Host Range of Two *Synchytrium* Species

N. N. Raghavendra Rao and M. S. Pavgi

Faculty of Agriculture, Banaras Hindu University, Varanasi, India

Summary. The host range of 2 species of *Synchytrium* (*S. lagenariae* Mhatre and Mundkur and *S. trichosanthidis* Mhatre and Mundkur) has been studied on cucurbitaceous and noncucurbitaceous plants. The results of inoculation studies have shown that all the cucurbitaceous and a majority of the noncucurbitaceous plants were susceptible to infection by both species indicating a closer relation between them.

Introduction

Synchytrium De Bary et Woronin is the largest known chytrid genus representing nearly 200 species worldwide in distribution. Only a few species have been intensively studied in consideration to taxonomic criteria. The criteria broadly include the type of life cycle, developmental cytology, gall structure and host reaction. Karling (1954) has laid emphasis on the host range and/or host specificity as one of the criteria for identification of *Synchytrium* species.

Many workers on the genus have created species on the basis of hostinfection. This is particularly evident in the species parasitizing cucurbitaceous hosts, where a number of species have been described based mainly on the host infected (Gupta and Sinha 1951, Mhatre and Mundkur 1945). Karling (1964) tentatively reclassificed them under 2 species, viz. *Synchytrium lagenariae* Mhatre and Mundkur and *Synchytrium trichosanthidis* Mhatre and Mundkur, thus retaining the species proposed in priority by their authors. However, he believed that *Synchytrium lagenariae* and *S. trichosanthidis* also might prove identical after a thorough study of their development, cytology and host range (Karling, personal communication, 1971). Little or no work has been done on the host range and/or host specificity in these species. The present study was to determine the host range of *Synchytrium lagenariae* and *S. trichosanthidis* within the family Cucurbitaceae and some noncucurbitaceous plants.

Material and Methods

Seeds of different cucurbitaceous ¹) and noncucurbitaceous ²) plants in small lots were surface-sterilized in 7% sodium hypochlorite solution, washed

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¹) *Benincasa hispida* (Thumb.) Cogn., *Citrullus lanatus* Thumb. and Munsf., *C. vulgaris* var. *fistulosus* Watt, *Cucumis melo* L., *C. melo* var. *mormo-*

several times with distilled water and separately sown in sand in 6" pots to yield 10—12 seedlings/pot. The seedlings/plants were inoculated at 2 growth stages, viz. cotyledonary and emerging leaves of young seedlings and emerging leaves of maturing plants, with a fresh zoospore suspension of the two *Synchytrium* species prepared separately following the technique described earlier and slightly modified as necessary (Raghavendra Rao 1976, Raghavendra Rao und Pavgi 1970).

Infection of the plants was accomplished inoculating them by one or a combination of methods: a) Resting spores separated from the gall tissue on a cucurbit leaf were sown on moist filter papers in Petri plates and observed at intervals for the progress in germination keeping the filter papers enough moist. When most of the spores (85—90%) had germinated, the filter papers were carefully lifted, cut into strips and 1—4 strips were inverted over the leaves of test plants. The paper strips were again moistened and the plants retained in a moisture chamber for 24—48 hrs. The strips were withdrawn and the plants were transferred to a moist place under shade. b) Heavily infected leaves bearing prosoral (sporangial) galls were thoroughly washed to remove adhering soil particles and suspended in distilled water until they became soft and pulpy, when most of the prosori had germinated releasing the zoospores. The zoospore suspension was filtered several times through a cheese cloth and the clear (zoospore) suspension used for inoculation. Inoculations of the test plants were made by i) transferring the inoculum with a capillary pipette on the test plant-leaf or plant part; or ii) atomizing the suspension on the test plant or iii) dipping the entire plant/plant part in the zoospore suspension. The inoculated plants were incubated in moist chamber for 24—48 hrs. c) Pieces of heavily infected cucurbit leaf (with sporangial galls) were placed on the leaf of a test plant. The inoculum and test plant were swathed with moist cotton and incubated under a moist bell jar for 24—36 hrs.

