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A Source of Bacterial Blight Resistance For Soybeans[1]

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Abstract. Incidence of bacterial blight of soybeans was observed from 1953 to 1959. During this period the disease was observed in 25 to 72 percent of the fields examined. A search was made for an improved source of blight resistance. A soybean introduction, P.I. 68708 was resistant to blight under natural conditions and when inoculated. It was also resistant to brown spot but was susceptible to race 8 of *Peronospora manshurica* as well as to Phytophthora rot. Yield, date of maturity, seed size, seed quality, and lodging resistance of the introduction were comparable to the same characters of the variety Blackhawk.

Bacterial blight is one of the most common diseases of soybeans in the Midwest, where it has been established for many years. It was observed by Heald (1906) in Nebraska as early as 1905 and was later reported in Connecticut by Clinton (1916) and in North Carolina by Tisdale (1918). With the large, progressive increase in soybean acreage since 1942, bacterial blight has become widespread. The disease has been observed in Iowa for 20 years.

The organism causing bacterial blight of soybeans, *Pseudomonas glycinea* Coerper, characteristically forms cream-white colonies tinged with brown on beef-peptone agar medium (Elliot, 1951). The bacteria, if seed-borne, produce lesions on the cotyledons after seed germination. The bacteria spread to the upper leaves within a few weeks and produce small, translucent, watersoaked spots. As the lesions grow older there is often a halo of chlorotic tissue along their outer margins, and later they become necrotic. When the disease is severe, the lesions may coalesce and form irregular, necrotic spots surrounded by large, chlorotic areas of leaf tissue (Elliot, 1951; Johnson *et al.*, 1954).

Once the disease develops, there is no known practical means of controlling it. If the disease is not prevalent in an area, the best preventive measure is to plant disease-free seed (Elliot, 1951). This practice is frequently impractical because of the difficulty of tracing

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the seed lot origin, and because seed is often combined from various sources before it is sold.

The need for bacterial blight resistant varieties of soybeans has long been recognized. Varietal variation in susceptibility to the disease was noticed by Woodworth and Brown (1920). More recently, the varieties Flambeau and Hawkeye have been recognized as being somewhat less susceptible than other northern varieties (Johnson *et al.*, 1954). The principal deterrents to the development of truly resistant soybean varieties have been the lack of a source of high resistance and an inadequate understanding of the inheritance of disease resistance.

Materials and Methods

Disease resistance and agronomic characters were observed in field plots of 10-foot rows end-trimmed to 8 feet prior to harvest. Each variety or plant introduction was replicated four times.

Lodging notes and plant height were recorded at maturity. Plant height was taken as the average length, in inches, from the ground to the tip of the stem. Chemical composition of seed was determined by the U. S. Regional Soybean Laboratory. Oil and protein contents of seed were obtained on a moisture-free basis.

Field-grown plants were inoculated with the bacterial blight organism. Inoculum was prepared by growing the bacterium in 4-liter flasks containing two liters of V-8 juice medium. The medium was prepared by adding the contents of one 12-ounce can of Campbell V-8 vegetable juices[4] to 5 grams of dextrose and bringing the total volume to two liters with water. The medium was adjusted to pH 7 after sterilization. The bacteria were grown in the culture medium for 48 hours, and one part of inoculum was diluted with 120 parts of water before use. Plants were sprayed with inoculum delivered from a motor-driven sprayer at a pressure of 80 pounds per square inch. They were inoculated when approximately six weeks of age, and disease ratings were recorded two weeks later.

Seedling plants were evaluated for downy mildew (*Peronospora manshurica* (Naum.) Syd ex. Gaum.) and Phytophthora rot (*Phytophthora sojae* Kauf. & Gerd.) resistance in the greenhouse. They were rated for downy mildew 10 days after the seedlings had been inoculated. They were inoculated with a water suspension of conidia of the downy mildew fungus and held in a moist chamber overnight. Disease ratings were recorded for Phytophthora rot one week after 10-day-old seedlings had been inoculated with the fungus by insertion of mycelium into the hypocotyls.

[4]Mention of commercial products does not imply endorsement or recommendation over others of a similar nature not mentioned.

