PROCEEDINGS OF THE CARIBBEAN FOOD CROPS SOCIETY

SIXTH ANNUAL MEETING
ST. AUGUSTINE, TRINIDAD
JULY 7-13, 1968

VOLUME VI

A STUDY OF THE VARIETAL RESISTANCE OF TOMATO TO BACTERIAL WILT

II. THE PRACTICAL VALUE OF F 1 HYBRIDS AND THEIR CONTRIBUTION TO THE GENETIC BASIS OF RESISTANCE

By B. Digat, Plant Pathologist and M. Derieux, Genetist

C.R.A.A.G., Domaine Duclos Petit-Bourg Guadeloupe Institut National de la Recherche Agronomique (France)

I. INTRODUCTION

From the work initiated by IRAT* since 1963 and the subsequent work done since 1964 by INRA† in collaboration with IRAT, it appeared that several tomato varieties had variable levels of tolerance to bacterial wilt in the French West Indies.

A small fruited variety "199", imported from Puerto Rico, showed such a good tolerance that it was chosen as the resistant parent in a cross with the commercial variety FLORALOU. The hybrids obtained were studied in Guadeloupe, Martinique and French Guiana (1) and showed a sufficiently high level of tolerance.

In 1966 a Guadeloupean ecotype "CRA 66" was selected for its high degree of tolerance, and used as a parent in a cross with FLORALOU.

The purpose of this work is to give the results obtained in Guadeloupe from these two hybrids.

II. MATERIAL

1. Bacterial inoculum: Pseudomonas solanacearum E.F. Sm

The specific characters of the bacterial strains from Guadeloupe have been described (2, 3, 4).

Only the GUA TO 1‡ a highly virulent strain which causes a fast rapid wilting in tomato plants was used for the artificial inoculation as well as for the field trials.

In the laboratory, four-week old plants were inoculated either by the root-dipping technique using 5 ml of a two milliards pathogens suspension per plant or by injecting the stem with the inoculum.

In the field, the soil was inoculated by mixing one crushed wilted plant per square metre of soil.

2. Resistant parents: "199" and "Cra 66"

Variety "199"

This variety is the result of a double cross made at the University of Puerto Rico (Rio Piedras Station) by the late Dr. AZZAM (Platillo x L. pimpinellifolium) x (L. esculentum x Platillo).§ It was introduced and selected by the IRAT in Guadeloupe in 1964.

---

*Institut de recherches Agronomiques Tropicales et des Cultures vivrieres.
†Institut National de la Recherche Agronomique.
‡GUA TO 1: strain isolated from a Duclos (Guadeloupe) soil where trials are made.
§Variety PLATILLO is native of Puerto-Rico.

Two lines in the F 8 obtained from variety "199" were retained:

199 (39.15)*

199 (39.16)

The fruits of these lines are small and non pulpy, with green mucilage between the seeds and concentic cracklings near the peduncle.

The resistance of these two varieties to infection by the bacterial wilt fungus *pseudomonas solanacearum* is very high (98 per cent). Presence of pathogens in the plant can be proven by:

1. Grafting susceptible varieties on to these lines.
2. Bacterial isolation in vessels, of plants that did not exhibit wilt symptoms.

Variety "Cra 66"

Many small fruited ecotypes coming from *L. pimpinellifolium Mill.* and *L. esculentum var. cerasiforme* are grown in Guadeloupe where they are called "tomadoses". A survey showed that this group "tomadoses" exhibited a wide range of tolerance to bacterial wilt from extremely susceptible to highly tolerant.

Up to the present time, one "tomadose" called "CRA 66" with dark green foliage, great vigour and small pink fruits is resistant to bacterial wilt. Homogencity and immunity are in Guadeloupe environmentally maintained in offspring obtained by selfing.

Artificial inoculations by stem injection showed that "CRA 66" was extremely susceptible by this method to *Ps. solanacearum*. The "resistance wall" seemingly must be attributed to the roots.

Among the plants grown in the Plant Breeding Station of Montfavet† (FRANCE) for crossing, one earlier plant with decumbent foliage was called CRA 1. The others, homogeneous were grouped and called CRA 2.

3. Susceptible parent: "FLORALOU"

Variety "FLORALOU" is the susceptible parent. It was selected because its fruits contained very good commercial characteristics for the West Indian environment. Moreover it shows resistance to *Cladosporium fulvum* CKE. and *Fusarium oxysporum f. sp. lycopersice* (Sacc.) SNYDER and HANSEN, race 1. Floralou shows also a good tolerance to tobacco mosaic virus.

III. METHODS

1. Behaviour of the first category of hybrids (199 x FLORALOU) and of the corresponding back-crosses (199 x FLORALOU x FLORALOU)

This trial was conducted in Duclos (Guadeloupe) during the rainy season (November 6, 1967). This period is very favourable to the expression of virulence by pathogen. On the other hand, climatic conditions are unfavourable for the plant (day length reduction, high rainfall).

