Races of the Aster-Wilt Fusarium

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ABSTRACT

Races of *Fusarium oxysporum* f. sp. *callistephi* were evident after inoculating staghorn sumac (*Rhus typhina*); 24 cultivars of China aster (*Callistephus chinensis*); and 12 of African marigold (*Tagetes erecta*) with nine different isolates from aster, and three isolates from wilting sumac. With aster as a common host, races 1 and 2 of *F. oxysporum* f. sp. *callistephi* were from aster, and race 3 was from sumac. Races 1 and 2 did not cause wilt of sumac, but race 3 from sumac caused wilt of sumac and aster, all causing similar symptoms of disease on aster. However, there was a time differential for symptom expression on aster, as race 3 from sumac caused much slower wilting of aster than races 1 and 2. Forty-three other formae speciales (ff. sp.) and races of *F. oxysporum* were nonpathogenic on aster and sumac. Races 1 and 3 of f. sp. *callistephi* were also nonpathogenic on a susceptible host of each of these other ff. sp. Only race 2 caused wilt of marigold. Since race 2 Hoffman preceded race 2 Olsen, the latter is invalid, and since its exact status is uncertain, it is proposed as race 4. Phytopathology 61:820-824.

Additional key words: f. sp. *rhois*.

Wilt of China aster (*Callistephus chinensis* Nees.) was probably first mentioned in the United States in 1896 by Galloway (7), but it was not until 1918 that Beach (5) proved the causal agent to be *Fusarium conglutinans* Wr. var. *callistephi* Beach, which is *F. oxysporum* Schlecht. f. *callistephi* (Beach) Snyd. & Hans. according to the revised classification (21). Baker (4) gives a resume of the salient features of the wilt disease; and Hoffman (8), an extensive list of literature. The disease has been reported from at least 19 countries.

A vascular wilt of staghorn sumac (*Rhus typhina*) (26), caused by *Fusarium oxysporum* Schlecht. (Snyd. & Hans.) f. *rhois* Snyd. & Hepting (22), was described further by Toole (25). It caused wilt of aster in our experiments, and was tentatively designated a race of the aster-wilt *Fusarium* (3).

Based on the differential reactions of asters only, Horst (9, 10) reported physiological specialization in the aster-wilt *Fusarium*, which suggests two races of the fungus, but these were not so designated. Hoffman (8) distinguished two races of *F. oxysporum* f. sp. *callistephi* by using numerous cultivars of aster as differentials, among them Sonnenstrahl, Bellablanca, Rosen Gloria, and Rosenknopse. Race 1 was pathogenic on all, and race 2 was essentially nonpathogenic on the latter three cultivars. Olsen (17) reported a wilt of African marigold (*Tagetes erecta*) caused by a *Fusarium oxysporum* (*Tagetes* form) to which most cultivars of China aster were as highly susceptible as to the aster form, but *T. erecta* was susceptible to the *Tagetes* form only. He established two races of f. sp. *callistephi;* the aster form, race 1, and the *Tagetes* form, race 2 (18). Lim (15) reported wilt of African marigold in Malaya and Singapore caused by a *Fusarium* that also was pathogenic on China aster.

Since a culture of the *Tagetes* form from California or Malaya was unavailable, this paper reports the results of experiments with the sumac-wilt *Fusarium* and the races of f. sp. *callistephi* from aster designed to show the probable interrelationships of the formae speciales (ff. sp.) and races involved in the aster-sumac-marigold-wilt complex. Our citations are restricted chiefly to investigations of methods, cross inoculations, and races of the causal organisms.

Materials and Methods.—Both mass and monoconidial isolates of the wilt fusaria were used. Isolates from aster, race 1, were from North Carolina, New York, Ohio, Virginia, Canada, Germany, and Japan; and race 2, from California and Scotland. The sumac-wilt isolates were from Connecticut (CONN), Massachusetts (MASS), and Virginia (VIRG). Seed of staghorn sumac were collected along the Blue Ridge Parkway in Virginia. The seed of 24 cultivars of aster, including several of those used by Hoffman, and 12 cultivars of African marigold were from commercial sources in the United States and Germany.

