



Pear breeding for Fireblight resistance. Program and first studies in France

Bernard Thibault

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B. Thibault

Station de Recherches d'Arboriculture Fruitière
Institut National de la Recherche Agronomique
Domaine de Bois l'Abbé
Beaucouzé - 49000 Angers
France

Abstract

In 1975 a pear breeding program was started in order to obtain some pear varieties with a late picking date (30 to 50 days after Bon Chrétien Williams) and resistant or less susceptible to fireblight, caused by the bacteria *Erwinia amylovora* (Burr.) Winslow et al.

The first crosses were made between a parent of good quality, but susceptible (General Leclerc, Notaire Lepin) and a parent with good resistance to fireblight (Maxine, Mac, Dawn etc.).

For the last year the crosses are made only between resistant or less susceptible varieties mainly belonging to the genus *Pyrus communis*. A half diallel cross will be realised with 7 parents.

Testing the resistance is made either outside in the south-west of France (Dax) or in a greenhouse (Wageningen, the Netherlands) in the framework of the C.E.E. cooperation.

The first results are presented.

1. Introduction

Since the summer of 1978, when the first contaminations in pear orchards were noted in the south-west of France, the problem of substituting the common European varieties is raised with acuteness in our country.

Some varietal differences were seen, for instance Passe Crassane proved to be more susceptible than Bon Chrétien Williams. It is hoped that the disease will not establish in dryer areas like the south-east of France.

Two approaches of the problem seem justified, namely

- at short term to practice or develop cultural methods, including chemical control, in order to maintain the presently grown pear varieties in the best locations for pear production. The cultural and sanitation measures to be taken, however, increase the cost of production
- at long term to search for pear varieties sufficiently resistant to fireblight lowering the cost of production again and reducing the risk of spread of fireblight.

This paper deals with the last mentioned approach.

In the USA and Canada much effort has already been taken to search for varieties resistant or less susceptible to fireblight. The results obtained by screening the world's variety assortment and through breeding new less susceptible varieties are remarkable.

However, we have to recognize that no variety created for its resistance to fireblight is now commonly grown in commercial orchards. Despite its susceptibility the variety Bartlett (= Bon Chrétien Williams)

accounts now for three quarters of the tonnage of pears produced in the U.S.A. (mainly for processing).

The efforts of pear breeders across the Atlantic are mainly directed towards varieties likely to replace Bartlett: same picking date, same taste, same uses.

In France and even in southern Europe the percentage of Bon Chrétien Williams of the total pear production is much lower (table 1).

Table 1 - Production of pears

	Total	Williams		Late varieties	
	tonnes	tonnes	%	tonnes	%
FRANCE	420 000	90 000	21.4	90 000	21.4
ITALY	1 200 000	170 000	14.2	300 000	25.0
SPAIN	450 000	24 000	5.3	85 000	18.8
	<u>2 070 000</u>	<u>284 000</u>	<u>13.7</u>	<u>475 000</u>	<u>22.9</u>

On the other hand the part of late maturing varieties accounts for 20 to 25% of the total production.

It therefore seemed important to start a breeding and selection program aiming at late maturing varieties with good keeping quality and resistance to fireblight.

2. Material and Methods

2.1. Choice of parents

It is known that the susceptibility of different genotypes to fireblight is very variable according to physiological or climatic conditions.

Therefore about 50 European varieties and 20 American or Canadian new hybrids were collected and planted in an experimental orchard located in Dax-area where fireblight was discovered in 1978. The pomological characteristics of these varieties and hybrids were well known in France through the introduction for many years in the INRA station at Angers.

What parents were available at the outset?:

- Some new varieties issued by U.S.D.A. such as Dawn, Magness, Moon-glow or by the University of New Jersey such as Lee, Mac, Star or by Tennessee Station such as Mericourt. They all show, with a variable degree of resistance, some important defects about the habit of the tree, the productivity or the quality of the fruits.
- Some older varieties or chance seedlings having shown an interesting level of resistance and a fairly good quality: Beurre Capiaumont, Doyenne Gris, Duchesse d'Angoulême, Figue d'Alençon, Louise Bonne d'Avranches, Maxine, Pierre Corneille, Sirrine, Starking Delicious.
- Thanks to the courtesy of T. van der Zwet, Beltsville, U.S.A. and H. Quamme, Harrow, Canada a score of new hybrids showing good quality and good resistance could also be introduced.

Table 2 shows a list of the different parents with their characteristics concerning the picking-date, the productivity, the taste and the level of resistance (noted in their country of origin).