---

*39.15 and 39.16 IRAT numbers (1).
Among them two sections (A, B) was designed the identity of which had been established later.

†Thanks are due to P. PECAUT, head of Station d'Amelioration des Plantes Naraicheres, Montfavet (FRANCE), for collaboration in the scheme and for the hybridization necessary throughout this program.

Two rows of 100 plants representing each hybrid and back cross were established in an infected field. The experimental plan is as follows:

199 39—15

B C 39—15

HYBRID F 1 39—15 X FLORALOU

B C 39—15

HYBRID F 1 39—15 X FLORALOU

B C 39—16

HYBRID F 1 39—16 X FLORALOU

B C 39—16

HYBRID F 1 39—16 X FLORALOU

FLORALOU

2. Comparison between the two F 1 hybrid categories: (199 X FLORALOU) and (C R A X FLORALOU)

This experiment was laid down during the dry season (March 13, 1968) in a latin-square design. The items in comparison were:

First F 1 hybrid category: 199—39—15 X FLORALOU

2nd F 1 hybrid category: C R A 1 X FLORALOU

C R A 2 X FLORALOU

SUSCEPTIBLE PARENT: FLORALOU

Each treatment involved 4 plots of 25 plants.

3. Back-crosses study

The bacterial wilt resistance of the first back-cross offsprings was studied. The trial was done in the dry season (March 13, 1968).

Eight plants were selected at random from the first back-cross and either selfed or again back-crossed to floralou:

Eight offsprings from selfing (199 X FL. 2)=(199 X FLORALOU X FLORALOU) 1 to 8.

Eight offsprings from crossing with FLORALOU, that is to say 2nd back-cross: 199 X FL. 3=199 X FLORALOU X FLORALOU X FLORALOU.

Each cross or genetical origin was represented by two plots of 25 plants each in a lattice square design laid down to test the wilting resistance of these crosses.

Wilting plants were counted every three days. The number of healthy plants remained constant up to sixty days after planting.

The presence of *Ps. solanacearum* was shown in each wilting plant by serological method (5).

4. RESULTS

1. Behaviour of the first F 1 hybrids category (199x FLORALOU) **and of the corresponding back-crosses** (199 x FLORALOU x FLORALOU) **table 1, page 11.**

Previous trials at the same place during the dry season have shown a mean tolerance level of 85 per cent in F 1 and 73 per cent in F 2.

These results lead to the conclusion that bacterial wilt resistance is determined by one dominant gene.

However, a subsequent trial, planted in the same place during the rainy season showed that the tolerance level of the F 1 varied from 29 to 78 per cent. For back-crosses it varied from 3 to 57 per cent. It is evident, therefore, that tolerance cannot be determined by dominant factors.

2. Comparison between the two F 1 hybrid categories (199 x FLORALOU) **and** (CRA FLORALOU). **Tables 2, 3, 4, 5, page 12.**

CRA 1 x FLORALOU and CRA 2 x FLORALOU hybrids showed no difference in tolerance level. (Fruit quality and growth habit neither were different).

On the other hand they were significantly more resistant to bacterial wilt than 199 x FLORALOU F 1 which showed a rather weak tolerance level (59 per cent).

Row effect was very significant. Consequently wilting plants when ground and mixed with the soil did not suppress the infestation differences caused by previous cultures and soil heterogeneity.

3. Back-crosses study (Tables 6, 7, page 13)

In this trial, bacterial wilt resistance appeared to be recessive:

1°/ The second back-crosses 199 x FL 3 were no different from the control except for one plant on the first replicate and four plants in the other.

2°/ In four plants from the first back-cross selfing (199 x FL 2) a bacterial wilt resistance level not significantly different from 1/4 was noticed. Three plants were no different from the control and one plant was just at the limit of significance.

The interpretative model could be as follows:

FLORALOU	: R R,	susceptible.	
199	: r r,	resistant.	
F 1	: R r,	suseeptible.	
first back-cross	: 1/2 R r,		: 1/2 RR
first back-cross selfing (199 x FL 2)	: 1/4 R R, 1/2 Rr, 1/4 rr		: R R
second back-cross (199 x FL 3)	: 1/2 R r, 1/2 R R,		: R R

That is to say: 4 (199 x FL. 2) fully susceptible.

4 (199 x FL. 2) giving 1/4 of resistant plants
8 199 x FL. 3 fully susceptible.

V. DISCUSSION

In our series of trials, the tolerance level of F 1 hybrids (199 x FLORALOU) decreased:

85 per cent during the dry season (January–March, 1967).

46 per cent during the rainy season (November–December, 1967).

59 per cent during the dry season (January–March, 1968).

These trials were carried out at the same location. This decrease in tolerance can be explained by the evolution of the bacterial population in soil towards more and more virulent strains. This could be caused by the selection pressure established by a tolerant host (6).