Plants were grown in steamed sand in 8-liter glazed pots and watered with a nutrient solution. Those derived from seed planted directly in the pot were in a circle about 2.5 cm from the edge. Plants of a few species such as aster, celery, cabbage, stock, sweet-potato, tobacco, and tomato were usually transplanted to the pots. Roots of the former were cut on one side by pressing an inverted Büchner funnel into the center of the pot, but roots of the latter, after becoming established, were cut on one side with a large test tube. All plants in either category were inoculated as young plants, usually with several leaves, but not as young seedlings. The disease recorded was not damping-off. Five hundred ml of a 3-day-old liquid inoculum were poured around the cut roots in each pot at each of two inoculations about 5 to 7 days apart. Plants were removed from the pots when they were severely diseased. At the termination of an experiment, those that showed no external symptoms were cut diagonally 2-5 cm above the soil line, and also vertically when there was discoloration, to note its extent. These data are omitted, as they seemed to be of minor importance in defining host relationships. During the course of the experiments, the necessary precautions were taken to prevent accidental contaminations. Plants were grown in a manually ventilated greenhouse with a thermostatic setting of 28 C.

As cross inoculations were made, plants susceptible to each *Fusarium* wilt isolate were inoculated to check the virulence of the cultures and to see that conditions in the greenhouse were favorable for the development of wilt. Noninoculated plants of each cultivar were included as checks. Isolations of fusaria were made from diseased plants in the cross-inoculation experiments by plating surface-sterilized stem sections on water agar. The identity of these isolates was established by inoculating the proper host. Further details of methods are given elsewhere (1, 2).

RESULTS.—*Inoculation of aster with isolates of wilt fusaria from aster and sumac.*—The results of the early inoculations (1951-61) of plants of 14 cultivars of aster, each cultivar in at least two pots, with the wilt fusaria from aster and sumac, respectively, are given in Table 1. Aster-wilt isolates from North Carolina and New York only were available during 1951-56, and the freshly isolated North Carolina cultures were used almost exclusively. These were shown later to be race 1. Heavenly Blue aster was equally susceptible to the aster- and sumac-wilt fusaria (Table 1). Improved Giant Crego, Kirkwell light pink, and Imbricated Pompon also were susceptible to both organisms, with 100% wilted plants when inoculated with the aster *Fusarium* and 75, 77, and 82%, respectively, with the sumac *Fusarium*. Most cultivars of aster were somewhat resistant to the sumac *Fusarium,* but only one cultivar was resistant to the aster *Fusarium*. In an early experiment when Heavenly Blue aster was inoculated with numerous ff. sp. of the wilt fusaria, only those from aster and sumac caused wilt, but symptom expression was slower with the sumac-wilt isolate, since only two plants of 14 in a pot showed symptoms after 13 days when all plants inoculated with the aster-wilt isolate were dead. However, other plants continued to wilt during the 52 days of the experiment. In subsequent experiments, there was the same slow appearance of symptoms. The average time for severe wilt of the Heavenly Blue aster plants inoculated with virulent isolates of the aster *Fusarium* was 15.4 days, whereas, for the sumac *Fusarium,* it was 46.1 days. Symptoms of disease were the same on plants inoculated with either the aster *Fusarium* (4, 5, 11, 13) or the sumac *Fusarium*.

The first indication of loss of pathogenicity of the sumac *Fusarium* for Heavenly Blue aster was noted when two of four previously virulent isolates were avirulent. However, 1 year later, the other two isolates also caused either mild or no wilt. At the same time, the two isolates, which were tested on sumac, were as virulent on sumac as when first collected. Reduced virulence or complete loss of pathogenicity for a secondary host with retention of virulence for the primary host has commonly occurred with various wilt fusaria grown on potato-dextrose agar.

Inoculation of staghorn sumac with aster- and sumac-wilt fusaria.—The sumac plants inoculated with several aster-wilt isolates from 1951-1961 showed no external or internal symptoms of disease (Table 1). Races 1 and 2 of f. sp. *callistephi* obtained in 1963 were also nonpathogenic on sumac. Inoculation with sumac-wilt

TABLE 1. Percentages of wilted plants of aster and staghorn sumac inoculated with wilt fusaria from aster and sumac, 1951-61