2.2. Crosses carried out

Table 3 sums up the different crosses which were made.

The first hybridizations began during the spring of 1975. The Fruit Laboratory of Beltsville agreed to inoculate the young seedlings under greenhouse conditions. It was a cross between General Leclerc, a new French variety, heavy bearer and with good quality but probably susceptible to fireblight and Starking Delicious, a non susceptible variety. The progeny included 150 seedlings.

In 1976 two progenies were made between Notaire Lepin, a susceptible variety but transmitting good quality to its offsprings, and two resistant varieties: Mac and Dawn. Around 220 hybrids were obtained for each cross.

After *Erwinia amylovora* was detected in pear orchards in the south-west of France, the forementioned progenies were planted in the spring of 1979 in an experimental orchard at Dax. Inoculations with *Erwinia amylovora* were carried out in June and July 1980.

During the spring of 1978, 5 other progenies were undertaken between Notaire Lepin and different gene sources for resistance: Dawn, Mac, Maxine, US 309 and US 62.563.44 for a total of 600 seedlings settled in Dax in the spring of 1980. They will be inoculated in June 1981.

In april 1979, 16 progenies were carried out between Pierre Corneille, which showed no symptoms of fireblight under natural infection conditions in Harrow and various resistant varieties. Some of these progenies and others, made in 1980, were incorporated in a half diallel plan with 7 parents and 21 progenies (table 4). This could provide a better knowledge of the general as well as the specific abilities to transmit the resistance for these 7 parents.

2.3. Assessment of the resistance

Inoculation of seedlings produced in 1976 and 1978 was carried out in June at the top of a growing shoot, using a hypodermic syringe. Inoculations were made by J.P. Paulin, Phytobacteriology Station, Angers.

Next September the severity of fireblight injury in the shoots was measured. Three classes were used: less than 25% of the shoot length blighted, from 25% - 50% of shoot length blighted and more than 50% of shoot length blighted. The diseased part of the shoots were removed and new inoculations were made next year.

The seedlings produced in 1979 and 1980 are or will be tested for their resistance to fireblight in 3 different ways

- inoculations under greenhouse conditions in the Research Institute for Plant Protection, Wageningen, the Netherlands, thanks to the collaboration of H.P. Maas Geesteranus
- artificial inoculations after planting in an orchard at Dax in the south-west of France
- under natural infection conditions at Dunkerque in the north-west of France, where fireblight occurs since 1972 on hawthorns and where lower temperatures prevail.

The hybrids that will have shown some resistance will be grown until the end of their juvenile period and will be then artificially inocula-

ted on flowers. Finally the resistant hybrids will be assessed for their productivity and the quality of their fruits.

3. Results

3.1. Inoculations in the open

The first results are about the crosses planted at Dax in the spring of 1979 and inoculated by needle in June 1980. Many plants did not show any symptoms. They will be inoculated again in 1981.

48 plants out of 163 had a reaction in the cross Notaire Lepin x Dawn and 37 out of 187 in the cross Notaire Lepin x Mac. The repartition in the three classes mentioned above is shown in table 5.

3.2. Inoculations under greenhouse conditions

All the seedlings inoculated at Beltsville were killed by fireblight.

1850 seedlings belonging to 11 crosses were inoculated in 1980 by H.P. Maas Geesteranus by cutting the top of young leaves in a bacterial suspension.

The results involving 1728 seedlings are shown in table 6 under three headings: very susceptible, dead; no symptoms; more or less clear symptoms such as:

- infection limited to the leaf but without reaching the stem
- shoot infection stopped with appearance of a new healthy shoot
- shoot bent without any necrosis.

Three gene sources delivered less than 70% very susceptible plants: US 62.574.13; Doyenne Gris and Duchesse d'Angoulême, the first one giving almost 24% plants without symptoms.

4. Discussion

Although the number of seedlings were rather limited and although the experiments are not yet completed some ideas may be highlighted:

- as far as inoculations in the open are concerned, it seems that Dawn has transmitted a better resistance rate on shoots than Mac;
- inoculations under greenhouse conditions resulted in more severe infection than those carried out in the open. It is, however, difficult to compare results from the outdoor and the greenhouse tests since different progenies were involved. The series inoculated in the open originated from crosses between 'susceptible' x 'resistant' varieties, whereas the series inoculated under greenhouse conditions originated from crosses between 'less susceptible' x 'less susceptible' varieties or 'less susceptible' x 'resistant' varieties.