The seasonal variations in the ecological conditions can bring on a modification of the balance between host tolerance bacterial virulence. This could explain the seasonal differences in tolerance levels.

When the effects of replications at the same site and during the rainy season are added, a great decrease of tolerance level can occur. Consequently, in spite of the very good tolerance level of the new hybrid CRA x FLORALOU, results will have to be confirmed in the rainy season and by repeated cultures at the same place. The stability of this hybrid should be better than the stability of 199 x FLORALOU F 1 since tolerance of CRA is close to immunity. Fruits obtained have a good commercial value: no bitter taste, no green mucilage between seeds, the mean size (90 g) a little smaller than the size of 199 x FLORALOU (100 g) and the concentric crackling frequency is the same in the two hybrids (30 per cent).

The results obtained suggest that bacterial wilt resistance of Tomato is determined by one recessive gene and that in F 1 hybrids it could be linked with hybrid vigour.

Indeed, in plants infected by the bacteria, reduction of Indol-3-Acetic acid oxydase activity results in accumulation of Indol-3-Acetic acid which becomes toxic and effects in wilting (7, 8, 9).

Highly vigorous hybrids and susceptible plants have a different metabolism. Hybrids could thus support IAA accumulation, if it is effective. Bacterial wilt tolerance could be explained in this way.

TABLE 1

Varieties	Percentage Tolerance			
199—39.15	100			
Floralou	16			
	× 39.15		× 39.16	
F1 (199 × Floralou)	36	29	44	78
BC (199 × Floralou) Floralou)	57	11	18	3

TABLE 2

Varieties	Percentage Tolerance
Floralou	2
CRA 1 × Floralou	83
CRA 2 × Floralou	87
199 × Floralou	59

TABLE 3

Rows	Percentage Tolerance
I ...	73
II ...	67
III ...	56
IV ...	35

TABLE 4

Replications (COLUMNS)	Percentage Tolerance
1	71
2	52
3	56
4	52

TABLE 5

Analysis of Variance

Source of Variation	DF	Variation	F	P
Columns	3	20,3	3,6	—
Rows	3	70,0	12,3	< 0,01
Varieties	3	383,7	67,8	< 0,001
Error	6	5,66	—	—

Significant difference (5 per cent)= 16,6.

TABLE 6

Results

Back-Cross	(199 × FL 2)	(199 × FL 3)
1	2,4	1,2
2	3,0	0
3	5,7	1
4	7,6	1
5	0	0
6	5,3	2,2
7	7,5	5,1
8	0	1

TABLE 7

Analysis of Variance

Source of Variation	DF	Variance	F	P
Replications	1	1,71	4,88	≃ 0,05
Back Crosses	15	3,63	10,37	< 0,01
Error	15	0,35	—	—

Significant difference (5 per cent)= 2,56.

VI—REFERENCES

1. CORDEIL J. ET DIGAT B. 1967. "Etude de la resistance varietale au Fletrissement bacterion." "Tolerance d'un croisement 199 × FLORALOU en Guadeloupe et en Guyane Francaise." *Proceedings of Fifth Annual Meeting of the Caribbean Food Crops Society* (in press).
2. DIGAT B. ET ESCUDIE A. 1967. "Reconnaissance du Fletrissement bacterien aux Antilles Francaises." *Phytiatrie-Phytopharmacie* **16**: 187–197.
3. DIGAT B. 1967. "Survey of the bacterial wilt of Solanaceous Crops in French West Indies and in French Guiana." *Proceedings of Fifth Annual Meeting of the Caribbean Food Crops Society* (in press).
4. DIGAT B. 1968. "Why and How to distinguish the *Pseudomonas solanacearum* strains, causal agent of the bacterial wilt of Solanaceous and Musaceous crops in the Caribbean zone. "*Proceedings of Sixth Annual Meeting of the Caribbean Food Crops Society* (in press).
5. DIGAT B. ET BULIT J. 1967. "The use of grafting to control the bacterial wilt of Tomato in the French West Indies." *Proceedings of Fifth Annual Meeting of the Caribbean Food Crops Society* (in press).
6. OKABE H. AND GOTO M. 1961. "Studies on *Pseudomonas solanacearum* X I. Pathotypes in Japan." *Shizuoka Univ. Pac. Agr. Rept.* **11**: 25–42.
7. SEQUEIRA L. AND KELMAN A. 1962. "Accumulation of growth substances in plants infected by *Pseudomonas solanacearum*." *Phytopathology* **52**: 439–448.
8. SEQUEIRA L. 1963. "Growth regulators in plant disease." *Ann. Rev. Phytopath* **1**: 5–30.
9. SEQUEIRA L. 1964. "Inhibition of indolacetic acid oxydase in tobacco plants infected by *Pseudomonas solanacearum*" *Phytopathology* **54**: 1078–1083.