Induced Teliospore Formation by *Phakopsora pachyrhizi* on Soybeans and Other Hosts

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ABSTRACT

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Telia and teliospores of *Phakopsora pachyrhizi*, causal fungus of rust of soybean (*Glycine max*), were formed on *Cajanus cajan* (pigeon pea), *Glycine canescens* (wild soybean), *G. javanica*, (wild soybean), *G. wightii* (wild soybean, lines K-51394, PI 277534, and PI 319474), *G. max* (cultivar TK5, PI 230970, and PI 230971), *Pachyrhizus erosus* (yam bean), *Phaseolus lunatus* (lime bean), *Phaseolus vulgaris* (common bean), *Rhynchosia minima*, and *Vigna unguiculata* (cowpea) when the hosts were inoculated and grown in a growth room programmed for a 12-hr photoperiod (2,060 lux), 60–100% relative humidity, and diurnal temperatures between 24 ± 1 C minimum night temperature.

Morphology of telia and teliospores is used to classify the rust fungi (3), and viable teliospores are necessary to determine life cycles and to make genetic studies. The uredial stage of *Phakopsora pachyrhizi* Sydow, causal fungus of rust of soybean (*Glycine max* (L.) Merr.), has been reported on 87 hosts. The occurrence of telia and teliospores has been reported on only six of those hosts (1,3,5–8). C. C. Yeh and C. Y. Yang (Asian Vegetable Research and Development Center, Taiwan, *unpublished*) observed teliospore formation on the soybean cultivar TK5 in the field, and Kitani and Inoue (7) observed teliospores on soybean under field conditions in Japan. Bromfield (2) reported telia and teliospores on Wayne soybeans grown under greenhouse conditions. Hsu and Wu (4) recorded teliospore formation of *P. pachyrhizi* on soybeans incubated for 36 days after inoculation at 15 and 20 C, but not at 25 C.

Classification of this pathogen has been based on the uredial stage because of the absence of telia and teliospore formation on most host plants in the tropics. This had led to taxonomic confusion. There are at least 12 synonyms of *P. pachyrhizi*, but only two are based on a description of the telia and teliospores (1,8).

The induction of telia and teliospores of *P. pachyrhizi* under controlled conditions on hosts other than soybeans has not been reported. Teliospores of *P. pachyrhizi* have been reported on *Canavalia villosa* Benth. in Guatemala (3); on *Meibomia supina* (SW.) Britt. in Puerto Rico (1); on *Pachyrhizus angulatus* Rich in Taiwan (8) and on *Crotalaria linifolia* Linn. fil and *Desmodium rhytidophyllum* F. Muell., but not on soybeans in Australia (5). The formation of teliospores of *P. pachyrhizi* on leaves of soybeans and other legume hosts (some for the first time) is reported.

MATERIALS AND METHODS

Plants tested. Plants of the following legume species were grown in the greenhouse in pots containing a mixture of field soil, compost, sand, and rice hulls (5:3:1:1, v/v): *Cajanus cajan* Millsp. (pigeon pea), *Glycine canescens* F. J. Herm (wild soybean), *G. clandestina* Wendl. (wild soybean), *G. max* (L.) Merr. (soybean cultivar TK5, PI 230970, and PI 230971), *G. tabacina* (Labill) Benth. (wild soybean), *G. tabacina* var. *latifolia* (wild soybean), *G. wightii* (R. Grah. ex Wight & Arn.) Verdc. (wild soybean, line K51394 from K. R. Bromfield, Plant Disease Research Laboratory, USDA, SEA, Frederick, MD, and PI 277534, PI 319474, PI 319476, and PI 319477 from H. R. Hanes, Plant Germplasm Quarantine Center, USDA, Beltsville, MD, *G. javanica* L. (wild soybean), *Lablab niger* DC (hyacinth bean), *Macroptilium atropurpureum* (DC) Urban (siratro), *Macrotyloma axillare* (E. Oney) Verd., *Pachyrhizus erosus* Urban (yam bean), *Phaseolus vulgaris* L. (common bean), *P. lunatus* L. (lima bean), *Rhynchosia minima* DC, *Sesbania exaltata* (Raf.) Rydb. (pea tree), *S. vesicaria* Elliott (bag-pod), and *Vigna unguiculata* (L.) Walp. (cowpea).

Preparation of inoculum. Soybean (cultivar TK5) leaves infected with *P. pachyrhizi* and showing symptoms of rust of soybean were collected in the field, washed with running tap water in the laboratory, blotted with absorbent tissue, and then placed in either a sealed plastic bag or in 9-cm-diameter culture plates containing filter paper (Whatman No. 1) saturated with distilled water and incubated for 2 days at 24 C. Fresh uredospores were collected with a camel's-hair brush and transferred to a sterile beaker. A suspension of these uredospores was prepared in distilled water with Tween-80 (~80 μg/ml) and adjusted to the desired spore concentration by using a hemacytometer.

