Pathogenicity on Bean of *Pseudomonas syringae* pv. *syringae* Recovered from the Phylloplane of Weeds and from Bean Crop Residue

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ABSTRACT

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Weeds in or near fields with a history of bacterial brown spot of bean were evaluated to determine if *Pseudomonas syringae* pv. *syringae* overwinters on them. Pathogenicity of strains was determined with a detached bean pod assay. Strains of *P. s. syringae* were recovered from 29 of 108 and 27 of 136 samples of individual weed species collected in 1986 and 1987, respectively, but the pathogen was only recovered from two samples each year. In 1988, most samples were mixtures of weed species collected from three fields. The pathogen was recovered from 30 of 202 weed samples. Soil and bean residue from the previous season were also sampled in these fields. The pathogen was recovered from soil up to 5 June, and from bean residue throughout the season. For all 3 yr, the pathogen was recovered only from weeds at sites where brown spot had been severe the previous year. The pathogen was most frequently recovered from weeds within fields where bean residue infested with the pathogen was abundant. The pathogen was recovered from two pea samples and one soybean sample collected from sites associated with beans, not from 135 samples of 13 other crop species, and never from weeds in nonagricultural sites. For these reasons we suggest that bean residue, and not weeds, is a significant source of inoculum for bacterial brown spot in New York.

Additional keyword: epiphyte.

Many bacteria that are pathogens of plant foliage have epiphytic associations with their hosts (8). As epiphytes, these bacteria may provide inoculum for disease. Lindow et al (16) found that *Pseudomonas syringae* was a widely distributed epiphyte on many plant species, and speculated that these epiphytes may serve as a source of inoculum (for various diseases) for either the plant on which they reside or nearby plants. *P. s.* pv. *syringae*, the causal agent of bacterial brown spot of bean (*Phaseolus vulgaris* L.), has a well-described epiphytic association with bean (3,4,14). In Wisconsin (15), epiphytic populations of *P. s. syringae* on snap bean leaves were reported as being predictive of outbreaks of brown spot.

Nonhost plants have been implicated as providing inocula for brown spot epidemics (4,14). Epiphytic populations of *P. s. syringae* on hairy vetch were correlated with brown spot outbreaks in nearby bean fields (4). Lindemann et al (14) suggested that *P. s. syringae* can overwinter on several nonhost plant species that possibly contribute inoculum for brown spot epidemics in Wisconsin. Bean crop residue also has been suggested as an overwintering source for the pathogen (6). Hoitink et al (9) found that the pathogen survived in soil until April and on bean crop residue until March in a field that had bacterial brown spot the previous year. Schuster (20) also reported the overwintering in the field of *P. s. syringae* on inoculated bean residue. Because *P. s. syringae* is known to be seedborne (9), infested seed can also be an inoculum source for establishment of epiphytic populations in bean plantings.

Host specificity has been reported among strains of *P. s. syringae* (2,4,5,18,19). Cheng et al (2) found that *P. s. syringae* isolated from brown spot lesions incited characteristic water-soaked, sunken lesions on excised bean pods, whereas strains of the bacterium from other hosts caused necrotic reactions. Ercolani et al (4) also reported that strains of *P. s. syringae* isolated from bean induced typical brown spot symptoms on the foliage of greenhouse-grown beans, while strains from other plants except hairy vetch and sweet clover caused necrotic flecks. Because strains of *P. syringae* that are not pathogenic to bean are often found in epiphytic association with bean (14) and nearby weeds (4), it is important to carefully determine the potential of strains to cause brown spot.

This study was undertaken to evaluate the pathogenic capability on bean of strains of *P. s. syringae* recovered from the phylloplane of weeds, from crop species reported as hosts, and from other sources. Sampling was concentrated on weeds from fields where beans were not grown that season to ensure that populations had not originated on beans grown the year samples were collected. Bean crop residue and soil from fields where brown spot had occurred the previous year were also evaluated as potential overwintering sources of the pathogen.