In future a better comparison can be made as material from progenies, which have already been tested under greenhouse conditions, was planted outdoors at Dax and Dunkerque.

With respect to the methods used two other points can be brought forward:

- the heritability of resistance on flowers will be difficult to establish if a first screening is made on leaves or young shoots. In order not to bias results the inoculation on flowers should be made on whole progenies and not on already screened subjects.
- What is the value of the resistance of the plants that have shown a beginning of necrosis but where this necrosis has naturally stopped damaging only the leaf or a part of the shoot? Are they to be preferred to those without any symptoms but which could have escaped

infection?

Table 2 - Characteristics of varieties and hybrids showing some resistance to fireblight

	Picking date (1)	Productivity (2)	Quality (3)	Degree of resistance (4)
Dawn	+ 10	2	5	6- 8
Magness	+ 30	1	4	8-10
Moonglow	+ 25	3	2	7- 8
Star	=	3	3	5
Mac	+ 20	2	3	7- 8
Lee	+ 20	3	1	1- 2
Mericourt	+ 30	3	2	7- 8
D. d'Angoulême	+ 40	3	3	7- 8
L. Bonne	+ 20	4	4	5
P. Corneille	+ 30	5	5	5
Maxine	+ 10	3	3	7-10
Starking Del.	+ 10	3	3	7- 8
Sirrine	+ 10	3	4	5
B. Capiaumont	+ 20	5	3	7
Doyenne Gris	+ 50	4	3	7
Figue d'Alençon	+ 60	5	3	7
Eldorado	+ 50	3	3	6
Mich. 437	+ 20	4	3	6
US 309	+ 25	5	3	7- 8
HW 602	- 8	?	4	8- 9
H 6831/1.12	+ 30	?	4	7- 8
H 6516/1037	+ 30	?	3	10
US 62.563.44	+ 10	4	4	7
US 62.574.13	+ 15	3	2/3	7
Ill.13.B.83	+ 40	3	3	?
H. 6720/1.001	?	4	2	10

(1) Compared with Bon Chrétien Williams

(2) or (3) Noted on 5

(4) U.S.D.A. System

Table 3 - Crosses made in Angers

			Number of seeds
1975	General Leclerc	x Starking Del.	150
1976	Notaire Lepin	x Mac	220
		x Dawn	220
1978	Notaire Lepin	x Mac	25
		x Dawn	350
		x Maxine	175
		x US 309	25
		x US 62.563.44	30
1979	Pierre Corneille	x Mac	350
		x Dawn	660
		x Maxine	160
		x Doyenne Gris	380
		x B. Capiaumont	50
		x D. d'Angoulême	270
		x Figue d'Alençon	500
		x Starking Delicious	260
		x Sirrine	590
		x HW 602	270
		x US 62.574.13	370
		x Ill. 13.B.83	750
1980	30 crosses with the same parents, plus:		
	H 6720/1.001		
	Michigan 437		
	Eldorado		

Table 4 - Half-diallel crosses

Dawn (W x Seck) x W						
x Comice						
Mac (W x J. de Malines)						
x NJ 1	80 ⁽¹⁾					
13.B.83 (Comice x Farming) x Maxine	80	80				
Mich. 437 (W x Seck) x W	80	80	80			
Figue d'Alençon	80	80	80	80		
Doyenne Gris	80	80	81	80	81	
Pierre Corneille	79	79	80	79	79	79
	Dawn	Mac	13.B.83	Mich. 437	Figue d'Alençon	Doy. Gris
(1) this number indicates the year of the cross						

Table 5 - Results after inoculation in the open at Dax - 1980

Crosses	% of the shoot with necrosis		
	25%	25-50%	50%
Notaire Lepin x Dawn	44	25	31
Notaire Lepin x Dawn	27	8	65

Table 6 - Results after inoculation under greenhouse conditions - 1980
Mother parent: Pierre Corneille

Pollen	Number of plants	% of seedlings		
		Very susceptible	No symptoms	Various delayed symptoms
Dawn	290	78.27	5.86	15.86
US 62574.13	92	61.95	23.91	14.13
Sirrine	201	69.65	14.92	15.42
13-B-93	276	73.55	5.43	21.01
Figue d'Alençon	244	85.65	3.69	10.65
Mac	157	71.33	12.10	16.56
Maxine	67	74.62	1.50	23.88
Starking Del.	94	74.46	10.63	14.89
HW. 602	79	77.21	7.59	15.19
Doyenne Gris	111	67.68	14.02	21.34
D. d'Angoulême	45	64.44	17.77	17.77