In all the methods, viability of the inoculum was assured by first examining the suspension under a microscope for the presence of germinable sporangia and their ability to form motile zoospores. Inoculations were usually done in the evening, when the temperature was enough low. The inoculated plants were kept under a moist bell jar or polyethylene bags for 24—48 hrs and later transferred to a shady place, until the infection galls developed. A sufficient number

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dica Duthie and Ful., *C. melo* var. *utilissima* Duthie and Ful., *C. sativus* L., *Cucurbita maxima* Duch., *Coccinia indica* W. and A., *C. cordifolia* W. and A., *Lagenaria sicararia* Mol. and Standl., *Luffa acutangula* Roxb., *L. cylindrica* Roem., *Luffa* sp., *Melothria madarasapatana* Cogn., *Momordica charantia* L.

[2] Noncucurbitaceous test plants included the following: Leguminosae: *Phaseolus mungo* L., *P. aureus* Roxb., *Cajanus cajan* (L.) Millsp., *Crotalaria juncea* L., *Cymopsis psoraloides* Dc., *Dolichos lablab* L., *Vigna catjang* Walp., *Arachis hypogaea* L., *Glycine max* L. — Malvaceae: *Hibiscus esculentus* L., *H. rosa-sinensis* L., *Gossypium* sp. — Solanaceae: *Capsicum annuum* L., *Lycopersicum esculentum* Mill., *Solanum melongena* L., *S. tuberosum* L. — Cruciferae: *Brassica juncea* L., *B. oleracea* L. var. *botrytis*, *B. oleracea* L. var. *capitata*, *Raphanus sativus* L. — Compositae: *Carthamus tinctorius* L., *Cosmos* sp., *Zinnia elegans* L. — Labiatae: *Leucas aspera* Spreng. — Miscellaneous hosts: *Amaranthus* sp., *Beta vulgaris* L., *Spinacia oleracea* L., *Lactuca decipicus* Clarke, *Mangifera indica* L., *Morus alba* L., *Daucus carota* L., *Tabernaemontana coronaria* Willd., *Coriandrum sativum* L., *Sesamum indicum* L., *Rauwolfia serpentina* Benth. and Kunze. —

Phylogenetically related hosts: *Begonia* sp., *Passiflora edulis* L., *Carica papaya* L.

(5 or more) of replications was maintained in each case and the inoculation experiments were repeated in three or more crop seasons. Examination of the inoculated plants was periodically made and the type of development of galls on each plant noted. Uninfected plants were repeatedly inoculated to ensure their nonsusceptibility. Observations were recorded on the relative susceptibility of the cotyledonary and emerging leaves, formation of sporangial and/or resting spore galls and development of aborted galls, if any.

Observations

The relative susceptibility of different cucurbitaceous and non-cucurbitaceous hosts to infection was studied at two growth stages by the two *Synchytrium* species. Some salient features of infection by the two species are mentioned below:

Cucurbitaceous hosts:

All the cucurbitaceous host species tested were found susceptible to infection by both species of *Synchytrium* indicating a wide host range within the family Cucurbitaceae. All the host plants were susceptible at the 2 growth stages forming both sporangial and resting spore galls in varying numbers. The sporangial galls became visible 8—10 days after inoculation and under cool, moist conditions they rapidly multiplied causing secondary infections, thus repeatedly forming sporangial galls. As the weather became (semi)dry, a change-over to the resting spore gall development was noticed. The development of sporangial and resting spore galls was almost similar on all the test plants, indicating absence of any differential host reaction. Some of the cucurbitaceous hosts such as *Benincasa hispida*, *Cucumis melo*, *C. melo* var. *utilissimus* and *Citrullus lanatus* are not cultivated during the rainy season, while the environmental conditions remain favorable for infection and as such these hosts usually escape infection in the remaining part of the year. Inoculation experiments have, however, shown them equally susceptible and may become heavily infected, if grown during the rainy season. The other hosts, cultivated during the rainy season, become heavily infected under the field conditions.

The leaves of some of the cucurbitaceous hosts such as *Benincasa hispida*, *Cucurbita moschata*, *Melothria madaraspatana* and *Trichosanthes dioica* are covered with numerous trichomes making their inoculation somewhat difficult. When the leaves were thoroughly moistened or wetted with "Surfactol — 100" (Rohm & Haas Inc., Philadelphia, Pa; 1 drop to 50 ml dist. water) and inoculated, they were equally susceptible to infection. Presence of trichomes on the leaves and young shoots of *C. moschata* and *T. dioica* may possibly account for a low disease incidence on them under the field conditions. The leaves of other host plants are smoother and the number of hairs/trichomes appeared far less and as such in the inoculation studies no difficulties were experienced on them.

