PROCEEDINGS

OF THE

CARIBBEAN FOOD CROPS SOCIETY

TENTH ANNUAL MEETING
PUERTO RICO

1972

VOLUME X

COMPARED VIRULENCE OF PSEUDOMONAS SOLANACEARUM IN DIFFERENT TYPES OF SOIL

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INTRODUCTION

Bacterial wilt on tomato and eggplants appears very often in vegetable-growing areas of French West Indies. The production of these vegetables is, therefore, a lottery for the grower, especially if he wants to include regularly these solanaceous crops in his rotations.

Empirical observation may lead to general previsions summarized in table 1.

Climatic factors explain probably some of the different situations observed (absence of bacterial wilt above 1,500 feet elevation, probably linked with low temperatures, absence of bacterial wilt on the first solanaceous crop in dry volcanic areas, probably linked with soil dryness during severel months in the year.)

But the absence of severe manifestations of bacterial wilt in limestone soils of Grande-terre, Marie Galante and places in Southern Martinique, even after successive irrigated crops* show that soil constitution is also an important factor influencing the possibility and quickness of soil invasion by Pseudomonas solanacearum.

MATERIAL AND METHODS

Our experiments were done with tomato plants of the variety Floradel, susceptible to bacterial wilt. Plants aged of 20 to 25 days were produced in 2 inches pots, and transplanted in 5 or better 7 inches pots filled with the soil sample to be examinad. The large pots were inoculated 3 weeks before transplantation by pouring on their surface 4 ml (5 inches pots) or 8 ml (7 inches pots) of a virulent bacterial suspension obtained by adding 100 ml of distilled water to 1 test tube of a virulent culture of Pseudomonas solanacearum aged 3 days.

The plants were then observed during 21 days for the rapidity and severity of bacterial wilt symptoms.

TABLE 1

Type of soil	Altitude	Climatic conditions	Preceding crop	Bacterial wilt incidence 1/	
				1st Crop	Successive crops with irrigation
volcanic soil	more than 1500 feet	-	-	0	0
volcanic soil	near sea level	dry areas (less than 80 inches of rainfall)	-	E	+++
		wet areas	sugarcane or pasture	E	+++
			banana	++	+++
limestone soil	near sea level	-	-	0	E

1/ 0: no bacterial wilt, E: plant diseased in a low percentage, mild symptoms, ++: disease severe, +++: disease very destructive.

A scale from 0 (healthy plant) to 4 (dead plant) was used, intermediate notes expressing various degrees of leaf epinasty and adventitious root development, transient or permanent wilt. The mean note obtained per plant was multiplied by 25, in order to obtain 100 for complete mortality.

* From the experience of experimental gardens at the Beauport sugar factory and St-Francois INRA farm (Grande-Terre) Vidon experimental farm (Marie Galante) and Sainte-Anne IRAT experimental plots (Martinique).

The soil samples were used either in their natural condition, after passage through a 0.3 inch sieve or after different treatments:

1. Sterilization with formaldehyde (12 ml of 30% formaldehyde/7 inch pot)
2. Steam sterilization during 15 mm at 212°F
3. Steam sterilization during 1 h at 248°F twice at 24 h interval
4. Addition of several doses of finely divided pure calcium carbonate

RESULTS

The results of 3 characteristic experiments are presented:

Experiment 1

A vegetable garden soil from volcanic Guadaloupe was compared to a vegetable garden soil from Grende Terre (limestone soil).

TABLE 2

Location	Treatment	Disease index on successive days		
		6th day	12th day	21st day
Vegetable garden soil from volcanic guadeloupe	steam sterilized	59	100	--
	check	51	100	--
Vegetable garden soil from grande-terre (limestone soil)	steam sterilized	0	12	22
	check	0	15	23

Experiment 2

Other types of sterilization on limestone soil, addition of calcium carbonate to volcanic soil. (table 3).

