

# New Physiological Race of *Peronospora manshurica* Virulent to the Gene *Rpm* in Soybeans

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## ABSTRACT

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In 1981, a new race of *Peronospora manshurica* virulent on the soybean (*Glycine max*) cultivar Union, which carries the gene *Rpm* for downy mildew resistance to all previously known races, occurred in the Illinois soybean disease monitoring plots. The reaction of 18 soybean cultivars was determined to the new race, designated race 33, as well as to race 2, which was collected at Urbana from the cultivar Williams before downy mildew appeared on Union. Five cultivars (Pridesoy, Palmetto, Kabott, Ogden, Acadian) from a set of differential cultivars and three others (Fayette, Tracy, PI 88788) were found to be resistant to both race 2 and race 33.

Downy mildew, caused by *Peronospora manshurica* (Naum.) Syd. ex Gaum., is one of the most prevalent soybean foliar diseases (4,7,10). The fungus infects leaves, grows within the plant by establishing mycelium with haustoria, invades pods, and covers seeds with a crust of oospores (2). Systemic infection of susceptible cultivars with *P. manshurica* often reduces soybean seed quality (7). Sporangia are secondary inoculum and are produced on the underside of the infected leaf. Sporangia can be readily disseminated throughout the growing season (8).

The existence of physiological races in *P. manshurica* was first reported by Geeseman (5) in 1950, and 32 races have been identified on the basis of reactions on 11 differential soybean cultivars (3). Soybeans carrying the gene *Rpm* are reported to be resistant to all known races of *P. manshurica* (1). This report describes the occurrence of a new physiological race of *P. manshurica* virulent to a soybean cultivar carrying the gene *Rpm*.

## MATERIALS AND METHODS

**Monitoring plots.** A soybean monitoring program in Illinois was established in 1977 to determine the incidence and severity of foliar diseases, to detect new races of current pathogens, and to identify areas of high disease risk (10). In

1981, an isolate of *P. manshurica* from infected leaves of the cultivar Williams was collected at Urbana before downy mildew appeared on plants of the cultivar Union at Urbana. Isolates of *P. manshurica* from infected leaves of Union plants were collected from eight locations (Fig. 1).

Collected leaves were placed with the abaxial side up on moist filter paper in petri dishes (90 × 15 mm) and kept at 20 C for 16 hr. Sporangia produced on the lower side of the leaves were collected by gently brushing lesion surfaces with a No. 3 camel's-hair brush and dipping the brush in a beaker containing water and 0.1% Tween 80.

**Isolate comparison.** Isolates collected from Union were compared in the greenhouse to the isolate collected from Williams. Sporangial suspensions (3,000–5,000 sporangia per milliliter) of each isolate (eight Union isolates, one from each of eight locations, and one Williams isolate from Urbana) were sprayed on seedlings of Williams and Union when the first trifoliolate leaves were completely expanded. The soybeans were grown in clay pots (20 × 26 cm), each pot containing three seedlings. Two pots of each cultivar were inoculated with an isolate individually. The inoculated seedlings were covered with sealed plastic bags for 16–20 hr at 20–22 C in the greenhouse.

Seven to 10 days after inoculation, disease reactions of the inoculated seedlings were classified as resistant (symptomless) or susceptible (symptoms and sporulation). Sporangia collected from a single lesion on leaves of both Williams and Union were increased and isolates were maintained on both Williams and Union plants in separate rooms of the greenhouse for each isolate.

**Physiological races.** Physiological specialization of the isolates was determined on a set of 18 soybean cultivars (Table 1). Eleven cultivars were used to differentiate races 9 through 32 (2,3) and five additional cultivars were used to identify races 1 through 8 (6). Williams and Union were also included, resulting in a set of 18 soybean cultivars. Six seedlings of each cultivar (three per pot) were inoculated with each of four isolates, one from Williams and three from Union. Inoculated sets of the 18 cultivars were kept in separate rooms of the greenhouse for each isolate. The reaction of each cultivar to the individual isolates was recorded 7–10 days after inoculation. The test was performed twice.

## RESULTS AND DISCUSSION

**Monitoring plots.** Before 1981, downy mildew did not occur on Union, which carries the gene *Rpm*, but did occur on each of the other soybean cultivars grown at all locations of the Illinois soybean disease monitoring plots (9). In 1981, downy mildew lesions were observed on Union at Girard and Eldorado in southern Illinois (Fig. 1) in early August and at all locations by early September.