MATERIALS AND METHODS

Type of sites sampled. To evaluate the occurrence and potential overwintering of *P. s. syringae* on weeds, two types of sites were sampled in western New York. The first group included snap bean fields where severe outbreaks of brown spot had occurred in 1985 (85A, 85B, 85C, 85D), in 1986 (86A, 86B, 86C, 86D), and in 1987 (87A, 87B, 87C) (Table 1). These sites were selected because of their distribution in the major bean-growing regions of western New York. The 1987 sites were selected in different regions where brown spot epidemics had occurred at different times and different cultivation treatments had been used the previous year. The snap bean crop at site 87A was unharvested after a mid-August brown spot outbreak rendered the beans unmarketable. This site was planted to corn in May 1988. Site 87B was harvested on 21 July 1987 when leaves but not pods were affected by a severe brown spot outbreak. After harvest the field was disked and then left undisturbed until planted to corn in May 1988. Site 87C was harvested in mid-September despite severe brown spot that caused 20% culls among pods evaluated at the processing plant. This site was subsequently disked and planted to rye that fall. The second group consisted of three nonagricultural sites (A, B, C) located in woodland areas free of farming, and a corn field located in a region with no history of bean production. These sites were sampled on various dates in the spring and summer of 1986, 1987, and 1988.

Type of samples collected. In 1986 and 1987, samples consisting of 25–50 g of foliage (i.e., leaves, stems, and flowers) of weed species were collected, sealed in individual resealable plastic bags,

and placed on ice in a chest. Weeds were collected from within 4 m of cultivated field edges (field borders) at brown spot sites, or from random locations at nonagricultural sites.

In 1988, 25–50 g of foliage from mixtures of miscellaneous weed species were collected and bulked together before assaying for epiphytes. At brown spot sites, samples were collected from field borders and from within fields. They were placed in individual resealable bags as described previously. In March, April, and May, mixed samples of grasses were collected separately from mixed samples of nongrass weeds. Some mixed weed samples collected in May, and all samples collected in June, July, and August were combined samples of grass and nongrass weeds. Occasionally, selected weed species were sampled individually at brown spot sites as previously described. Foliage from a mixture of woody perennial weed species adjacent to the fields was also collected in May, June, and July at all sites.

Soil and bean crop residue samples were also collected from the 1988 brown spot sites. Samples consisting of 10–20 g of bean crop residue (primarily stem and hypocotyl pieces) were collected from April to August 1988, sealed in resealable bags and refrigerated at 4 C for up to 7 days until processed. At the same time, approximately 250 g of soil was collected from the top 10 cm of 25–30 random locations within a field with a surface-sterilized hand trowel and then mixed together in a surface-sterilized 20-L bucket. A 1-L resealable bag was then filled with a subsample of this mixture, sealed, and stored at 4 C for up to 7 days until processed.

Bean and several crop species reported as hosts of *P. s. syringae* (1) were also assayed in 1986, 1987, and 1988 for epiphytic *P. s. syringae*. During May, June, and July, 25–50 g of foliage (without disease symptoms) of cultivated plant species were collected at various locations in New York, and placed in resealable plastic bags as previously described.

Processing of samples. Foliar samples were processed within 24 hr either by placing them in 300 ml of sterile phosphate buffer (0.1 M, 7.0 pH) (14) in a sterile 500-ml Erlenmeyer flask and shaking them for 1 hr on a wrist action shaker (1986), or by sonicating for 10 min after adding 300–500 ml of sterile phosphate buffer to the sample bag (1987 and 1988). Sample washes were dilution plated onto King's medium B (KB) in 1986, 1987, and 1988, modified *P. syringae* medium (mPSM) in 1987 (2), or Mohan and Schaad's (17) modified KB medium (KBC) in 1988, and incubated at 22 C for 48–72 hr. Colonies with characteristics indicative of *P. syringae* (i.e., small, rough-margin, opaque colonies that fluoresce blue-green under long-wave UV light) were transferred to fresh KB medium for further characterization.