	Wilt *Fusarium* from			
	Aster (race 1)		Sumac	
Cv.	External symptoms of wilt	Total plants	External symptoms of wilt	Total plants
Aster	%	*no.*	%	*no.*
American Beauty, Crimson	100	13	58	12
Ball Early White	94	17	0	19
Ballet Queen (Queen of the Market) Salmon-Rose	100	20	12	17
California Giant, Dark Purple	95	19	36	18
California Giant, Double Deep Rose	28	18	30	20
Giant Branching, Azure Blue	100	20	19	21
Heavenly Blue	92	134[a]	96	153
Heavenly Blue	100	107[b]		
Imbricated Pompon, Blackish Blue	100	14	82	17
Improved Giant Crego, Enchantress	100	20	75	16
King, Needle Type, Lavender	100	47	45	38
Kirkwell, Dark Blue	100	20	56	18
Kirkwell, Light Pink	100	20	77	17
Queen of the Market, White	100	20	22	18
Sumac, staghorn	0	112	59	277[c]
Sumac, staghorn			75	137[d]

[a] Results of four pot tests with isolates of reduced virulence are included.

[b] All highly virulent isolates.

[c] Isolates from Virginia, Connecticut, and Massachusetts, some showing reduced virulence.

[d] Freshly collected and more virulent isolates.

TABLE 2. Percentages of wilted plants of aster inoculated with wilt fusaria from aster and sumac[a], 1961-66

Cv.	*Fusarium oxysporum* f. sp. *callistephi* Race 1 External symptoms of wilt	Race 1 Total plants	Race 2 External symptoms of wilt	Race 2 Total plants
	%	*no.*	%	*no.*
Azure, Clear Light Blue	96	47	5	20
Bellablanca	89	28	0	9
Crego, Azure Blue	100	9	11	9
Early Giant, mixture	100	10	0	10
Rosenknopse	100	10	0	10
Royal Azure Blue	100	10	0	10
White, All Double Pure White	96	44	0	20
Giant California Sunshine, mixt.	100	10	100	9
King, Needle Type, Lavender	100	85	100	19
King, Needle Type, Shell Pink	100	46	100	10
Kirkwell, Light Pink	100	45	100	9
Queen of the Market, White	100	33	80	13
Royal White	50	16	90	10
Sonnenstrahl	100	27	100	13

[a] No wilting of 3-29 plants of aster cultivars Azure, Clear Light Blue; Bellablanca; Crego, Azure Blue; Giant Calif. Sunshine; and King, Needle Type, Shell Pink when inoculated with the sumac *Fusarium*, but 59% wilt of Sonnenstrahl.

isolates revealed appreciable differences in virulence; the freshly isolated VIRG culture caused wilt of 75% of the plants while the older CONN and MASS cultures caused wilt of only 59% of the plants (Table 1).

Inoculations of aster with F. oxysporum f. sp. callistephi races 1 and 2, and with the sumac-wilt Fusarium.—Selective pathogenicity of f. sp. *callistephi* is clearly shown in Table 2, as the first seven cultivars were highly susceptible to race 1 and highly resistant to race 2, and the other seven cultivars were susceptible to both races. In Table 2, for cultivars with 27 or more plants inoculated with race 1, the per cent of wilted plants was obtained by combining the results with six isolates from different locations, other than New York, since these gave similar results. The isolate from New York was an old one of reduced virulence. For cultivars with less than 27 plants under race 1 (Table 2), only the isolates from North Carolina and Japan were used, and the results combined. All cultivars were inoculated with both isolates of race 2, and the results combined, as no differences in their pathogenicity were noted.

Although many of the aster cultivars in Table 1 were listed as resistant to the aster *Fusarium*, all except one were susceptible to the North Carolina isolate then available, which is now known to belong to race 1. Most of these cultivars were not available for later tests with race 2.

Before reduced virulence or loss of pathogenicity of the sumac *Fusarium* for aster was noted, it caused 45, 77, and 22% wilt of plants of King lavender, Kirkwell light pink, and Queen of the Market white, respectively (Table 1). In 1964-66, the percentages of wilted plants for these cultivars were 16, 35, and 0, respectively, and 0 for five other cultivars in Table 2.

Inoculation of marigold with F. oxysporum f. sp. callistephi races 1 and 2 and the sumac-wilt Fusarium.—Mission Giant and Tall African All Double Orange marigold were susceptible to f. sp. *callistephi* race 2, but nonsusceptible to race 1 and the sumac *Fusarium* (Table 3). The sumac *Fusarium* was nonpathogenic on six other cultivars of African marigold (Table 3).