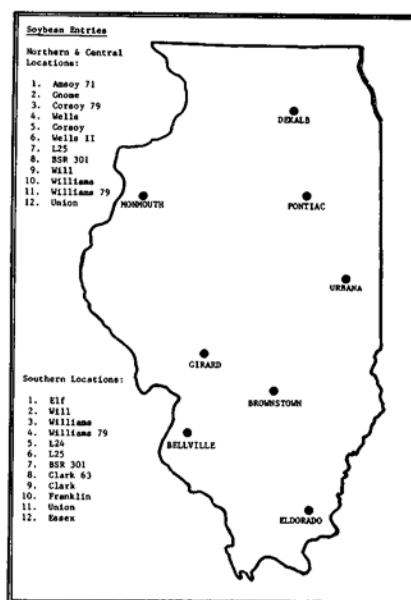


Fig. 1. The 1981 soybean entries (1–12) and soybean monitoring plots (●) for foliar diseases in Illinois.

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**Table 1.** Reactions of 18 soybean cultivars to two isolates of *Peronospora manshurica* in Illinois

Differential cultivar	Isolate source	
	Williams <sup>a</sup> (race 2)	Union <sup>b</sup> (race 33)
<b>From 11 used to identify</b>		
<b>  races 9-32</b>		
Pridesoy	R <sup>c</sup>	R
Norchief	S	S
Mukden	S	S
Richland	S	S
Roanoke	S	S
Illini	S	S
S100	S	S
Palmetto	R	R
Dorman	R	S
Kabott	R	R
Ogden	R	R
<b>From 14 used to identify</b>		
<b>  races 1-8</b>		
Wabash	S	S
Laredo	S	S
CNS	S	S
FC 33123	S	S
Acadian	R	R
<b>From monitoring plots</b>		
Williams	S	S
Union	R	S

<sup>a</sup> Cultivar without the *Rpm* gene for resistance to downy mildew.

<sup>b</sup> Cultivar with the *Rpm* gene for resistance to downy mildew. Isolates were obtained from three locations in southern Illinois; each produced the same result.

<sup>c</sup> R = symptomless, S = downy mildew symptoms. Results of two tests, each consisting of two replications of three seedlings per replication.

These observations at the monitoring plots were the first known occurrences of downy mildew on any soybean cultivar carrying the gene *Rpm*.

In early August, downy mildew severity was more pronounced on the susceptible cultivars, such as Williams (8%), than on Union (3%) at Girard and Eldorado. As the season progressed, however, an increase in downy mildew severity was observed on Union, and in

early September, severity was 8% on Union and 10% on Williams. At other locations, downy mildew severity ranged from 4 to 8% on Williams and was less than 2% on Union. Early season differences in downy mildew severity among Union and the other cultivars were probably due to differences in the proportion of the total amount of inoculum virulent on Union compared with that virulent on the other cultivars.

**Isolate comparison.** All isolates obtained from Union were virulent on both Williams and Union in a greenhouse test. The isolate obtained from Williams was not virulent on Union but was virulent on Williams. Therefore, the isolates from Union were probably a new physiological race of *P. manshurica* that was virulent on the host gene *Rpm* for downy mildew resistance.

**Physiological races.** Reactions of 18 cultivars to the Williams and Union isolates are given in Table 1. On all cultivars, the Williams isolate reacted the same as race 2 described by Grabe and Dunleavy (6). Our classification of FC 33123 and Roanoke differed from that of Grabe and Dunleavy (6), however. They used a severity rating scale of 1-5 based on infection types to identify races and rated the reactions of FC 33123 and Roanoke to race 2 as resistant (small flecks). We classified the reactions of FC 33123 and Roanoke as susceptible because sporulating lesions were produced.

The Union isolates obtained from three locations in southern Illinois produced the same reactions on the 18 differential cultivars. These results differed from all previous reports of the reactions on these cultivars to all other known races of *P. manshurica* (2,3,6). Therefore, we have designated this new race as race 33, race 32 being the last one described (3).

Eleven of the 18 cultivars used in our study were susceptible to both race 2 and race 33. Cultivars Dorman and Union were resistant to race 2 but susceptible to race 33. Five cultivars, Pridesoy,

Palmetto, Kabott, Ogden, and Acadian, were resistant to both races. At the monitoring plot locations where race 33 was prevalent, we observed differences in reactions to downy mildew among various breeding lines of soybeans. Most lines were susceptible, but among those appearing to be resistant were Fayette, Tracy, and PI 88788 and several advanced breeding lines derived from them. Evaluation of Fayette, Tracy, and PI 88788 in the greenhouse has confirmed they are resistant to both race 2 and race 33 of *P. manshurica*.

Downy mildew has not been found to significantly reduce soybean yield, but severe infection often reduces seed quality (7). The prevalence of downy mildew over a wide geographic range and the diversity of the races in the United States (2,3) indicate its potential significance in soybean production.

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