中華農業研究 (Jour. agric. Res. China) 32(1) : 069~074 (1983)

Physiological Races of *Phakopsora pachyrhizi* in Taiwan [1]

C. C. Yeh[2]

ABSTRACT: Soybean cvs. Ankur, TK 5, TN4, and P.I.'s 200492 and 230971 are suggested as differentials for race identification of *Phakopsora pachyrhizi* causing soybean rust in Taiwan. Three races of *P. pachyrhizi*, based on lesion type, were identified among 50 sngile uredial cultures from soybean leaves collected at five locations in Taiwan. Reaction was determined 14 days after inoculation on intact leaves on plants as well as on detached leaves. The distribution of the three races varied among locations. Common bean, cowpea, hyacinth bean, lima bean, pigeon pea and yam bean also were tested but because no difference in lesion type was observed they were not used as differentials.

Phakopsora pachyrhizi H. & P. Sydow, the cause of soybean rust, was reported on 87 hosts [15]. The different reaction of many hosts to infection by the fungus suggests the presence of different races [4,6,7,8,11,12,13]. Lin [5] showed that collections of *P. pachyrhizi* from soybean varied in pathogenicity and virulence among non-soybean hosts. Two races of *P. pachyrhizi* were observed at the Asian Vegetable Research and Development Center (AVRC) Taiwan [14] but not confirmed. Two infection types on soybean leaves were suspected to indicate different races of *P. pachyrhizi* [2,9,10]. Bromfield [1,2] demonstrated at least two races from Australia based on containment glasshouse studies. Using differential reactions of four soybeans inoculated with uredospores collected from different countries, Bromfield [3] identified four races of *P. pachyrhizi*. The uredospores used by Bromfield were collected with cotton swabs and maintained on Wayne soybean leaves in the glasshouse. Yeh (unpublished) observed two lesion types on the soybean leaves of P.I.'s 200492 and 230970 used in Bromfield's [3] studies, and on TK 5 and Shih-Shih when inoculated with uredospores obtained from soybean plants in the field at Taiwan Agricultural Research Instituts(TARI). Thus, race identification of *P. pachyrhizi* is confusing because no standardized scheme has been developed. In this study, five soybean cultivars and seven leguminosae species were inoculated with 50 single-uredial cultures of *P. pachyrhizi* for investigation of the presence of races of the fungus in

1. Contribution No. 1050 from Taiwan Agricultural Research Institute (TARI).
2. Plant Pathologist, Department of Plant Pathology, TARI, Wufeng, Taichung 431, Taiwan, Rep. of China.

Taiwn.

Materials and Methods

Plant tested

The following plants were grown in the glasshouse in pots containing pasteurized sandy loam : common bean (*Phaseolus vulgaris* L. cv. 5-Inch), cowpea (*Vigna ungniculata*(L.) Walp. cv. Early Ramshorn), hyacinth bean (*Lablab purpureus* L. local), lima bean (*Phaseolus lunatus* L. localh), mungbean (*Vigna radiata*(L.) Wicz. local), pigeon pea (*Cajanus cajan* Millsp. local), yam bean (*pachyrhizus erosus* Urb. local) and soybeans ((*Glycine max*(L.) Merr. cvs. Ankur, TK 5, TN 4, Shih-Shih, P.I.'s 200492 and 230971).

Collection and purification of inoculum

Phakopsora pachyrhizi-infected soybean leaves were collected at Taiwan Agricultural Research Institute (TARI)cv. TN 4 ; the Asian Vegetable Research and Development Ceter (AVRDC) cv. TK 5 ; Pingtung cv. Shih-Shih ; Hualien cv. Shih-Shih ; and Taitung cv. Shih-Shih (Fig. 1). The leaves were washed gently with running tapwater, blotted with absorbent tissues to remove excess moisture and release old uredospores, and then sealed in transparent plastic bags. Freshly produced uredospores were obtained after 24 to 48 hrs at room temperatures (20-30 C).

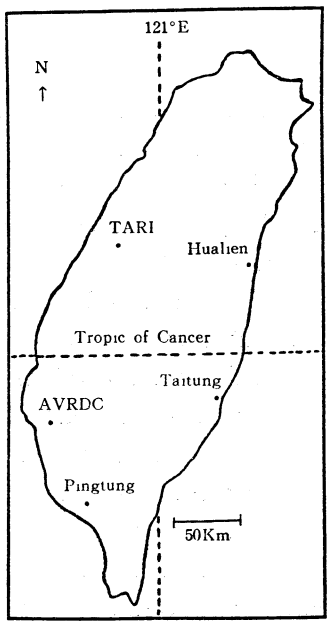


Fig. 1. *Phakopsora pachyrhizi* collection sites in Taiwan. (TARI=Taiwan Agricultural Research Institute, Taichung ; AVRDC=The Asian Vegetable Research and Development Center, Tainan.

