



**STUDIES ON *PHAKOPSORA PACHYRHIZI*,
THE CAUSAL ORGANISM OF SOYBEAN RUST**

by

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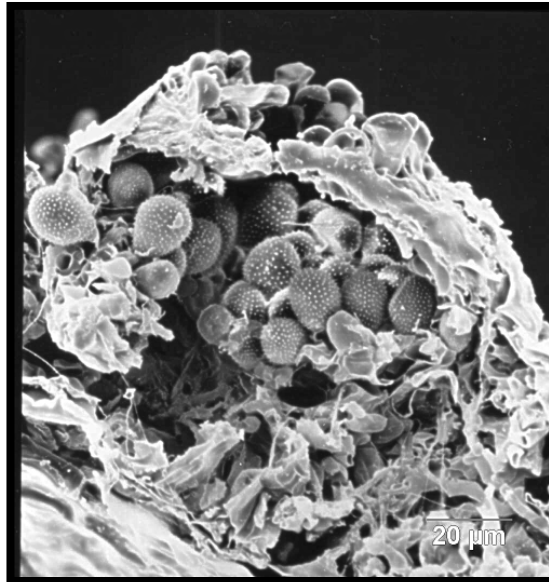
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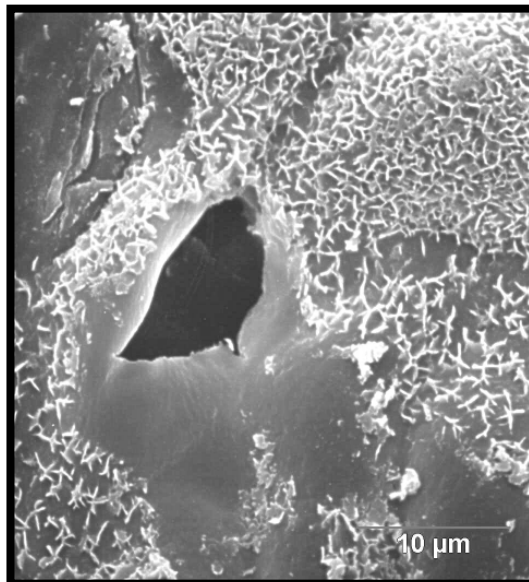
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Electron micrograph showing a uredium with uredospores.



Phakopsora pachyrhizi is one of the few fungi that use direct penetration through epidermal cells.

Rust never sleeps
Neil Young

ABSTRACT

Phakopsora pachyrhizi H. Syd and P. Syd, the causal organism of soybean rust (SBR) was first reported in Japan in 1902. In 1934 the pathogen was found in several other Asian countries and as far south as Australia. In India, SBR was first reported on soybeans in 1951. There have been several early reports of SBR in equatorial Africa but the first confirmed report of *P. pachyrhizi* on the African continent was in 1996 from Kenya, Rwanda and Uganda. Since then, the pathogen has spread south with reports from Zambia and Zimbabwe in 1998 and in Mozambique in 2000.

In February 2001, *P. pachyrhizi* was first detected on soybeans near Vryheid, in Northern KwaZulu-Natal, South Africa (SA). As the season progressed, the disease was observed in other parts of the province, and epidemic levels were found in the Cedara, Greytown, Howick and Karkloof production regions. Soybean rust subsequently spread to Amsterdam and Ermelo in the Highveld region of SA. The disease reappeared in SA in March 2002. It is now established that the pathogen is a threat to soybean production in the country with yield losses in the region of 10-80%.

A literature review on SBR investigating the taxonomy of the pathogen, its morphology, symptoms, host range, infection process, epidemiology, control options and the economic importance of *P. pachyrhizi* was compiled to provide the necessary background information to conduct research under local conditions and to assist in interpretation of results of experiments.