Samples of bean crop residue were processed within 7 days of collection by blending 5 g of residue with 100 ml of sterile phosphate buffer for 1 min at high speed in a surface-sterilized electric blender. The resulting suspension was then dilution plated onto KBC medium and colonies were characterized as previously described for foliar samples in 1988. Soil samples were assayed within 7 days of collection by mixing 100 ml of sterile phosphate buffer with 50 g of soil (from which all visible bean crop residue had been removed by hand) and sonicating them for 10 min. Samples were then dilution plated onto KBC and colonies with characteristics indicative of *P. syringae* were transferred to KB medium for further characterization.

Identification of *P. s. syringae*. In 1986, after 24 hr of incubation on KB at 22 C, putative strains of *P. syringae* were tested for oxidase activity (10) and ice-nucleation activity at −3.5 C by a toothpick assay (11). Strains that were ice-nucleation active at −3.5 C and oxidase negative were evaluated for utilization of mannitol, sorbitol, homoserine, L-tartrate (7), levan production (7), and production of acid from sucrose (13), and tested for their pathogenicity on bean by a bean pod assay (2). Excised greenhouse-grown bean pods were inoculated with an insect pin laden with bacterial cells, incubated for 4–5 days, and then observed for characteristic symptoms (2). In 1987, putative strains of *P. syringae* were tested for oxidase production and for ice-nucleation activity at −3.0 C. Strains that were oxidase negative and ice-nucleation active at −3.0 C were then tested for pathogenicity on excised bean pods and evaluated for utilization of mannitol, inositol, L-lactate, L-tartrate, homoserine, and anthranilate, levan production, and acid production from sucrose. In 1988, putative strains of *P. syringae* recovered from crop species other than bean were characterized as in 1987. However, of the fluorescent, oxidase-negative pseudomonad strains recovered from weeds, only those that were ice-nucleation active at −3.0 C and caused pod reactions indicative of the pathogen were biochemically characterized as in 1987.

Strains described as *P. s. syringae* in this study were oxidase negative, ice-nucleation active at −3.0 C or −3.5 C, utilized mannitol, sorbitol, L-lactate, and inositol, and produced levan and acid from sucrose. Strains referred to as the pathogen are strains of *P. s. syringae* that caused a reaction in inoculated bean pods (water-soaked, sunken lesion without necrosis) characteristic of strains isolated from brown spot lesions.

TABLE 1. Recovery of *Pseudomonas syringae* pv. *syringae* from the foliage of weeds collected at sites where bacterial brown spot had occurred in recent bean plantings, at nonagricultural sites, and in a corn field

Site	Year		
	1986	1987	1988
Bacterial brown spot sites[a]			
85A	1/16 (36)[b]	0/3(23)	ns[c]
85B	0/0 (9)	0/1 (6)	ns
85C	1/4 (26)	ns	ns
85D	0/5 (13)	ns	ns
86A	ns	0/2 (16)	ns
86B	ns	0/5 (17)	ns
86C	ns	2/7 (22)	ns
86D	ns	0/0 (5)	ns
87A	ns	ns	19 (66)[d]
87B	ns	ns	7 (51)
87C	ns	ns	4 (43)
Nonagricultural sites			
A	0/4 (13)	0/5 (20)	0 (21)
B	0/0 (11)	0/4 (20)	ns
C	ns	0/0 (7)	ns
1988 corn field site	ns	ns	0 (21)
Totals	2/29 (108)	2/27 (136)	30 (202)

[a]Sites where severe bacterial brown spot had occurred on snap beans in 1985 (85), 1986 (86), and 1987 (87).
[b]Number of samples from which *P. s. syringae* pathogenic on bean was recovered/number of samples from which *P. s. syringae* was recovered (number of samples collected).
[c]Not sampled.
[d]For 1988, number of samples from which *P. s. syringae* pathogenic on bean was recovered (number of samples collected).

RESULTS

Recovery of *P. s. syringae* from weed samples. In 1986, 108 samples of 43 weed species were collected at six sites (Table 1) and *P. s. syringae* was recovered from 29 samples of 26 species (Table 2) at four sites. However, strains of *P. s. syringae* pathogenic on bean were recovered from only two samples, *Stellaria media* L. (common chickweed) and *Cornus* sp. (dogwood) collected on 12 and 14 May 1986, respectively (Table 2). The samples came from two sites where brown spot had occurred in 1985. Strains of *P. s. syringae* recovered from nonagricultural sites were not pathogenic on bean.

