Variability in Bean Bacterial Pathogens

M. L. Schuster and D. P. Coyne
University of Nebraska

In Bergey's Manual of Determinative Bacteriology (1957) are listed about 200 species and varieties of bacteria that incite diseases of major crop plants. Currently there are reported over 12 species that cause bean diseases. These species also attack other plant species. Of these, five are economically important: Xanthomonas phaseoli, X. phaseoli var. fuscans, Pseudomonas phaseolicola, Corynebacterium flaccumfaciens, and Pseudomonas syringae.

Not only is there a diversity of phytopathogenic bacterial species, there is greater diversity within many of the species. Many species are a confederation of strains with some characters in common, but differ in others including pathogenicity. New bacterial strains are being produced by mutation or other kinds of genetic changes. Accordingly most species comprise a diverse and changing population of biotypes.

It is a truism that the occurrence of strains of a bacterial pathogen complicates control. Strains are of great importance in breeding and maintaining disease-resistant varieties. Most pathogens are dynamic, and it is because of their shifty nature that the disease situation is seldom static.

The problem of new pathogenic strains is continual because of the genetic changes in the pathogens within a region that they have long occupied, because of the introduction of old organisms into new areas, and because changes in cropping practices can effect ecological upsets.

The reason for the bacterial blight epidemics in the U.S.A. in the 1960's appears to be the development of new races, the introduction of old organisms into new areas, and weather favorable for the diseases.

COMMON BLIGHT- A case in point is the discovery of new strains of X. phaseoli from bean seed from Colombia which were more virulent than a standard from Nebraska (Schuster and Coyne, 1971). Later, isolates from Uganda were found to be comparable to the Colombian strains (Schuster, Coyne, and Hoff, 1973). Samples of infected bean leaves from South and Central America yielded either X. phaseoli or X. phaseoli var. fuscans. Comparative virulence tests have not been made to date. Colonial variants of X. phaseoli which ranged from rough to mucoid differed in ability to produce leaf lesions and polysaccharide production (Corey and Starr, 1957). Detection of virulence of bacteria (X. phaseoli and P. phaseolicola) was accomplished on special culture media (Small and Worley, 1956).

Some of the Colombian X. phaseoli isolates differ in their host range. For example X. phaseoli - C-7 and X. phaseoli var. fuscans are capable of inducing cowpea blight and stem canker. The taxonomy of the Xanthomonas is still in a state of flux (Dye, 1962) and there is a great deal of synomony in the genus. The current trend is to group species and employ special forms (Sabet, 1959; Dye, 1962, Elrod and Braun, 1947). In the case of the cowpea pathogen it could be referred to as X. phaseoli f. sp. vignicola rather than Xanthomonas vignicola (Burkholder, 1944). The fuscous blight organism still retains its varietal status.

BEAN WILT- Since first discovered by Hedges (1926) and named Corynebacterium flaccumfaciens (C.f.), two additional strains, C. f. aurantiacum (C.f.a.) (Schuster and Christiansen, 1957) and C. f. violaceum (C.f.v.) (Schuster et al., 1968) have been discovered. These strains are similar serologically, physiologically, and in DNA base composition (Schuster et al., 1957, 1968) but C.f.a. appears more virulent in greenhouse tests. Hulluka (1972) substantiated this in his population studies in three bean cultivars; the final population of C.f.a. was 5-10 times that of C.f. and C.f.v. in all three cultivars.

HALO BLIGHT- Variability in virulence for P. phaseolicola was first demonstrated in Nebraska (Jensen and Livingston, 1944); differences in colony types (rough and smooth) was found in 1934 (Adam and Pugsley). Patel and Walker (1965) differentiated P. phaseolicola race 1 from race 2 on the basis of reaction of Red Mexican U13. On this basis, races 1 and 2 have been reported in several different countries.

Schroth, et al., (1971) concluded that there is an infinite number of races within the P. phaseolicola - P. glycines - P. mori group. They believe that neither P. phaseolicola race 1 nor race 2 is homogeneous with respect to virulence when tested on a number of cultivars. In central Nebraska, where halo blight devastated a 600-acre pilot snap bean acreage in 1964, strains of the pathogen were isolated which were more virulent than race 2 (Schuster, Coyne, and Kerr, 1966). Hubbeling (1973) and Johnson (1969) described haloless halo blight of bean; grease spots soon became necrotic. Hubbeling (1961) discussed such a strain assuming it was unable to produce toxins which induce leaf chlorosis. Such a strain could be considered as a mild strain of race 1. Omer and Wood (1969) found pre- and simultaneous- inoculation with a weak strain reduced the growth of the more virulent strain of halo blight bacterium.

BROWN SPOT- Coyne and Schuster (1969) tested the reaction of several bean cultivars with two P. syringae isolates (Nebraska and Minion) and found differences in virulence. Trugreen was susceptible to Minion isolate and tolerant to the Nebraska isolate. GN 1140 and Tempo appeared highly tolerant to both isolates. Recent occurrences of P. syringae on beans in Wisconsin in 1964 and 1965, and on beans, corn, and sorghum in Nebraska in 1969, and elsewhere, may in part be attributed to new races of the pathogen.

Breeding and Genetics

SEARCH FOR RESISTANCE IN BEANS TO PSEUDOMONAS SYRINGAE

D. J. Hagedorn University of Wisconsin

Since 1969 we have tried each year to discover resistance in bean to the bacterial brown spot pathogen (Pseudomonas syringae)under field conditions. The plots were located at the Hancock Agricultural Research Farm in the overhead irrigated "central sands" about 80 miles north of Madison. Beans were planted the third week of June. Alternate "inoculum" rows of a susceptible cultivar were planted with seed liberally dusted or "inoculated" with finely-ground dried leaves which had been selected the previous season because they showed numerous typical brown spot lesions. Sixty-six commercial cultivars and 100 Plant Introductions (PIs) were tested in 1969; 80 commercial cultivars and 317 PIs in 1970, 120 PIs in 1971, 231 PIs in 1972, and 206 PIs in 1973. The bean PIs tested were primarily white seeded bush types, but sometimes the plants were more like the runner than the bush type. Although Phaseolus vulgaris beans were studied primarily, 20 other species of Phaseolus were also tested including P. coccineus, P. angularis, P. calcaratus, and P. atropurpureus.

The results obtained during 1969-1971 have been presented in the Plant Disease Reporter 56:325-327. They showed that the most field-tolerant cultivars were dry beans of Michigan origin (Michelite and Saginaw), wax bean strains (Earliwax and Puregold Wax), and such green processing types as Tempo and Trugreen. The most field-tolerant PIs were PI 136692, 207391, 326353, 326419, and 339377. These PIs had a field disease index (DI) of 12 or 13 while the Tenderwhite control had a DI of 75 in 1970 and 62 in 1971. Follow-up greenhouse studies of the above field results showed that field-tolerance did not hold up properly - to the point where it was easily identifiable in the greenhouse. Results from the 1972 and 1973 field plots were similar to those of previous years. Twelve promising lines from 1972 were chosen from the 1972 plot for greenhouse study. They were all P. coccineus beans. Again greenhouse results were disappointing. The 1973 field plot yielded 8 bean PIs for greenhouse testing. The only P. vulgaris line was definitely susceptible; the P. coccineus PIs remain to be tested.

In conjunction with our greenhouse studies on testing beans for reaction to P. syringae we felt the need for improved techniques. Therefore a study of this type was undertaken. It is summarized here: The atomizing technique for initiating bean