Inoculation and incubation. Five 4-wk-old plants of each legume species were sprayed with the uredospore suspension (25,000 spores per milliliter) until runoff by using a portable air pump and a chromatographic reagent sprayer. The plants were then placed in a transparent plastic moist chamber housed in a growth room programmed for 12-hr photoperiods (2,060 lux), 60–100% relative humidity, and diurnal temperatures between 24 ± 1 C maximum day temperature and 15 ± 1 C minimum night temperature. After 2 days, the plants were removed from the moist chamber and kept in the growth room for observation. Telia and teliospore production were recorded for each host.

RESULTS AND DISCUSSION

A method, which included incubation in a moist chamber under constant cool temperatures, was developed to induce telia and teliospore formation of *P. pachyrhizi* on several legumes. The method will be useful for the identification of this fungus and will aid in determining the host range of *P. pachyrhizi*.

Telia and teliospore production is reported for the first time in

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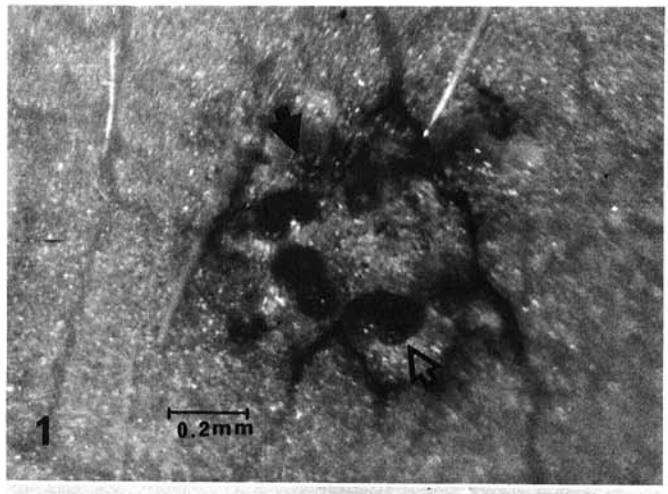

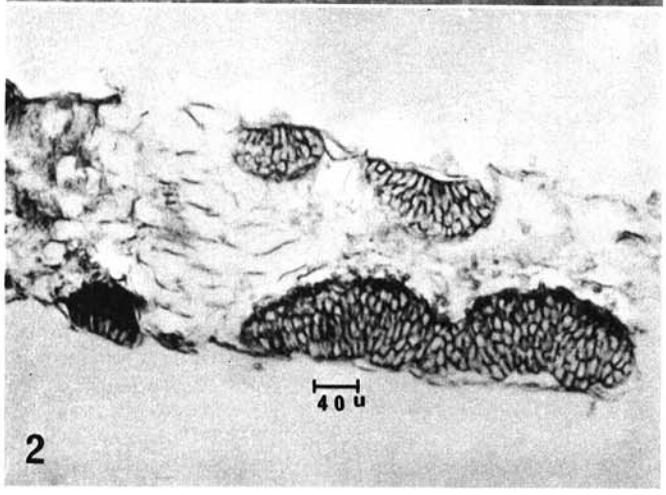

Figs. 1 and 2. Fruiting structures of *Phakopsora pachyrhizi* on soybean leaves: **1,** a telium (open arrow) and a uredium (black arrow) on PI 230970; **2,** telia and teliospore formation on adaxial and abaxial surfaces of PI 230971.

leaf tissues of *C. cajan, G. canescens, G. javanica, G. wightii* (lines K51394, PI 277534, and PI 319474), *G. max* (PI 230970 and 230971, *P. lunatus, P. vulgaris, R. minima,* and *V. unguiculata.* Telia were produced adaxially, abaxially, singly or in clusters (Figs. 1 and 2). Telia and teliospores also were induced on *P. erosus* and *G. max* (TK5), confirming the reports of Sydow and Sydow (8) for *P. erosus* and Bromfield et al (2) and Hsu and Wu (4) for *G. max.*

The telia and teliospores always were produced after uredia had formed and occurred either around a uredium or at the periphery of the lesion, first on the lower (older) leaves, and later on upper leaves. Young telia were light brown, becoming dark brown or black with age. Lesion density on infected leaves did not affect development of telia; telia and teliospore formation were observed on soybean leaves even if only a single rust lesion developed. We report for the first time telia and teliospore production on adaxial leaf surfaces of TK5 and PI 230971 soybeans.

Telia and teliospore production were induced at 35 days after inoculation on *G. canescens, G. javanica,* and *G. wightii*; at 30 days after inoculation on *G. max* and *P. erosus*; and between 50 and 60 days on *C. cajan, P. lunatus, P. vulgaris, R. minima* and *V. unguiculata.* The cool incubation temperatures induced telial formation as suggested by Hsu and Wu (4). No telial formation was observed on rusted soybean plants growing in the field during the time of this study. The maximum temperature in the field ranged from 24.2 to 35 C; the minimum ranged from 18 to 25.2 C. The lack of low temperatures in the field may explain the scarcity of telia of *P. pachyrhizi* in the tropics.

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