Noncucurbitaceous hosts:

Majority of the noncucurbitaceous plants tested were found susceptible to infection by both *Synchytrium* species, indicating their wide host range. Most of the host plants showed a broad similarity with minor variations in infection by both species. The leguminous and cruciferous hosts in general were highly susceptible in all the growth stages. Among the 9 leguminous hosts, 6 were found susceptible. *Dolichos lablab* escaped cotyledonary infection, while *Arachis hypogaea* and *Glycine max* remained completely immune in all the growth stages. Repeated inoculations on them gave negative results. The four cruciferous hosts were susceptible; however, resting spore galls failed to develop on their cotyledonary leaves, but developed well on the mature leaves. The malvaceous plants were completely immune to infection. Their failure to infection was initially thought due to the presence of numerous trichomes on their leaves, making the inoculations difficult. KARLING (1955) also observed similar difficulty while inoculating malvaceous hosts with *Synchytrium australe* SPEG. Hence, repeated inoculations after wetting the host leaves with "Surfactol — 100" were made, but without success. Among the four members of Solanaceae, only *Solanum melongena* expressed susceptibility to infection by both species. Only the young emerging leaves of maturing plants developed resting spore galls, while the lower stem portions of tomato (*Lycopersicum esculentum*) sparsely developed resting spore galls on them, whereas potato and red pepper (*Capsicum annum*) remained immune to infection. *Leucas aspera,* the only member tested from the Labiatae, was found highly susceptible, in which the emerging leaves of mature plants showed infection by both *Synchytrium* species. However, *S. lagenariae* produced only sporangial galls, whereas *S. trichosanthidis* yielded both types of galls.

Among the miscellaneous plants tested for susceptibility, *Amaranthus* sp., *Beta vulgaris*, *Daucus carota*, *Sesamum indicum*, *Spinacia oleracea* and *Coriandrum sativum* showed susceptibility to infection by both *Synchytrium* species, while others expressed it differentially, the latter three host species developing the galls on the emerging leaves of maturing plants only. *Morus alba* was susceptible to only *S. trichosanthidis,* developing only sporangial galls on the young leaves of maturing plants; *Tabernaemontana coronaria* and *Rauwolfia serpentina* remained immune to the two pathogenic species. Besides, the three phylogenetically related plants showed immunity to infection by both the species.

Synchytrium lagenariae developed only few but aborted galls on the crown leaves of *Hibiscus esclentus* and both species incited abortive galls on the young leaves of *Mangifera indica*. No abortive galls were noticed on any of the cucurbitaceous hosts tested for infection.

Discussion

Most of the cucurbitaceous host species have been successfully infected with an inoculum separately isolated from host collections representing. *S. lagenariae* and *S. trichosanthidis*. Both species showed a close similarity with few variations in their host range of noncucurbitaceous plants, though the degree of infection varied on different hosts. This variation may primarily be due to environmental and/or inoculation conditions favoring infection. Thus, the studies have revealed that most of the cucurbitaceous hosts might be infected under natural conditions from any inoculum of *Synchytrium* species derived from a cucurbitaceous host. The results have supported KARLING's contention in part regarding the host range of the two *Synchytrium* species, delineated as an important taxonomic criterion.

Susceptibility of various noncucurbitaceous hosts is an interesting feature in many respects. Many of them are reported to be hosts for other species of *Synchytrium* and most of these *Synchytrium* species have been erected mainly on their susceptibility to infection by that isolate. Intensive host range and developmental studies are yet lacking in many of them. A thorough study and evaluation of different taxonomic criteria in these species may reveal several of them to be identical. The *Synchytrium*-infected noncucurbitaceous hosts may also act as collateral hosts for cucurbitaceous host crops and thereby help in building up an inoculum potential for the secondary spread. Differential susceptibility of some of the noncucurbitaceous crop plants specifically in the crown leaves of maturing plant hosts such as *Dolichos lablab*, *Carthamus tinctorius*, *Leucas aspera*, *Spinacia oleracea* to infection by both species may ensure continuity of inoculum through sporangial galls in regions, where the environment permitted. Field observations indicated that *Dolichos lablab*, *Phaseolus aureus*, *Phaseolus mungo*, *Raphanus sativus*, *Vigna sinensis* etc. when grown with cucurbits became heavily infected by *Synchytrium* species. This further points out that the cucurbit Synchytria can easily pass on to various noncucurbitaceous hosts also under field conditions.

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