Plants were rated for bacterial blight, downy mildew, brown spot (*Septoria glycines* Hemmi) and Phytophthora rot on a scale ranging from 1 (immune) to 5 (completely susceptible). A rating of 2 indicated that a plant was resistant; 3, slightly susceptible; and 4, moderately susceptible.

Observations and tests had revealed no evidence of resistance in any of the commonly grown soybean varieties. Accordingly, about 1,000 plant introductions from the collections maintained by the U. S. Regional Soybean Laboratory were evaluated for resistance to bacterial blight at Urbana, Illinois. Artificial inoculation, coupled with a heavy natural infection, provided ideal conditions for bacterial blight development in the nursery. Almost all of the material was heavily infected, but several introductions were virtually free from infection. These plant introductions were observed under field conditions at Ames, Iowa, during the period 1957-1959.

Results

Incidence of bacterial blight of soybeans in Iowa fields was observed closely during 1953-1959. Considerable variation in disease incidence with peaks of intensity in 1953 and 1957 was observed (Figure 1). The highest disease incidence was observed in 1957, when bacterial blight was found in about three-fourths of 61 soybean fields located in 31 of Iowa's major soybean-producing counties. The lowest incidence was observed in 1959, when the disease was present in only 25 percent of the fields observed.

Prevalence of bacterial blight has created a decided need for a blight-resistant soybean variety possessing all the desirable agronomic attributes of improved susceptible varieties. An intensive screening of soybean lines believed to be resistant to bacterial blight was required.

Eight soybean lines believed to be resistant were compared under field conditions in 1957. Although no line was immune to the disease, several were resistant. A plant introduction, P.I. 68708[5], was notably more resistant than the other lines. It was consistently more resistant to development of bacterial blight than Lincoln, a susceptible variety (Table 1). Heavy, natural bacterial blight infection was present in the soybean test plots in 1957 and 1958. In these years, P.I. 68708 showed only a few, small lesions, whereas Lincoln showed many lesions, some of which coalesced and formed large necrotic areas. Very little chlorosis was associated with the lesions on leaves of P.I. 68708, but the heavily infected leaves of Lincoln plants were almost entirely chlorotic (Figure 2). P.I. 68708 showed no more infection when artificially inoculated with *P. gly-*

[5]U. S. Department of Agriculture plant introduction number.

cinea under field conditions than when naturally infected, whereas inoculated Lincoln plants were consistently completely susceptible. Lincoln plants were rated only 4 in 1959 when there was less natural disease development. Plants of P.I. 68708 showed no bacterial infection during the entire season and were rated 1.

Table 1

Bacterial Blight Rating[1] for P.I. 68708 and Lincoln Soybeans Naturally Infected with *P. glycinea,* Ames, Iowa, 1957-1959

Year	P.I. 68708	Lincoln
1957	2	5
1958	2	5
1959	1	4

[1]Disease rating ranges from 1 (immune) to 5 (completely susceptible)

Figure 1. Incidence of bacterial blight of soybeans in Iowa from 1953 to 1959.

P.I. 68708 was compared with Blackhawk, Hawkeye, and Adams for disease resistance to race 8 of the downy mildew fungus, Phytophthora rot, and brown spot. When naturally infected under field conditions, the plant introduction was resistant to brown spot. It was slightly susceptible to Phytophthora rot and completely susceptible to race 8 of the downy mildew fungus when plants were inoculated in the greenhouse (Table 2). The introduction was not as resistant to Phytophthora rot as was Blackhawk, but it was more resistant