In 1987, 137 samples of 46 weed species were collected at nine sites (Table 1) and *P. s. syringae* was recovered from 27 samples of 15 species (Table 2). The pathogen was only recovered from two weeds, *Ranunculus bulbosus* L. (common buttercup) and *Erigeron annuus* L. (daisy fleabane), both collected on 16 June 1987 from the border of a site (86C) where brown spot had occurred in 1986. Strains of *P. s. syringae* recovered from three nonagricultural sites in 1987 were not pathogenic on bean.

In 1988, the pathogen was not recovered from 42 weed samples collected at the nonagricultural and corn field sites. However,

the pathogen was recovered from 30 of 202 weed samples collected at three brown spot sites (Table 1). At site 87A, the pathogen was recovered from 19 of 66 weed samples (Table 3), all collected from within the field. The pathogen was not recovered from 29 samples collected from the field border. At site 87B, the pathogen was recovered from seven of 51 weed samples: three collected within the field and four from the border. The pathogen was not recovered from any samples collected at the site after the week of 5 May 1988. At site 87C, the pathogen was recovered from four of 43 weed samples: one collected within the field and three from the border. However, the pathogen was not recovered from any weeds collected after the week of 22 May 1988. The pathogen was never recovered from weeds collected at non-agricultural and corn field sites.

Recovery of *P. s. syringae* from bean residue and soil samples. The pathogen was recovered from 23 of 38 (60%) bean crop residue samples collected at the brown spot sites in 1988 (Table 3). Only eight of 31 (26%) soil samples collected at these sites yielded the pathogen, and it was not recovered from soil collected after the week of 5 June 1988.

Recovery of *P. s. syringae* from crop plants. From 1986 to 1988, the pathogen was recovered from 40 of 166 samples of symptomless bean leaves (Table 4). The pathogen was also recovered from two of 23 pea and one of 15 soybean samples, but not from 135 other samples from reputed hosts of *P. s. syringae*. The two pea samples that yielded the pathogen were collected in fields where beans had severe brown spot the previous year, and bean residue was present. Only one strain of the pathogen was recovered from the positive soybean sample, and this sample was collected in a bean-growing region. The pathogen was not recovered from corn or rye collected in 1988 within the brown spot sampling sites.

DISCUSSION

Since the early 1980s, bacterial brown spot has become an increasingly important problem in central and western New York snap bean production areas. This disease has been important in Wisconsin since the 1960s, where weeds were reported to be an important source of overwintering inoculum (4,14). We anticipated similar findings from this study, but our data do not support the conclusion that weeds are significant sources of inoculum for brown spot in New York.

During the 3 yr of this study, 333 weed samples were collected at sites where brown spot had occurred previously, but where beans were not grown during the season when samples were collected. In addition, 113 weed samples were collected at locations without a history of bean production. Strains of *P. s. syringae* pathogenic on bean were only recovered from samples collected at brown spot sites. The pathogen was recovered from 11 of 261 (4%) weed samples collected from field borders, whereas it was recovered from 23 of 72 (32%) weed samples collected from within the field. The pathogen was not recovered from weeds in field borders after mid-June, and it was only recovered from a single weed sample from within the field after the week of 19 June. This suggests that strains of the pathogen do not persist on weeds throughout the summer.

The pathogen is known to have evolved an epiphytic relationship with bean, and it can be recovered readily from bean foliage (3,12,14). If the pathogen also were adapted for epiphytic association with the weed species from which it was recovered, we would expect to find it as a frequent inhabitant of these species throughout the growing season in bean production regions, and occasionally on weeds not near beans. Because the pathogen was only recovered from weeds at bean fields infested with brown spot, and did not persist on them throughout the season, it appears that the pathogen is not well adapted for epiphytic survival on weeds. We conclude that while the pathogen may occasionally be associated with weeds at locations with a history of brown spot, these are transient relationships, and therefore not important in the epidemiology of brown spot in New York.