Inoculation of other plants with the aster- and sumac-wilt fusaria.—There were no external symptoms of wilt in any plants of the genera, species, or cultivars listed below when grown in pots of sand and inoculated separately with each of one or more isolates of *F. oxysporum* f. sp. *callistephi* race 1 and the sumac-wilt *Fusarium*, with the exceptions given later. One banana plant and five to nine plants of cabbage, carnation, eggplant, stock, sweetpotato, tobacco, and tomato, and 10 or more of all other plants were inoculated. Vascular discoloration, present to a slight extent in a few instances, was not an acceptable criterion for differentiating races.

The plants inoculated were alfalfa (*Medicago sativa* L. 'Grimm'); asparagus (*Asparagus officinalis* L. 'Mary Washington'); banana (*Musa balbisiana* Colla); bean (*Phaseolus vulgaris* L. 'Mexican Pink'); beet (*Beta vulgaris* L. sugarbeet 'G. W. 359'); cabbage (*Brassica oleracea* var. *capitata* L. 'Copenhagen Market'); carnation (*Dianthus caryophyllus* L. 'Apollo' and 'Orion'); *Cassia tora* L.; celery (*Apium graveolens* L. var. *dulce* DC. 'Golden Self-Blanching'); chrysanthemum (*Chrysanthemum morifolium* [Ramat.] Hemsl. 'Encore'); cotton (*Gossypium arboreum* L. 'K-1'), (G. *barbadense* L. 'Sakel'), and (G. *hirsutum* L. 'Hurley Special Rowden'); cowpea (*Vigna sinensis* [Torner] Savi 'Lady Finger', 'Groit', 'California Blackeye 5', and 'Arling-

TABLE 3. Percentages of wilted plants of marigold inoculated with wilt fusaria from aster and sumac[a]

Cv.	*Fusarium oxysporum* f. sp. *callistephi* Race 1 External symptoms of wilt	Race 1 Total plants	Race 2 External symptoms of wilt	Race 2 Total plants
	%	*no.*	%	*no.*
All Double Orange[b]	0	60	17	47
Crackerjack	0	58	0	41
Mission Giant Goldsmith	0	63	0	59
Mission Giant, mixture	0	155	69	118
All Double Orange, Tall African[c]	1	70	72	46

[a] No wilting of 14-51 plants of Crown of Gold; Frills; Lemon Ball; Man-in-the-Moon; Mission Giant mixture; Riverside Beauty; Tall African All Double Orange; and Yellow Fluffy cultivars of marigold when inoculated with the sumac *Fusarium*.
[b] Geo. J. Ball, Inc.
[c] Bodger Seeds, Ltd.

ton'); cucumber (*Cucumis sativus* L. 'Palmetto'); cyclamen (*Cyclamen persicum* Mill.); eggplant (*Solanum melongena* L. 'Black Beauty'); gladiolus (*Gladiolus* spp. 'Picardy'); gourd (*Luffa aegyptiaca* Mill.); lily (*Lillium longiflorum* Thunb. 'Harson'); lupine (*Lupinus angustifolius* L. 'Blue Bitter') and (*L. luteus* L. 'Neven'); Maltese cross (*Lychnis chalcedonica* L. 'Scarlet'); Mexican sunflower (*Tithonia rotundifolia* [Mill.] Blake 'Torch'); mimosa (*Albizzia julibrissin* Durazz.); muskmelon (*Cucumis melo* L. 'Hale's Best Jumbo'); mustard (*Brassica juncea* [L.] Coss 'Southern Giant Curled'); narcissus (*Narcissus pseudonarcissus* L. 'Golden Harvest'); onion (*Allium cepa* L. 'Eclipse'); passion vine (*Passiflora edulis* Sims); garden pea (*Pisum sativum* L. 'Thos. Laxton'); radish (*Raphanus sativus* L. 'Long White Icicle'); safflower (*Carthamus tinctorius* L. 'Gila'); sesame (*Sesamum indicum* L. 'Criollo'); soybean (*Glycine max* [L.] Merr. 'Yelredo'); spinach (*Spinacea oleracea* L. 'Bloomsdale Savoy Leaved'); Ten Weeks stock (*Matthiola incana* [L.] R. Br. 'Bright Pink' or 'Standard Gold'); sweetpotato (*Ipomoea batatas* [L.] Lam. 'Porto Rico'); sweet william (*Dianthus barbatus* L. 'Giant Pure White'); tobacco (*Nicotiana tabacum* L. 'Burley 5' and 'Gold Dollar'); tomato (*Lycopersicon esculentum* Mill. 'Bonny Best'); and watermelon (*Citrullus lunatus* [Thunb.] Mansf. 'Garrison' or 'Watson').