Epidemiological trials were conducted at the University of KwaZulu-Natal under controlled environmental conditions in a dew chamber and conviron. Development of *P. pachyrhizi* on the susceptible cultivar (LS5995) was quantified in combinations of seven temperatures (15, 19, 21, 24, 26, 28 and 30°C) and five leaf wetness durations (LWD) (6, 9, 12, 14 and 16hrs) at three relative humidities (RH) (75%, 85% and 95%). Studies indicate that optimum temperature for uredospore infection is 21-24°C with a LWD greater than 12hrs and RH 85-95%. The number of pustules as well as lesion

size on the abaxial and adaxial leaf surface increased with increasing LWD at all the RH values tested. Infection did not occur on plants incubated at 15°C and 30°C at 85% or 95%RH whereas at 75%RH infection did not occur on plants incubated at 15°C, 19°C and 30°C regardless of LWD. Number of pustules per lesion produced at 75%, 85% and 95%RH was highest at 24°C and showed a gradual increase with increasing LWD. Lesion size on both leaf surfaces increased after 12hrs LWD at 24°C at 75% and 85%RH whereas at 95%RH lesion size increased after 14hrs LWD at 24°C.

Exposure of uredospores to ultraviolet light which is equivalent to ultraviolet C (sunlight) which is $< 280\text{nm}$, shows a decrease in germination (7%). Under continuous darkness, the germination percentage was found to range from 58% after 48 hrs. Germination was found to peak at 16hrs in darkness with a gradual decrease as time increased whereas germination under ultraviolet light was highest after 6hrs with a gradual decrease with increased exposure to light. Germ tube lengths were found to be shorter when exposed to ultraviolet light ($107\mu\text{m}$) compared to controls kept in the dark ($181\mu\text{m}$). Results obtained clearly show a negative effect of ultraviolet light on the germination and germ tube length of uredospores. A 0.1ml suspension of uredospores on 1.25% water agar Petri dishes was exposed to cycles of 14h ultraviolet light and 10h darkness for 48h. Results indicate an increase in germination percentage of uredospores when exposed to 10h of darkness following a 14h period under ultraviolet light.

Controlled environmental studies were conducted to determine alternative hosts of *P. pachyrhizi* in SA. The control used in this experiment was Prima 2000, a susceptible cultivar to soybean rust. Seven legume plants [*Cajanus cajan* (L.) Huth, *Glycine max* (L.) Merr, *Lablab purpureus* (L.) Sweet, *Lupinus angustifolius* (L.) Finnish, *Phaseolus vulgaris* (L.), *Pueraria lobata* (M&S) Willd and *Vigna unguiculata* (L.) Walp] and three dry bean lines (Bonus; OPS-RS2 and PAN 159) showed typical SBR symptoms when rated after 21 days post inoculation with uredospores for percentage disease severity. Disease severity was significantly different within the alternative hosts, but *G. max*,

P. vulgaris and *P. lobata* were not significantly different from Prima 2000 (control). A uredospore suspension of 2.5×10^5 uredospores ml⁻¹ from plants that showed typical SBR symptoms was made and inoculated onto Prima 2000, a susceptible soybean cultivar. Uredospores from pustules on *G. max*, *L. purpureus*, *L. angustifolius*, *P. vulgaris*, *P. lobata*, *V. unguiculata*, Bonus and PAN 159 produced viable uredospores on PRIMA 2000. These plants are considered alternative hosts of *P. pachyrhizi*.

Effect of leaf age on susceptibility of soybean to SBR was tested under controlled environmental conditions. Mean number of lesions as well as lesion size were greater on younger leaves than on older leaves of plants at the same physiological age. Plants at the early vegetative and reproductive stages had a significantly lower number of lesions as well as a smaller lesion size. Plants at the V6 and R1 growth stages were significantly more susceptible to *P. pachyrhizi* than plants at other developmental stages.

Trichoderma harzianum Rifai, Eco-77® a commercial biological control product, was evaluated for its efficacy as a biological control agent of *P. pachyrhizi*. *Trichoderma harzianum* sprayed at the standard concentration on infected soybean plants was significantly more effective in controlling *P. pachyrhizi* than plants sprayed at 1/2X and 2x the standard concentration. This was noted in both Trial 1 and 2. Data indicate that spraying the filtrate two days after inoculation produces less disease.