TABLE 3

Location	Treatment	Disease index on successive days		
		6	14	21
Vegetable garden soil from volcanic guadeloupe	check	45	74	100
	+ 2‰ $CaCO_3$	11	43	83
	+ 4‰ $CaCO_3$	8	22	54
Vegetable garden soil from Grande-terre (limestone soil)	check	1	13	18
	formaldehyde	4	5	22
	120° two times	8	15	28
	inoculated at* transplantation	1	36	42
	inoculated by stem puncture	19	95	100

*Without root injury

Experiment 3

Different soil samples from volcanic Guadeloupe and Grande-Terre.

TABLE 4*

Locality		Observations	Disease index 20th day
	Petit-Canal	vegetable garden soil	46
Grande-Terre	Petit-Canal	vegetable garden soil	24
	Petit-Canal	Mangrove soil	17
	Gardel	Pasture soil	15
	St-Francois	vegetable garden soil	19
	Morne-a-l'eau	vegetable garden soil (1st year)	11
	Pointe-a-Pitre	vegetable garden soil	12
mean	disease index for Grande-Terre		20.5
	Vieux-habitants	vegetable garden soil in a dry area	62
	Matouba	vegetable garden soil at 1500 feet elevation	86
Volcanic Guadeloupe	Roujol	eggplant and Tobacco nursery	35
	Prise d'eau	vegetable garden-very low pH: 4.7	13
	Petit-Bourg	vegetable garden	71
	Duclos	vegetable garden	36
	Duclos	primitive forest soil	59
mean	disease index for volcanic Guadeloupe		50.3

*This experiment was realized in cooler conditions than the precedent ones, and disease development less rapid.

DISCUSSION AND CONCLUSIONS

It can be concluded, from experiments related above, that soil receptivity to invasion by Pseudomonas solanacearum is an inherent characteristic, resistant to formaldehyde, steam, or autoclave sterilization, therefore, not linked with a special kind of soil microflora.

Since with "resistant" soils, the low receptivity is better expressed when soil is inoculated 3 weeks before transplantation than when inoculated at transplantation, and absolutely not expressed when plants are directly stem inoculated we can conclude that this resistance is the consequence of a direct effect of soil on bacteria, and not of an indirect effect on plant susceptibility, as it occurs with Tomato Fusarium wilt. (DAVET, MESSIAEN & RIEUF 1966, JONES & WOLZ 1970). We can conclude from the 3rd experiment that volcanic soils are, as a general rule more receptive than limestone soils. Volcanic soils which are not actually contaminated (soil from dry areas in altitude or virgin soil from forest) may be virtually still more receptive than old vegetable garden soils. There are, however, some exceptions: one in Grande Terre (vegetable garden at Petit-Canal), one in Guadeloupe (vegetable garden at Prise d'eau). The second exception is very curious, since "receptive" soils have usually a pH between 5.5 and 6.5 "resistant soils" between 7 and 8.5. This "resistant" volcanic soil has an exceptionally low pH (4.7).

The work related in this paper may be considered only as a first approach of the question: on one hand the results are not new, since in KELMAN's book (1953), lowering the pH to 4.5 with sulfur, followed by a rise to 7.5 by lime application is presented as an effective method to control bacterial wilt.

On the other hand it would not be wise to take only pH in consideration. A rise of pH obtained with Mg, K or Na would it be effective in the same way as with Ca ? We must remember, too, that other differences exist for the pedologist between volcanic and limestone soils "ferralitic soils" and "vertisols." The type of clay is different: kaolinite in the first kind of soil, montmorillonite in the second type. We must remember that montmorillonite was presented by STOTZKY & al (1961) as the factor of resistance in some soils to invasion by Panama disease on bananas (caused by Fusarium oxysporum f. sp. cubense.)

These various considerations (pH, Ca versus other cations, clay type), and the fate of bacteria in "resistant soils" (do they disappear, or become avirulent ?) will be the subject of new experiments realized by Berniac and M. Beramis in 1972 and 1973.

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