# Distribution of *Phakopsora pachyrhizi* on *Lablab purpureus* in Puerto Rico

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**ABSTRACT**

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A survey of soybean rust caused by *Phakopsora pachyrhizi* in Puerto Rico from 1976 to 1979 indicated that hyacinth bean, *Lablab purpureus,* is a major reservoir of this pathogen. The uredinial state was the predominant form of the fungus; telial structures were observed on only two occasions. The indeterminate perennial growth of hyacinth bean helped the rust to survive over the seasons. Optimal ranges of ambient temperature and precipitation for development of soybean rust were 17–23 C and 140–260 cm, respectively. In the mountain valleys of the western interior of the island, seasonal rainfall, orographic precipitation, and dew, along with a temperature range of 19–21 C, provided an optimal environment for the continuous growth of hyacinth bean and the development of soybean rust throughout the year.

Additional key word: epidemiology

In the summer of 1976, *Phakopsora pachyrhizi* Sydow, the causal agent of soybean rust (SBR), was reported on soybean (*Glycine max* L. Merr.) in Puerto Rico (6). This constituted the first observation of *P. pachyrhizi* on soybeans in the Western Hemisphere (4). Cross-inoculation tests with hyacinth bean (HB), *Lablab purpureus* (L.) Sweet, and *G. max* in the greenhouse and field and a survey of alternative hosts of SBR indicated that hyacinth bean was a major reservoir of *P. pachyrhizi* on the island and that the pathogen was well distributed in the interior valleys (4,5).

The epidemiology of SBR in subtropical and tropical environments is not well understood. In Taiwan, SBR occurs throughout the year in regions where the optimal temperature range is 20–30 C, and rust development slows at temperatures below 20 and above 30 C (3,7). In Thailand, SBR is most prevalent from July to November (3).

This report presents the results of field observations from August 1976 to February 1979 on the relationship of temperature and moisture to the distribution of SBR on HB in Puerto Rico.

## MATERIALS AND METHODS

Puerto Rico is a rectangular island about 50 × 200 km in size that is located in the path of the Gulf Stream in the Atlantic Ocean. Cordillera Central, the mountain range (1,330 m at highest elevation) that runs east and west divides the island into about three-quarters northern slopes and one-quarter southern slopes. Interception of the moisture-laden easterlies by this mountain range determines the rainfall pattern of the islands (1,2).

I chose an arbitrary 50-m radius as the boundaries of an HB site. A site consisted of either a single vine climbing a mango tree, several vines supported by a house fence, or a hillside patch overgrown to volunteer HB. The town and barrio, route number, direction of travel, kilometer and hectometer road marks, elevation, location, description, and sometimes the names of property owners were recorded for each site. If a site formerly free of rust on HB was found affected in a later survey, it was recorded as having rust.

The elevation of each site was recorded on a metric altimeter. The needle of the altimeter was set at zero elevation at sea level at the start of each survey.

The amount of rainfall for a site was recorded as that of the nearest weather station or as the average of two stations bracketing the site. I used the 30-yr precipitation averages for 45 weather stations (1) or the 1975 climatological data, which included 89 weather stations (2).

The temperature of a site was based on its elevation. The 30-yr average temperature for the north coast was 25 C and for the south coast was 27 C. One degree Celsius was deducted for every 100 m of elevation above sea level.