In an early study in Wisconsin on the epidemiology of brown spot, Hoitink et al (9) did not recover the pathogen from perennial legume weeds in fence lines and windbreaks bordering bean fields. In contrast, later studies in Wisconsin (4,14) found that the pathogen was commonly recovered from weeds (hairy vetch,

TABLE 2. Weed species from which *Pseudomonas syringae* pv. *syringae* was recovered in 1986 and 1987

Family	Name	Common name	Year 1986	Year 1987
Asclepiadaceae	*Asclepias syriaca* L.	Common milkweed	0/1 (2)[a]	0/0 (1)
Caryophyllaceae	*Stellaria media* L.	Common chickweed	1/2 (2)	ns[b]
Compositae	*Achillea millefolium* L.	Yarrow	0/1 (2)	0/1 (2)
	Anthemis cotula L.	Mayweed	0/2 (2)	0/7 (11)
	Arctium minus (J. Hill)	Common burdock	0/1 (2)	0/1 (2)
	Cichorium intybus L.	Chickory	0/1 (1)	ns
	Erigeron annuus (L.) Pers.	Daisy fleabane	0/2 (4)	1/1 (6)
	Eupatorium purpureum L.	Sweet joe-pye-weed	0/1 (1)	ns
	Hieracium aurantiacum L.	Orange hawkweed	0/1 (2)	0/0 (3)
Cornaceae	*Cornus* sp.	Dogwood	1/2 (3)	ns
Cruciferae	*Barbarea vulgaris* R. Br.	Winter cress	0/2 (5)	0/1 (8)
	Capsella bursa-pastoris L.	Shepard's purse	0/1 (2)	0/0 (4)
	Sisymbrium altissimum L.	Tumble mustard	ns	0/1 (2)
	Sisymbrium officinale L.	Hedge mustard	ns	0/2 (3)
Guttiferae	*Hypericum perforatum* L.	Common St. Johnswort	0/1 (2)	0/2 (2)
Labiatae	*Leonurus cardiaca* L.	Motherwort	0/0 (1)	0/1 (1)
	Prunella vulgaris L.	Heal-all	0/1 (3)	0/0 (5)
Leguminosae	*Lotus corniculatus* L.	Bird's-foot trefoil	0/0 (2)	0/3 (6)
	Trifolium spp.	Clovers	0/1 (9)	0/1 (5)
Onagraceae	*Oenothera biennis* L.	Common evening primrose	0/1 (1)	ns
Ranunculaceae	*Ranunculus bulbosus* L.	Common buttercup	0/1 (6)	1/2 (7)
Rosaceae	*Geum virginianum* L.	Rough avens	0/1 (1)	ns
	Potentilla recta L.	Rough fruited cinquefoil	0/0 (2)	0/2 (3)
	Potentilla simplex Michx.	Common cinquefoil	ns	0/1 (5)
Rubiaceae	*Galium aparine* L.	Cleavers	0/1 (3)	0/1 (5)
Verbenaceae	*Verbena hastata* L.	Blue vervain	0/1 (1)	0/0 (1)
Unidentified			0/4 (14)	ns

[a]Number of samples from which *P. s. syringae* pathogenic on bean was recovered/number of samples from which *P. s. syringae* was recovered (number of samples collected).
[b]Not sampled.

yellow sweet clover, oak, black locust, winter rye, and sow thistle) associated with bean fields. It appears that many of these weeds were collected near fields where beans were being grown at the time weeds were sampled. Since beans can support large epiphytic populations of the pathogen (3,14), it would be difficult to determine if *P. s. syringae* recovered from weeds near bean fields had overwintered on the weeds or spread to the weeds from early-season associations with bean. Ercolani et al (4), also reported that the pathogen overwinters on hairy vetch, and could be recovered from hairy vetch during most of the season. We sampled several species of vetch during this study, but not hairy vetch because it did not occur at our sampling sites. Although we recovered the pathogen from crown vetch in November 1987 at site 87A (J. E. Hunter, *unpublished data*), its foliage did not persist throughout the winter, and subsequently the pathogen was not recovered from crown vetch when it regrew in 1988. We did sporadically recover the pathogen from purple vetch at site 87B, but these plants did not persist through July. Thus, although the pathogen was occasionally recovered from vetch in New York, the foliage of these weeds did not persist throughout the year; therefore, it is doubtful that the pathogen overwinters on them.

