Host range of the ginger strain of Pseudomonas solanacearum in Queensland

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Pseudomonas solanacearum (Erw. Smith, 1896) Erw. Smith, 1914 biotype 3 (Hayward 1964) is commonly present in the ginger (*Zingiber officinale*) growing district of south-eastern Queensland. This strain occasionally produces a slow wilt in ginger which is of little consequence. In many instances, the root knot nematodes (*Meloidogyne javanica* (Treub) Chitwood and *M. incognita* (Kofoid and White) Chitwood) are associated with such infections. The severe wilt of ginger which is of great concern to the industry is caused by *P. solanacearum* biotype 4 (Hayward, Moffett and Pegg 1967).

In 1954 a bulk shipment of ginger planting material was imported from Canton, China. Following the planting of this seed, considerable areas of ginger were destroyed by a wilt disease. *Fusarium* sp. found associated with this condition proved pathogenic on ginger (Simmonds 1955). Two years later this disease was considered to have been eliminated from Queensland following implementation of certain control measures including discarding infected planting material and avoiding planting in infested soil (Simmonds 1956). Also ginger acreages in the late 1950's were very low, only approximately 16 acres being planted in each of the seasons from 1955-56 until 1957-58. This in itself would have restricted disease spread. In 1965 a disease with identical symptoms to those described in 1955 occurred and *Pseudomonas solanacearum* biotype 4 was isolated. It is considered a possibility that this organism was imported in the seed material introduced in 1954 and remained undetected until the 1965 outbreak.

Fresh outbreaks have occurred in each subsequent year, except for the summer of 1968-69 when a severe drought considerably reduced ginger production.

Kelman (1953) listed a large number of hosts of *P. solanacearum* which included a wide range of weeds as well as economically important crops. An investigation was initiated in February 1968 to determine the host range and survival of *P. solanacearum* biotype 4 under field conditions in southern Queensland.

Materials and methods

Host range studies

On February 1, 1968, a trial was established on land where a ginger planting had been completely destroyed by bacterial wilt early in the 1967-68 growing season. A minimum of ten plants of each of a range of plant species were planted in single parallel row plots fifteen feet long in a randomized block layout with two replications. The species used are shown in table 1. Volunteer weeds such as *Xanthium pungens* (noogoora burr) and *Physalis minima* (wild gooseberry), which came up in the trial area, were also allowed to become established. Individual plants were collected as soon as wilting was observed and isolations made. However, in a number of instances plants wilted and died before they could be harvested. By the end of the summer, all remaining plants had been collected and isolations made from the vascular tissue. The culture medium used was a sucrose peptone agar (Hayward 1960). Where *P. solanacearum* was isolated, a single colony of the organism was sub-cultured, checked for purity, and the biotype grouping to which it belonged determined (Hayward 1964).

Following the severe drought of 1968-69, the opportunity was taken to determine whether biotype 4 had survived this period (20 months) of extremely dry conditions. Consequently the area used for host range studies in early 1968 was replanted in January 1970 with ginger, tomato, *Xanthium pungens*, *Solanum mauritianum* (wild tobacco tree), and *Physalis peruviana* (cape gooseberry). The latter two weeds were included in the second trial solely to extend the weed species tested. Isolations were made from a small number of these plants as they wilted and the biotype of positive *P. solanacearum* isolates determined.

During the summer months of 1967-68, and

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1969-70 weeds were collected from areas with outbreaks of ginger wilt. Weeds examined were not always exhibiting wilt symptoms but particular attention was paid to any plant showing stress during the day. Small slices of root or stem vascular tissue were suspended in sterile distilled water and, if bacterial streaming was observed, isolations were made.

Results

In the host range trial the rate at which the plants wilted varied. However, ginger, tomato, with the exception of line S5, capsicum, and egg plant wilted rapidly. Stunting, epinasty, and the production of adventitious roots were other common symptoms. These symptoms are commonly observed in plants affected by bacterial wilt. Although *P. solanacearum* was isolated from S5, the plants did not wilt but some adventitious roots were produced. Results of the isolations made in the 1968 trial and the 1970 replant trial are given in tables 1 and 2.

Large numbers of weeds were examined in ginger patches affected by bacterial wilt during the two summers, but only those hosts from which *P. solanacearum* was isolated are recorded in table 3.

TABLE 1

The number of isolates of biotypes 4 and 3 of Pseudomonas solanacearum *isolated from the plant species from the 1968 host range trial.*

Host	No. of plants harvested	Number of isolates Biotype 4	Biotype 3
Tomato (Q2)	29	28	1
Tomato (Platillo)	25	23	2
(Sioux)†	7	7	0
(Line S5)†‡	5	3	0
Potato	23	19	3
Capsicum	15	15	0
Egg plant	27	26	1
Peanut (Red Spanish)	35	2	1
Tobacco (Hicks)	41	2	0
Ginger	13	12	1
Solanum nigrum (blackberry nightshade)	23	23	0
Xanthium pungens (Noogoora burr)	3	0	3
Physalis minima (wild gooseberry)	2	2	0
Alpinia caerulea (wild ginger)	20	0	0

† A small number of plants were available and were included in the trial.