Soybean leaves of the same cultivars from which the fungus was originally collected were detached from noninoculated glasshouse-grown plants, washed, blotted and placed, with the lower surface upward, in sterile culture plates (9-cm) containing a layer of

cotton in the bottom and covered with filter paper (Whatman No. 1) saturated with distilled water. A suspension of the freshly produced uredospores (ca. 5,000 spores/ml) prepared from distilled water plus Tween 80 (ca. 80 ug/ml) of each collection was sprayed on the leaves and the culture plates with sprayed and nonsprayed (control) leaves were placed on a bench next to a window at room temperatures (20-30 C) .

After 2 weeks, 10 single uredia from each of the five collections were selected randomly and the uredospores were removed from each uredium separately, using separate sterile camel's brushes for each uredium. Uredospores of each of the 50 isolates were inoculated and maintained on detached leaves of the same cultivar from which they were removed for three to four generations until sufficient uredospores were obtained for testing.

Inoculation

Leaves on intact plants were inoculated in pots and detached leaves in culture plates as previously described. Leaves of each plants were inoculated separately with an uredospore suspension (ca. 20,000 spores/ml) obtained from the 50 single uredial isolates of *P. pachyrhizi*. The inoculated plants were removed from moist chamber after 24 hrs and kept in the glasshouse (20-31 C) for observation. The detached leaves in the culture plates were placed on the bench in the laboratory as described previously. The infection lesion type on both sets of leaves were recorded 2 weeks after inoculation.

Results and Discussion

Two different infectton types, TAN and reddish-brown (RB) [2,10], were observed 14 days after inocualtion. TAN-type lesions usually sporulated heavily, with 3 to 5 uredia per lesion. RB-type lesions produced less uredospores and with 0 to 2 uredia per lesion. This is the first report on identifying races of *P. pachyrhizi* in which inoculum of each isolate was multiplied from single uredium. Thus, no mixed lesion types were observed (Fig. 2) as reported by the other workers [10] and the author's studies (unpublished) at TARI. The mixed infection types on a soybean leaf were due to the presence of races of the fungus in the inoculum. Based on the differential reaction on the five soybean cultivars, three races of *P. pachyrhizi* from soybeans were identified. Race 1 produced TAN-type lesions on all soybean cultivars ; Race 2 produced RB-type lesions only on P.I. 230971 and TAN-type on the other four cultivars ; Race 3 produced TAN-type lesions on P.I. 200492 and RB-type on the other four cultivars (Table 1, Fig. 2). All 50 single uredial isolates produced TAN-type lesions on common bean and yam bean ; and RB-type on cowpea, hyacinth bean, lima bean, mungbean, and pigeon pea. Because no difference in lesion types was observed among these leguminosae species, they are not currently suggested as differentials in this study. They may be considered, however, in the future as they also have shown with different reactions [8,12,13].

For identification of the three races, only two soybean cultivars, P. I. 230971 and each one of the following : TK 5, TN 4 or Ankur, are necessary. However, considering the limited number of samples in this study and the observation of different reaction types on three other soybean cultivars [4,7,11], all five soybean cultivars are tentatively suggested as differentials.



Fig. 2. TAN (left) and RB (reddish-brown) (right) type of lesions of soybean rust caused by race 1 and 2, respectively, of *Phakopsora pachyrhizi* on P.I. 230971 soybean leaf.

Table 1. Reaction of the three races of *Phakopsora pachyrhizi* on five soybean cultivars.

Soybean cultivar	R ·ce		
	1	2	3
Ankur	TAN[a]	TAN	RB
TN 4	TAN	TAN	RB
TK 5	TAN	TAN	RB
P.I. 230971	TAN	RB	RB
P.I. 200492	TAN	TAN	TAN

a Lesion type : TAN=tan color lesion ; RB=reddish-brown.

The distribution of the three races varied among locations. Race 1 was common at AVRDC and Race 2 at TARI and Taitung. Race 1 and 2 were present in about equal populations at Pingtung and only two isolates of Race 3 were obtained in the Hualien collection (Table 2, Fig. 1). When more collections are made at different locaations and in different years, more races may be identified.

Table 2. Distribution of the 50 singlle uredial isolates of *Phakopsora pachyrhizi* collected at five locations in Taiwan.

Location[a]	Race		
	1	2	3
TARI	2	8	0
AVRDC	9	1	0
Pingtung	5	5	0
Taitung	0	10	0
Hualien	0	8	2

a TARI=Taiwan Agricultural Research Institute, Taichung ; AVRDC=The Asian Vegetable Research and Development Center, Tainan, Taiwan.

Acknowledgmenst

The author wishes to exdress his sincere appreciations to Dr. J. B. Sinclair, the Univerity of Illinois, and Dr. S. H. Ou, Taiwan Agricultural Research Institute (TARI), for critically reviewing the manuscript, and to Ms. L. L. Chou and Ms. F. L. Chen for technical assistance. This research was supported, in part, by Council for Agricultural Planning and Development, Executive Yuan, the Republic of China.