The interpretation of bioassays used in these studies may also be responsible for differences between our results and those reported in the later Wisconsin studies (4,14). Although an excised bean pod assay similar to what we used was used in these studies, the criteria used to differentiate the pathogen from other *P. s. syringae* were different. We used the criteria of Cheng et al (2) who reported that strains pathogenic on bean cause a water-soaked, sunken lesion without necrosis on bean pods, whereas strains of *P. s. syringae* not pathogenic to bean cause necrosis with or without water-soaking. The other studies (4,14) considered strains that caused water-soaking on bean pods to be the pathogen. This criterion would include strains that induced some necrosis in addition to a water-soaking reaction and would not be considered the pathogen by our definition.

Our results agree with those (4,14) that indicate that the pathogen can only be recovered from weeds near bean fields. We believe this is because bean crop residue is an abundant source of inoculum that can spread from the residue to weeds, especially within the field, and to bean. We repeatedly recovered the pathogen from bean residue until mid-August when sampling was discontinued. Furthermore, in laboratory studies with bean residue that had overwintered in the field, we found that splash droplets generated from the impact of water drops on pieces of residue contained the pathogen (J. E. Hunter, *unpublished data*).

Although the pathogen can overwinter in bean crop residue, it does not appear to survive there indefinitely. While the pathogen was recovered from residue throughout the season at sites 87A and 87C, the pathogen was not recovered from residue after early June at site 87B. We believe the disappearance of the pathogen from residue at site 87B was because the bean crop was harvested 1–2 mo earlier than at sites 87A and 87C. This extended the exposure of the residue to environmental conditions that hastened its decay. Additional attempts to sample bean crop residue at these sites in 1989 were not successful because no intact residue remained.

While *P. s. syringae* was recovered from several crop species (Table 4), the pathogen was only detected in two pea samples, and one soybean sample. Strains of the pathogen recovered from pea probably arose from bean residue located within those fields because beans grown there the previous year had brown spot. The single strain of the pathogen recovered from soybean was probably a transient from neighboring bean fields. Therefore, although the pathogen was occasionally recovered from pea and soybean, it is likely that these were transient associations with bacteria that came from bean. In the absence of recent plantings of beans, it appears that non-bean crop species do not support epiphytic populations of the pathogen.

Soil is another possible source of overwintering inoculum, but our data do not suggest that this is important. Other results (9) where the pathogen was also recovered from soil agree with our data indicating that long-term survival in soil is unlikely. However,

TABLE 3. Recovery of *Pseudomonas syringae* pv. *syringae* pathogenic to bean in 1988 from samples collected within and from the border of fields where brown spot had been severe in 1987

Month sampled (1988)[a]	Within fields			Field borders
	Weeds[b]	Bean residue	Soil	Weeds[b]
Site 87A				
March	4 (4)[c]	ns[d]	ns	0 (1)
April	7 (8)	2 (2)	1 (2)	0 (2)
May	4 (13)	1 (4)	2 (4)	0 (6)
June	3 (6)	3 (3)	1 (2)	0 (10)
July	1 (4)	2 (2)	0 (2)	0 (6)
August	0 (2)	2 (2)	ns	0 (4)
Subtotals	19 (37)	10 (13)	4 (10)	0 (29)
Site 87B				
March	1 (2)	ns	ns	0 (1)
April	2 (8)	3 (3)	1 (3)	0 (3)
May	0 (6)	2 (3)	2 (3)	3 (7)
June	0 (3)	1 (3)	0 (3)	1 (10)
July	0 (2)	0 (2)	0 (2)	0 (5)
August	0 (1)	0 (2)	ns	0 (3)
Subtotals	3 (22)	6 (13)	3 (11)	4 (29)
Site 87C				
March	ns	ns	ns	ns
April	0 (3)	1 (1)	1 (2)	1 (3)
May	1 (4)	1 (4)	0 (4)	2 (7)
June	0 (3)	2 (3)	0 (2)	0 (10)
July	0 (2)	2 (2)	0 (2)	0 (6)
August	0 (1)	1 (2)	ns	0 (4)
Subtotals	1 (13)	7 (12)	1 (10)	3 (30)
Grand totals	23 (72)	23 (38)	8 (31)	7 (88)