The severity of SBR on HB was rated visually on a five-point scale based on the

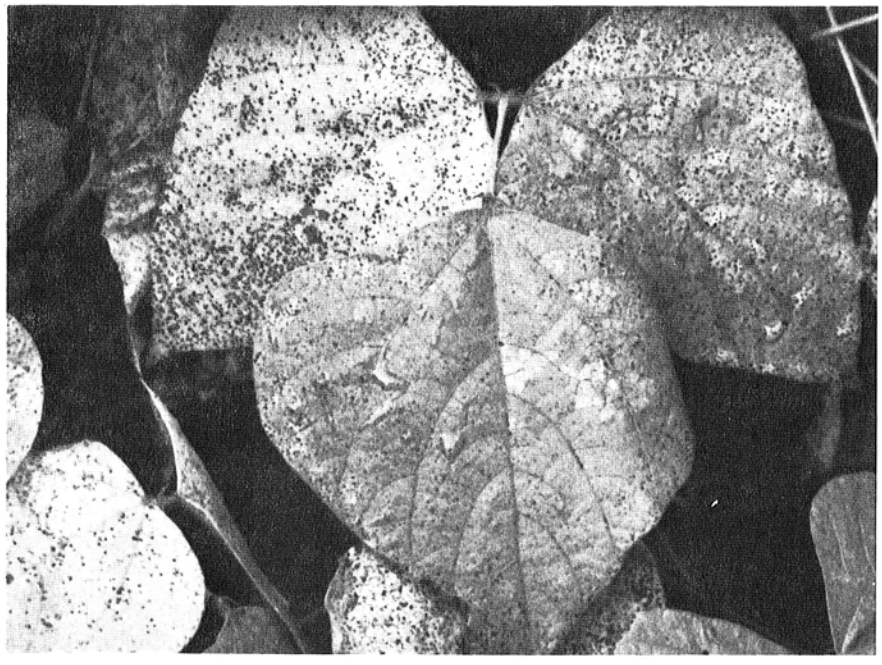

**Fig. 1.** Moisture-laden hyacinth bean leaves with soybean rust severities of 4 or 5 at 700-m elevation in the interior valleys near Jayuya, Puerto Rico.

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proportion of mature leaf surface affected by uredinia, with 1 = no infection, 2 = less than 5%, 3 = 5–25%, 4 = 26–50%, and 5 = 51–100% of leaf surface infected (Fig. 1). The overall rating of a site was based on the highest SBR rating on mature foliage.

Infected leaves were collected, wrapped in paper towels, placed in sealed plastic bags, and kept in a portable ice chest for the duration of the trip. Samples were dried, sterilized in a microwave oven, and maintained under refrigeration until they were examined for *P. pachyrhizi* telia.

## RESULTS

I found hyacinth beans only in areas with dense rural settlement. It was usually planted next to hedges and fences for home consumption. The highest concentration of HB, 125 of the 314 sites, was encountered at elevations of 300–750 m in the interior valleys of the northwest. In coastal areas during the dry months of January through March, HB plants lost 90% of their leaves; at the highly humid elevations of 500–750 m in the northwest, foliage was retained throughout the year. The endemic, indeterminate HB cultivars were either biennial or perennial.

SBR was found at 180 of the 314 HB sites; approximate distribution of the sites is shown in Figure 2. Frequencies of HB and SBR within the six climatological regions of the island are given in Table 1. A few small telia were found on two HB leaf samples collected at elevations between 750 and 800 m during November 1978.

Rust severity was closely related to elevation, with SBR infection in the 180 sites appearing more severe as elevation increased. The three sites with ratings of 2 were located below 300 m. Of the 19 sites with ratings of 3, 16 were located below 300 m and 3 above 800 m. The 97 sites with ratings of 4 were encountered at all elevations, but most commonly at 450–750 m. The 61 sites with ratings of 5 were mostly located at 450–750 m.

No sites were found to have SBR at sea level to 70 m, 13 were found at 80–90 m, 45 at 100–290 m, 80 at 300–590 m, 35 at 600–790 m, and 7 at 800–950 m. Figure 3 gives the frequency of sites with SBR in relation to elevation and temperature.

At sea level, *L. purpureus* grew well but *P. pachyrhizi* caused little or no disease. Between sea level and 100 m, 13 of 39 HB sites had SBR severities of 2 or 3. At the highest altitude—850–1,000 m—three of five HB sites had SBR severity of 3 and two were rustfree. In contrast, at 200–840 m, 162 of the 225 HB sites had SBR severities of 4 or 5.

Only two of the 180 sites with SBR occurred where maximum annual precipitation was less than 80 cm; 18 sites had precipitation of 80–140 cm, 103 had 141–200 cm, and 57 had 201–260 cm.

**Table 1.** Hyacinth bean distribution and incidence of soybean rust in Puerto Rico by topography and climate

| Region | No. of hyacinth bean sites | No. of soybean rust observations | Incidence of soybean rust, % |
|---|---|---|---|
| North coastal | 29 | 1 | 3.4 |
| Northern slopes | 50 | 14 | 28.0 |
| Eastern interior | 50 | 25 | 50.0 |
| Western interior | 135 | 119 | 88.1 |
| Southern slopes | 40 | 19 | 47.5 |
| South coastal | 10 | 2 | 20.0 |
| Total | 314 | 180 | 57.3[a] |

[a] Overall average for the island.