Literature Cited

1. Bromfield, K. R. 1976. Review of research on soybean rust. p. 16-23 *in* N. G. Vakili(ed.), Proc. Workshop on Soybean Rust in the Western Hemisphere. Nov. 14-17 1976, Mayaguez, Institute of Tropical Agriculture, Mayaguez, Puerto Rico, ARS, USDA.
2. Bromfield, K. R. 1979. Two different infection types under containment greenhouse conditions. Soybean Rust Newsletter 2 : 6.
3. Bromfield, K. R. 1981. Differential reaction of soybean accessions to *Phakopsora pachyrhizi*. Soybean Rust Newsletter 4 : 2.
4. Chan, K. L. 1977. Notes on soybean rust research in Taiwan. Soybean Rust Newsletter 1 : 18.
5. Lin, S. Y. 1966. Studies on the physiological races of soybean rust fungus *Phakopsora pachyrhizi* Syd. . J. Taiwan Agr. Res. 15 (3) : 24-28 (Chinese text, English summary).
6. McLean, R. J. , and Byth, D. E. 1980. Inheritance of resistance to soybean rust. Soybean Rust Newsletter 3 : 15-17.
7. Nundhapun, M. , and Surin, P. 1977. Soybean reactions to rust caued by *Phakopsora pachyrhizi* at Mae-Joe Experiment Station. Soybean Rust Newsletter 1 : 11-12.
8. Poonpolgul, S. , and Surin, P ·1980. Study on host range of soybean rust fungus in Thailand. Soybaen Rust Newsletter 3 : 30-31.
9. Shatmugasundaram, S. 1980. A screening technique for, and inheritance of, soybean rust infection type. Soybean Rust Newsletter 3 : 27-28.
10. Shanmugasundaram, S. , Tschanz, A. T. , and Bromfield, K. R. 1980. RB and TAN infection types on G 8586 and 8587 soybean at AVRDC. Soybean Rust Newsletter 3 : 29.
11. Singh, B. B. 1977. Breeding for resistance to soybean rust in India. Soybean Rust Newsletter 1 : 13-14.

12. Sudiadi, M. 1980. Host range study for soybean rust in Indonesia. Soybean Rust Newsletter 3: 32-24.
13. Vakili, N. G. 1978. Field observation and host range of soybean rust, *Phakopsora pachyrhizi* in Puerto Rico. P. 4-15 *in* Vakili, N. G. (ed.), Proc. Workshop on Soybean Rust inthe Western Hemisphere. Nov. 14-17 1976, Mayaguez, Institute of Tropical Agriculture, Mayaguez, Puerto Rico, ARS, USDA.
14. Yang, C. Y. , Yeh, C. C. , and Chen, C. H. 1974. Soybean disease. Asian Vegetable Research and Development Center, Program Review 1974. (Mimeographed report).
15. Yeh, C. C. 1981. Rust and purple seed stain of soybeans. Ph. D. thesis, Dept. of Plant Pathology, University of Illinois at Urbana-Champaign, Urbana, Illinois, 103pp.

臺灣大豆銹病菌生理小種之鑑定[1]

葉 忠 川[2]

摘 要

從農試所、亞蔬中心、屏東、臺東及花蓮等五個地區之大豆銹病標本，利用離葉法在培養皿內進行接種源之純化與繁殖，每個地區各分得十個單一夏孢子堆來源之菌株，將五十個菌株之夏孢子懸浮液以離葉法分別接種在大豆鑑別品種 Ankur, TK 5, TN 4, P.I. 200492 及 P.I. 230971上，在室內 (20—30 °C) 經過二星期後，按病斑型可區分爲三個生理小種，此三個生理小種在植株上之反應與離葉法者相同，生理小種1在所有鑑別品種上產生感病型反應(TAN)；生理小種2僅在 P.I. 230971 上產生抗病型反應 (RB)，其餘均爲感病型；生理小種3則僅在 P.I. 200492 上產生感病型反應，其餘爲抗病型，此三個生理小種在五個地方之分佈不盡相同，臺東及花蓮未分離到生理小種1；生理小種2在五個地區均有發現；生理小種3僅在花蓮分離到二菌株。50個菌株在菜豆 (四季豆) 及豆薯上均產生感病型反應，而在豇豆 (cowpea)，鵲豆 (hyacinth bean)，皇帝豆 (萊豆) 及樹豆 (P:geon pea) 上均產生抗病型反應，所以沒有被選用爲鑑別品種，但在將來的試驗或世界其他地區也許可以利用。

1.臺灣省農業試驗所 研究報告第1050號。
2.本所植物病理系副研究員。臺灣省 臺中縣 霧峰鄉。