[a]Samples were collected starting the last week of March, throughout April, May, June, July, and ending the second week of August.
[b]Weeds were collected as a mixture of grasses, nongrasses, or grasses and nongrasses combined, or individual weed species.
[c]Number of samples from which *P. s. syringae* pathogenic on bean was recovered (number of samples collected).
[d]Not sampled.

TABLE 4. Recovery of *Pseudomonas syringae* pv. *syringae* from cultivated and wild edible plants in New York

Plants sampled	Year			Totals
	1986	1987	1988	
Bean	4/10 (37)[a]	33/45 (115)	3/4 (14)	40/59 (166)
Pea	ns[b]	1/2 (6)	1/1 (17)	2/3 (23)
Soybean	0/0 (1)	1/1 (1)	0/5 (13)	1/6 (15)
Apple	0/2 (24)	0/0 (2)	0/13 (18)	0/15 (44)
Lima	0/1 (2)	ns	0/5 (10)	0/6 (12)
Rye	0/0 (1)	ns	0/4 (11)	0/4 (12)
Corn	ns	ns	0/0 (12)	0/0 (12)
Alfalfa	ns	ns	0/0 (11)	0/0 (11)
Clover	ns	ns	0/0 (11)	0/0 (11)
Wild cherry	0/1 (8)	0/1 (2)	ns	0/2 (10)
Cherry	0/0 (4)	ns	0/1 (5)	0/1 (9)
Wheat	0/0 (2)	0/1 (4)	ns	0/1 (6)
Nectarine	0/2 (3)	ns	ns	0/2 (3)
Wild pear	0/0 (2)	ns	ns	0/0 (2)
Wild apple	0/0 (2)	ns	ns	0/0 (2)
Apricot	ns	ns	0/0 (1)	0/0 (1)
Totals				43/99 (339)

[a]Number of samples from which *P. s. syringae* pathogenic on bean was recovered/number of samples from which *P. s. syringae* was recovered (number of samples collected).
[b]Not sampled.

it is possible that the pathogen survives in soil in numbers too low to be detected with the methods we used.

The recovery of the pathogen from bean residue was greatly facilitated by the use of the semiselective KBC medium (17). Detection of the pathogen in dilution-platings of residue suspensions on KB was often confounded by growth of saprophytic bacteria, while residue suspensions incubated on KBC typically yielded easily distinguished colonies of *P. s. syringae* (D. E. Legard, *unpublished data*). The failure of Hoitink et al (9) to recover the pathogen from overwintered bean residue during the season may have been due to the inability of his isolation medium to inhibit the growth of saprophytic bacteria. However, occasionally *P. s. syringae* grown on KBC was difficult to identify because on some batches of the medium the bacterium failed to produce its characteristic fluorescence. One such batch of KBC medium was encountered while processing bean debris samples, and was probably responsible for our difficulty in recovering the pathogen during May 1988.

The importance of epiphytic associations of *P. s. syringae* with weeds and crops other than bean in the epidemiology of bacterial brown spot is questionable. While *P. s. syringae* is a common phylloplane inhabitant of many weed and crop species in our region, strains pathogenic on bean were rarely associated with these species. Without exception, the pathogen was only recovered from plants growing in association with bean plantings or fields with a recent history of brown spot. Therefore, it seems unlikely that populations of *P. s. syringae* on weeds or non-bean crops are an important source of inoculum for brown spot in New York. However, the pathogen can overwinter in bean crop residue, and this source of inoculum likely plays a significant role in the epidemiology of brown spot of beans.

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