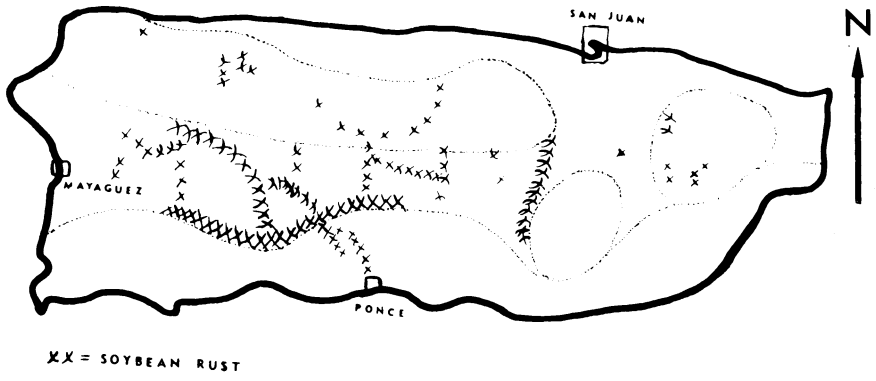


**Fig. 2.** Distribution of soybean rust on hyacinth beans in Puerto Rico in 1976–1979.

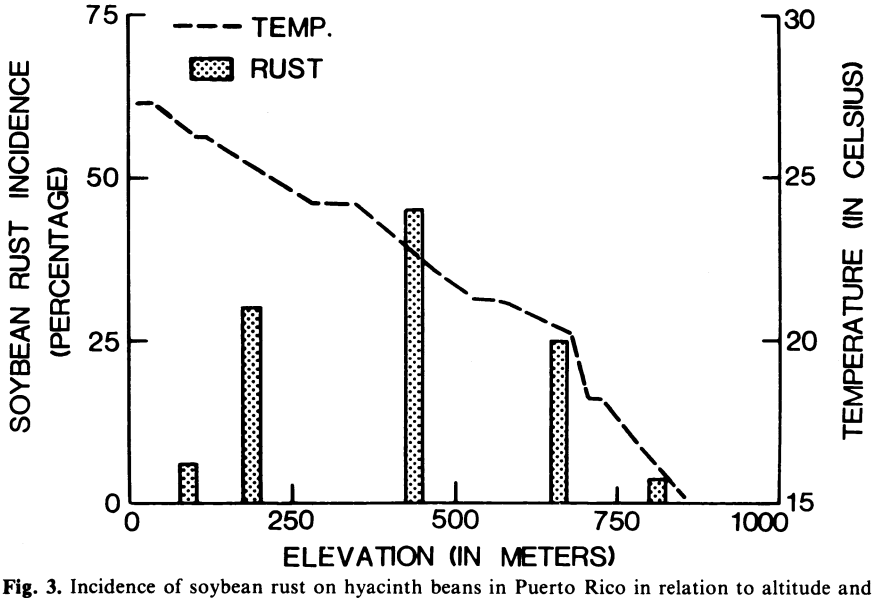


**Fig. 3.** Incidence of soybean rust on hyacinth beans in Puerto Rico in relation to altitude and temperature.

## DISCUSSION

SBR was most likely to develop on HB in Puerto Rico at elevations with average annual temperatures of 17–23 C. At elevations with temperatures of 24–26 C, both the frequency and severity of SBR decreased; at sea level on the south coast, with an average temperature of 27 C, development of SBR ceased altogether. At elevations of 850–950 m, with parallel average temperatures of 16 and 15 C, both the frequency and severity of SBR decreased; at 1,000 m and above and 14 C or less, no rust was observed. Differences between the temperature requirements for SBR in Puerto Rico and in Taiwan (3,7) suggest the existence of physiologic races.

Eighty-nine percent of the sites with SBR occurred in areas where annual precipitation was 150–260 cm. Rust also tended to be most severe in areas where annual precipitation was between 200 and 260 cm. Regardless of the seasonal pattern of precipitation, SBR was encountered year round in the interior valleys at 450–750 m.

Its indeterminate and biennial-perennial growth habit, drought tolerance,

and capacity to retain foliage when moderately infected with *P. pachyrhizi* made HB a perfect host for overseasoning of *P. pachyrhizi*. Elevations in the Cordillera Central provided the optimal temperatures as well as the high levels of seasonal rainfall, orographic precipitation, and dew that are ideal for the development and overseasoning of SBR in Puerto Rico. In Asia, yam beans (*Pachyrhizus erosus* (L.) Urban) serve as a reservoir of *P. pachyrhizi* (7).

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