The exceptions mentioned are as follows: banana and cabbage were not inoculated with the fungus from aster; and mustard was not inoculated with the fungus from sumac. In work by others, f. sp. *callistephi* was nonpathogenic on plants of cabbage (5, 8, 11, 12, 23, 24); beet (23); flax (6, 8); eggplant (16); and alfalfa, bean, broad bean, clover, lupine, and pea (8).

Inoculation of aster and staghorn sumac with other wilt fusaria.—No external symptoms of wilt were seen in any plants of Heavenly Blue or King needle-type cultivars of aster or staghorn sumac when inoculated with a virulent isolate of each of the following formae speciales and races of *F. oxysporum: apii; asparagi; batatas* races 1 and 2; *betae; carthami* race 1; *cassiae; chrysanthemi; cepae; conglutinans* races 1, 2, 3, and 4; *cubense* race 1; *cucumerinum; cyclaminis; dianthi; gladioli; glycines; lilii; luffae; lupini* race 2; *lycopersici* races 1 and 2; *medicaginis; melongenae; melonis; narcissi; niveum; passiflorae; perniciosum* race 1; *phaseoli; pisi* races 1 and 2; *sesami; spinaciae; tracheiphilum* races 1, 2, and 3; and *vasinfectum* races 1, 2, 3, and 4.

Beach (5) stated that the aster-wilt *Fusarium* was ". . . pathogenic to asters producing wilting and blackening, but not pathogenic to cabbage, while *F. conglutinans* produces wilting without blackening on asters, and is pathogenic to cabbage." Other workers reported the following fusaria nonpathogenic on aster; *F. conglutinans* (11, 12, 19, 20); *F. conglutinans* v. *betae* Stw. (19, 20, 23); *F. orthoceras* App. & Wr. v. *pisi* Linford (19, 20); *F. bulbigenum* Cke. & Mass. v. *niveum* E. F. Sm. (19, 20); *F. oxysporum* Schlecht. from cabbage, beet, and potato (20); *F. vasinfectum* Atk. (20); *F. oxysporum* f. sp. *carthami* (14); and *Fusarium* sp. from celery (20).

Discussion.—A search for wilted sumac plants along the Blue Ridge Parkway in Virginia was made by us and two members of the Park Service in 1960. Notes supplied by G. H. Hepting were so specific about the locations where the first wilting plants were found that we are confident the same areas were inspected, but only a dense stand of healthy plants was observed. Had the fungus disappeared, were environmental conditions unfavorable for disease, or were these wilt-resistant plants? It seems most likely that wilt-resistant plants have replaced the susceptible ones since the disease was first found in 1946, for in the greenhouse, a few inoculated plants in every pot grew vigorously, thus indicating their wilt resistance.

Hoffman, in 1964 (8), clearly established two races of *F. oxysporum* f. sp. *callistephi* by using Bellablanca, Rosenknopse, Sonnenstrahl, and other cultivars of aster as differentials. The first two cultivars were susceptible to race 1 and resistant to race 2, whereas Sonnenstrahl was susceptible to both races. Since we obtained similar results with these cultivars (Table 2), it seems valid to assume that our isolates which caused wilt of all the cultivars are race 1, and the isolates to which some cultivars are resistant are race 2. Wilting of the resistant cultivars of aster developed in Wisconsin by using aster-wilt fusaria from Indiana and Japan (20) was interpreted by us as evidence for more than one race of *F. oxysporum* f. sp. *callistephi,* although Wollenweber identified three pathogenic cultures of the fungus for Riker & Jones (20) as separate species in the section Elegans. The fungus from Indiana was *F. conglutinans* v. *majus* Wr.; the one from Japan, *F. oxysporum* Schlecht. f. 6 Wr.; and the one from Wisconsin, *F. conglutinans* Wr. v. *callistephi* Beach. The first two fusaria evidently belong to race 1, and the third to race 2.

