than just the transfer of genetic material. Up to this time, little was known about the viability of willow seed. Iherefore, seed was shipped via refrigerated and unrefrigerated transport and with varying shipping times. The results demonstrated that shipment of fresh willow seed in unrefrigerated conditions, with transport times up to eleven days, was successful. Under these conditions, loss of viability was not considered a limitation to seed exchange over long distances.

The exchange of seed continued. Rather than exchanging material to provide all participants with common collections, listings of seedlots available were distributed and participants could obtain material that was of interest to their respective national programmes.

CONCLUSIONS: FUIURE STRAIEGY

I. At the present stage it is no Jonger the intention to provide clones which are of immediate use in the new environment. The main objective is to exchange informations concerning the initiation or continuation of national or local breeding programmes, in which disease resistance and suitability to local climate are of high importance.

It is not always useful to send new material if nothing is known about the suitability or shortages of the mateáal already exchanged. Hence the importance of a systematical feedback.

2. In the future we shall concentrate on the exchange of half-sib (open pollinated) seed and pollen. It is likely that a different strategy wil! be adapted for the Ameácan and the European continent.

For North America the species *P.nigra* is especially of great importance, due to the resistance of this species to North Ameácan rust. From earlier exchanges, the group of DxN hybáds emerged as the more promising one. By providing *P.nigra* seed or pollen the resistance to leaf rusts can be incorporated by an own breeding programme.

There is little need for seed and pollen from the species *P.trichocarpa* and *P.deltoides*, since these species are domestic in that area. For Europe, bowever, an exchange of material of these two latter species is of great importance, especially in as far as the adaptation to colder climates is concemed.
In the program 1992-1994 the most suitable strategy for each continent will be followed.

3. It may be concluded that the basic collection of clones exchanged offers a large scope for further selection and breeding, but large-scale plantations of clones have to be carefully considered and not be carried out until the suitability of these clones bas been sufficiently proved on site. This is only possible after several years of continued observations on several places where planting is envisaged.