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# COMPARISON BETWEEN TWO METHODS OF SELECTION FOR RESISTANCE TO *Erwinia amylovora* IN YOUNG SEEDLINGS OF PEAR

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## Abstract

Ten parents were crossed with the old French variety 'Pierre Corneille' (*Pyrus communis*) in order to find a pear variety not too susceptible to fire blight. The ten parents were:

- a) European varieties,
- b) U.S. varieties,
- c) U.S. and Canadian selections.

These ten parents and the common parent 'Pierre Corneille' were all previously observed in State or Canada for their low susceptibility.

The progenies were divided in two parts and the selection for resistance was performed according to two ways :

- 1 - in glasshouse after inoculation on young seedlings in their first year of growing, on only one shoot.
- 2 - in the orchard, after inoculation of fifteen shoots (5 shoots x 3 years) on 3 to 5 year old seedlings.

The two methods are compared taking as criteria the index of susceptibility (Severity x Frequency) and the rate of selection.

## Introduction

In 1980 when we settled a breeding program for the resistance to fire blight on pear trees we had at our disposal :

- a greenhouse located in Wageningen (Holland) belonging to I.P.O. (Research Institute for Plant Protection) with no land outside.
- an experimental orchard located in Dax (South West of France) where there was no usable greenhouse.

Our first hybridizations set in action an old French variety 'Pierre Corneille' well known in our trials for the quality and attractiveness of the fruit and for its good productivity. In addition H. Quamme (1977) noted it at Harrow as not too susceptible.

Using this variety as female we brought pollen of ten varieties or selections observed in States or Canada and ranked as not too susceptible (Van der Zwet, 1984 ; Quamme, 1983 ; Lamb, 1970) : 'Dawn' - 'Doyenné Gris' - 'Duchesse d'Angouleme' - 'Figue d'Alençon' - 'Harvest Queen' - 'Illinois 13.B.83' - 'Mac' - 'Maxine' - 'Sirrène' - US 62.574. 13.

These 10 progenies gave about 2 500 seedlings : 1 600 were tested in the greenhouse and 900 directly in the field.

## Methods

### Inoculations in greenhouse

They were performed by H.P. Maas Geesteranus (Thibault, 1984). The plants of 25 to 30 cm height were not watered during 24 hours before inoculation. The culture of *Erwinia amylovora* (strain I P O 108, density  $10^8$  cell/ml) was poured in a large Petri dish. The top of the actively growing shoot was immersed into the suspension and the top of usually two unrolling leaves was cut off with a sharp knife. The wounded leaves were left for about 10 seconds in the suspension. The temperature was maintained at about 20°C and the screening undertaken four to five weeks later.

### Inoculations in the orchard

After their first season of growing in plastic pots 9 x 9 cm the young seedlings were planted during the winter 80/81. The inoculations on shoots were carried out in 1982 and continued each year in 1983 - 84 and 85. 18 to 24 shoots were inoculated by hybrid (3 to 6 in 1982 - 3 in 83 - 6 in 84 and 6 to 9 in 85). The period of inoculation took place generally at the end of May or the beginning of June when the shoot growth is very active. Inoculation was performed by needle prick and syringe just below the top of at least 30 cm long shoots (strain 2045 ; density  $10^8$  ).

## Results

### In greenhouse

When increase of shoot wilting had been stopped, the plants were classified into four groups (table 1) :

- a) plants with no symptom development
- b) plants with only wilting of the inoculated leaves
- c) plants with partial necrotic shoot but regrowth of axillary healthy buds
- d) plants with shoot wilting and necrosis, discarded

The plants of the first three classes were kept and planted in the Dax orchard.

### In the orchard

When the extension of the necrosis has ceased to extend, resultant fire blight lesions were measured (generally in the end of July). For each shoot with blight the percentage of extended lesion to the total length of the shoot was calculated ; the mean percentage of all these shoots gave the "Severity" of the attack.

For each hybrid, the ratio between the number of shoots with blight and the total number of inoculated shoots gave the "Frequency" or "Infectivity" (Le Lezec, 1984).

The product between Frequency and Severity gave the "Index of susceptibility" which varied from 0 to 100. This Index can be given also by the ratio between the sum of percentages obtained with blighted shoots and the total number of inoculated shoots (with or without lesions).

If we put :

a = number of blighted shoots

b = number of shoots without lesions

ℓ = length of the lesion

L = length of the blighted shoot

$$\text{Severity} = \frac{\sum_1^a \frac{\ell}{L} \times 100}{a}$$

$$\text{Frequency (Infectivity)} = \frac{a}{a + b}$$

$$\text{Index} = \frac{\sum_1^a \frac{\ell}{L} \times 100}{a + b} = \frac{\sum_1^a \frac{\ell}{L} \times 100}{a} \times \frac{a}{a + b} = S \times F$$

The classification of the hybrids was made following these characteristics (fig. 1) :

	<u>Severity</u>	<u>Frequency</u>	<u>Index</u>
A - very Low susceptibility	≤ 50	≤ 65	≤ 10
B - Low susceptibility	≤ 50	≤ 65	10 < I < 20
C - Medium susceptibility	> 50	> 65	10 < I < 20 20 < I < 40
D - High susceptibility			40 < I < 60
E - very High susceptibility			I ≥ 60

Only the hybrids of the class A were selected. The table 2 shows the results and the table 3 the rate of selection for these two methods.