No evidence of selective pathogenicity of the aster-wilt *Fusarium* was observed among four isolates in our early collection or after acquisition of the culture from Japan, as it also caused wilt of practically all wilt-resistant cultivars, a characteristic of f. sp. *callistephi,* race 1. Since the wilt-resistant asters developed by Riker & Jones (20) were resistant in their plots and susceptible to an isolate from Japan, a reasonable assumption is that the plots were infested not with race 1 but probably with race 2, unless there are other races.

In 1955, China aster was found to be a common host for *F. oxysporum* f. sp. *callistephi* from aster and *F. oxysporum* f. sp. *rhois* from sumac (3). We therefore called the latter a race of the former, but without a formal proposal. The logical order of races then would have been race 1 from aster and race 2 from sumac, but with *Fusarium* isolates from aster now clearly differentiated into races 1 and 2 by Hoffman and this investigation; the sumac-wilt *Fusarium* is designated as race 3 of f. sp. *callistephi.* In 1965, Olsen (18) differentiated two forms; the one from aster causing wilt of aster only was designated as race 1, and the one from *Tagetes* causing wilt of aster and marigold (*Tagetes*) was designated as race 2. The results presented here suggest that the aster form was probably race 1, and the *Tagetes* form, race 2 of f. sp. *callistephi.* The *Tagetes* form or race 2 of Olsen, therefore, may not be a new race but may be race 2 as described by Hoffman.

The supposition that races 1 and 2 of f. sp. *callistephi* are the wilt-fusaria involved in the aster-*Tagetes* complex in California is supported by these facts; many of the Wisconsin wilt-resistant asters were grown many years ago by Bodger Seeds Ltd. (13) in the general region where *Tagetes* wilt was found, and most of them were resistant, suggesting race 2; the only aster-wilt *Fusarium* from California in our collection belongs to race 2 and is pathogenic on some cultivars of African marigold, whereas the isolates of race 1 are weakly virulent or nonpathogenic on African marigold (Table 3). These results are similar to those of Olsen (18). However, without more evidence, the *Tagetes* form is tentatively designated as race 4 of f. sp. *callistephi.*

It is proposed, therefore, that these distinct pathogenic entities be designated as follows:

Fusarium oxysporum Schlecht. emend. Snyder & Hansen forma specialis callistephi Beach. Race 1 Hoffman.

Syn. *F. conglutinans* var. *majus* Wr. (27).

F. oxysporum Schl. f. *6* Wr. (27).

A forma specialis of *F. oxysporum* pathogenic on numerous cultivars of China aster as Azure, Bellablanca, Crego, Early Giant, Rosenknopse, and Royal Azure Blue. Occurs in the vascular tissue, causing blackening and wilting. Nonpathogenic on staghorn sumac, some cultivars of African marigold, and plants of 42 genera or species listed above.

Fusarium oxysporum Schlecht. emend. Snyder & Hansen forma specialis callistephi Beach. Race 2 Hoffman.

Syn. *F. conglutinans* Wr. var. *callistephi* Beach (27).

A forma specialis weakly virulent or nonpathogenic on some cultivars of China aster, such as those above susceptible to race 1, but as highly virulent as race 1 on some other cultivars such as Giant California Sunshine, King, Kirkwell, and Sonnenstrahl. Nonpathogenic on staghorn sumac, but pathogenic on some cultivars of African marigold, such as Tall African All Double Orange and Mission Giant.

Fusarium oxysporum Schlecht. emend. Snyder & Hansen forma specialis callistephi Beach. Race 3 Armst. & Armst.

Syn. *F. oxysporum* Schlecht. Snyd. & Hans. f. *rhois* Snyd. & Hepting (22).

A forma specialis pathogenic in vascular tissues causing blackening and wilting of China aster and wilting of staghorn sumac. Less virulent on most cultivars of aster than races 1 and 2. Nonpathogenic on African marigold and plants of 42 genera or species listed above.

Fusarium oxysporum Schlecht. emend. Snyder & Hansen forma specialis callistephi Beach. Race 4 Armst. & Armst.

Syn. *F. oxysporum* f. *callistephi* (Beach) Snyd. & Hans. Race 2 Olsen (18).

A forma specialis weakly virulent or nonpathogenic on cultivars of China aster, such as New Ball White, but highly virulent on others such as King, Crego, and Queen of the Market. Pathogenic on several cultivars of *Tagetes erecta* that are resistant to race 1. Similar to race 2 of Hoffman (8), and may be this race.

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