‡ Plants of this line did not wilt.

TABLE 2

Biotypes of isolates of Pseudomonas solanacearum *from wilted plants harvested during the 1970 host range trial.*

Host	Harvested plants from which *P. solanacearum* was isolated	No. of isolates Biotype 4	Biotype 3
Ginger	7	5	2
Tomato	6	1	5
Xanthium pungens (Noogoora burr)	4	0	4
Solanum mauritianum (wild tobacco tree)	7	1	6
Physalis peruviana (cape gooseberry)	1	1	0

Discussion

Sequeira (1962) found that fallowing and crop rotation over an 18-24 month period effectively reduced the population of the banana strain of *P. solanacearum* in Costa Rica. This was probably due to the very limited host range (*Heliconia* spp. and banana) of this strain. However, when the organism has a wider host range, the chances of survival of the specific strain are much greater.

Results in table 1 show that biotype 4 in Queensland is capable of producing a wilt of a number of economic crops normally susceptible to the strain (biotype 3) commonly present in this area. It is interesting to note that even in the experimental area, where the population of biotype 4 must have been extremely high, biotype 3 was still of some importance. *Alpinia caerulea*, a native member of the Zingiberaceae present in the district, was not susceptible to *P. solanacearum* in the host range trial (table 1) nor was this organism ever isolated from *A. caerulea* examined in the survey of weeds.

Some weeds were found to be hosts for both biotypes 3 and 4 (table 3). These included *Solanum*

TABLE 3

The biotype of Pseudomonas solanacearum *isolated from weeds collected in bacterial wilt infested ginger plantings during the summer months of 1967-68 and 1969-70.*

Host	Weeds from which *P. solanacearum* was isolated	Number of isolates	
		Biotype 4	Biotype 3
Solanum nigrum (blackberry nightshade)	8	7	1
Crassocephalum crepidioides (thickhead)	37	34	3
Solanum mauritianum (wild tobacco tree)	3	1	2
Xanthium pungens (Noogoora burr)	8	0	8
Physalis peruviana (cape gooseberry)	2	2	0
Physalis minima (wild gooseberry)	1	1	0
Dodonaea lanceolata (hop bush)	3	0	3
Bidens pilosa (cobbler's pegs)	1	0	1
Sida spinosa (spiny sida)	1	0	1
Ageratum houstonianum (blue billygoat weed)	1	1	0

nigrum (blackberry nightshade), *Crassocephalum crepidioides* (thickhead), and *S. mauritianum*. Biotype 4 only was isolated from *P. minima*, *P. peruviana*, and *Ageratum houstonianum* (blue billygoat weed). However, only a small number of plants of these species was examined. Although *X. pungens* and *Dodonaea lanceolata* (hop weed) are commonly found in ginger plantings, biotype 4 has so far never been isolated from these weeds. This is also true for *Rapistrum rugosum* (turnip weed), *Bidens pilosa* (cobbler's pegs) (Hayward, Moffett and Pegg 1967), and *Sida spinosa* (spiny sida). It was of interest that in one ginger planting where biotype 4 was isolated from *C. crepidioides*, a heavy infestation of root knot nematode was often associated.

Table 2 indicates that both biotype 3 and biotype 4 present in the trial area could survive through a severe drought period to invade plantings 20 months later. As no attempt was made to eliminate weeds from the area during this period, both strains may have survived in their appropriate hosts, and on cultivation in early January 1970 were still present in a viable state.

The tomato line S5 was the only variety tested with any field resistance to biotype 4. This supports results obtained with the S lines at Darwin in the Northern Territory (Heaton and Benson 1968).

The weed host range of biotype 4 appears to be more restricted than that of biotype 3. Nevertheless it does pose a considerable problem with respect to the survival, and thus the eventual elimination, of this organism. The average annual rainfall of the ginger growing area is approximately 70 inches. Most precipitation occurs during the summer months. Weed growth is prolific during the hot humid growing period. In the past, much of the ginger was grown on steep land (slopes up to 30°) and bare fallowing, to reduce the population of the organism, could not be contemplated. However, the industry is now mechanized and most of the crop is grown on relatively flat ground. Bare fallowing is therefore now a possibility. The recommended rotation for ginger is either rye, winter oats, or green panic (long term rotations). At this stage, the effect of such rotations on biotype 4 populations is unknown, but ginger growers should at least ensure that known susceptible weeds are excluded from rotations.

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