In order to know the reliability of the screening performed in the greenhouse, the plants selected, after plantation in the orchard were again inoculated on 12 to 15 shoots, in 1982 (3 to 6 shoots) 1983 (3 shoots) and 1984 (6 shoots). Each hybrid was then classified in one of the five classes used after inoculation in the field. With only one exception the percentage of plants in the class A (very Low susceptibility) varied between 85 to 100 %. For the progeny with 'Figue d'Alençon' this percentage was only 75 %.

## Discussion

The rate of selection is very different : 26 % in the greenhouse and 63 % in the field. This difference suggests that the rate of selection was too severe in the greenhouse ; so many hybrids not too susceptible were destroyed.

Van der Zwet (1973) noted that in the progenies where the two parents were Highly resistant and Moderately resistant, about 90 % of the seedlings ranks in the class 10 - 5 (10 = no blight - 5 = 26.50 % of tree blighted) and with parents moderately resistant and susceptible this percentage varied from 59 to 79 %. So we can consider our rate of 63 % as normal.

No statistic calculation is practicable on the figures obtained in greenhouse. But the results obtained after the second inoculation in the field showed that the classification in three classes : "with no symptoms" - "only leaf wilting" and "Healthy regrowth" had not a biological basis (table 4 ).

In the orchard we made comparisons between the distributions of frequencies in each class A - B - C - D - E for each progeny with G  $\hat{2}$  test (Sokal and Rohlf, 1969). The ten distributions are different at the level 5 % and we can make three groups of progenies according to the percentage of selections with low and very low susceptibility.

- a weak percentage = progenies with 'Duchesse d'Angoulême' and 'Sirrène'
- a medium percentage = progenies with 'Mac', 'Figue d'Alençon', 'Doyenné Gris', 'Dawn' and 'Maxine'
- a high percentage = progenies with 'US 62.574.13', 'Illinois 13.B.83' and 'Harvest Queen'.

It is noticeable that these last three parents have been selected in programs for resistance.

## Conclusion

It seems that in our conditions, the use of parents showing phenotypically a good level of resistance (moderate x moderate or moderate x high) leads to a good percentage of selected seedlings. This is in conformity with the results of Quamme (1976 and 1979). As it is difficult to class the parents it is difficult too, to establish a correlation between the phenotypic value of the parents and the value of the progenies. Our evaluation of varieties (Thibault, 1986) gives a classification for the parents (table 5) which is not very far from the classification of the progenies with the exception of 'Figue d'Alençon'.

The conditions of the screening in greenhouse could be reexamined. Perhaps it could be possible to select seedlings with a small amount of necrosis even if no regrowth occurs at the screening time. Quamme (1979) selected the hybrids with less than 25 % of infected shoot. On the other hand we must be aware of the importance of physiological and climatical factors : a plant susceptible in green house could be suscep-

tible in the field some time or another. The balance is difficult to find. We have to keep in mind that these selections will be submitted to agronomical and pomological screenings for which we need a great variability.

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Table 1 : Classification of seedlings after inoculation in greenhouse

Progenies	a no symptoms	b leaf wilting	c healthy regrowth	d discarded
Dawn	19	33	10	227
Doyenné Gris	25	16	3	53
Duchesse d'Angoulême	8	9	0	29
Figue d'Alençon	7	17	9	209
Harvest Quenn	10	11	2	61
Illinois 13-B-83	15	44	15	203
Mac	18	16	1	112
Maxine	10	19	9	120
Sirrine	31	25	6	140
U S 62.574.13	23	10	8	57
	166	200	63	1 211
	429			

Table 2 : Classification of seedlings after inoculations in the field %

Progenies	A	B + C	D + E
Dawn	61,8	34,5	3,7
Doyenné Gris	60,5	34,9	4,6
Duchesse d'Angoulême	34,1	43,9	22,0
Figue d'Alençon	59,1	36,6	4,2
Harvest Queen	82,0	16,4	1,6
Illinois 13-B-83	81,3	18,1	0,5
Mac	56,7	41,8	1,5
Maxine	73,9	23,1	3,0
Sirrine	34,7	63,1	2,1
U S 62.574.13	76,2	20,0	3,7

Table 3 : Results of the two ways of selection

Progenies	In Greenhouse			In the Field		
	N <sup>br.</sup>	Selected		N <sup>br.</sup>	Selected	
		Number	%		Number	%
Dawn	289	62	21,4	137	84	61,8
Doyenné Gris	97	44	45,3	48	26	54,1
Duchesse d'Angoulême	46	17	37,0	42	14	33,3
Figue d'Alençon	242	33	13,6	72	42	58,3
Harvest Queen	84	23	27,4	61	50	81,9
Illinois 13-B-83	277	74	26,7	187	148	79,1
Mac	147	35	23,8	68	38	55,8
Maxine	158	38	24,1	138	99	71,7
Sirrine	202	62	30,7	96	33	34,3
U S 62.574.13	98	41	41,8	81	61	75,3
	1 640	429	26,1	930	595	63,9

Table 4 : Results after re-inoculation in the orchard

Classes after greenhouse	Classes after re-inoculation in orchard %		
	A	B + C	D + E
No symptoms	92,6	6,4	1,0
Leaf wilting	91,3	8,7	0,0
Healthy regrowth	96,8	3,2	0,0



Table 5 : Evaluation of the parents in the field

Progenies	1984	1985
U S 62.574.13	A	B
Illinois 13-B-83	A	A
Harvest Queen	A	C
Maxine	A	A
Dawn	A	D
Doyenné Gris	A	E
Figue d'Alençon	E	E
Mac	A	A
Duchesse d'Angoulême	C	/
Sirrine	C	E

Fig. 1

CLASSIFICATION ACCORDING TO 3 CRITERIA ON SHOOTS