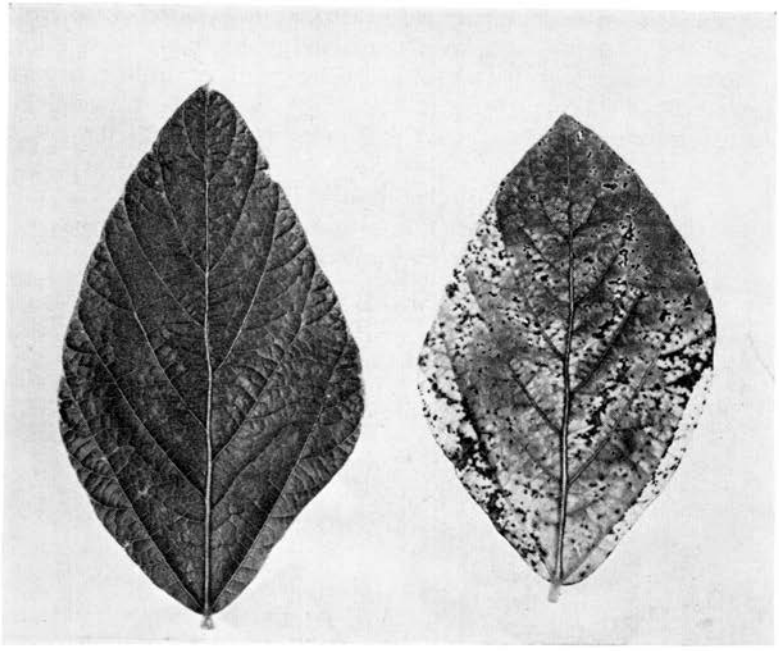

Figure 2. Left, an inoculated leaflet of P.I. 68708 soybeans with only a few small, chlorotic bacterial blight lesions at lower left; right, an inoculated leaflet of Lincoln soybeans with considerable chlorosis and numerous dark, necrotic bacterial blight lesions.

than were Hawkeye and Adams. P.I. 68708 was evaluated for Phytophthora rot resistance in Ohio, where it was reported to have resistance when grown in a soybean field naturally infested with the fungus (A. F. Schmitthenner, personal communication, 1960).

Table 2

Downy Mildew, Phytophthora Rot, and Brown Spot Ratings[1] for P.I. 68708 Soybeans and Three Soybean Varieties, Ames, Iowa, 1959

Plant introduction or variety	Downy mildew[2] (race 8)	Phytophthora[2] rot	Brown spot[3]
P.I. 68708	5	3	2
Blackhawk	5	2	3
Hawkeye	5	4	5
Adams	5	4	4

[1]Disease rating ranges from 1 (immune) to 5 (completely susceptible)
[2]Plants inoculated under greenhouse conditions
[3]Natural infection under field conditions

In addition to having high resistance to bacterial blight, P.I. 68708 has several agronomic advantages over the other resistant lines observed. It matures early enough to be grown in most of the soybean-producing states in the northern portion of the United States and

in Ontario, Canada, for the purpose of varietal improvement. Its maturity date is between Blackhawk and Hawkye, which mature in Iowa during the last half of September (Table 3). The resistant plant introduction compared favorably in yield and chemical composition with both Blackhawk and Hawkeye. One disadvantage of P.I. 68708 was its short height. It was 29 inches high, whereas Blackhawk was 41 inches and Hawkeye was 45 inches high.

Table 3

Comparison of Agronomic Characters of P.I. 68708 Soybeans With Those of Two Improved Soybean Varieties Grown at Ames, Iowa, in 1959

Plant introduction or variety	Average yield (bu./a.)	Date of maturity (mo.-day)	Plant height (in.)	Chemical composition of seed	
				Oil %	Protein %
P.I. 68708	34.2	9/20	29	22.0	39.5
Blackhawk	35.1	9/19	41	22.1	40.4
Hawkeye	39.8	9/23	45	21.9	41.4
L.S.D. (5%)	4.2				

Seeds of P.I. 68708 were brought to the United States from Harbin, Kirin, Manchuria, in 1926. P.I. 68708 has purple flowers, gray pubescence, a yellow seed coat, and a buff hilum. Mostly 2-seeded pods were produced bearing seed of good quality, weighing 14.3 g/100 as compared with Blackhawk and Hawkeye seeds which weighed 15.8 g/100 and 18.1 g/100, respectively. Plants tended to grow very compact and erect, and pods were not susceptible to shattering.

Because of its resistance to bacterial blight and brown spot, coupled with several desirable agronomic characteristics, P.I. 68708 is a good source of germplasm for incorporating bacterial blight resistance into northern soybean varieties.

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