The effect of temperature on ascospore germ tube growth of *Mycosphaerella musicola* and *Mycosphaerella fijiensis* var. *difformis*.

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EFFET DE LA TEMPERATURE SUR LA CROISSANCE DU TUBE GERMINATIF D'ASCOSPORES DE *MYCOSPHAERELLA MUSICOLA* ET *MYCOSPHAERELLA FIJIENSIS* VAR. *DIFFORMIS*.

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RESUME - Les températures maximums pour la croissance du tube germinatif des ascospores de *M. musicola* et *M. fijiensis* var. *difformis* sont de 28°C sur feuille de bananier et 26°C sur gélose. *M. fijiensis* croît plus vite que *M. musicola* à toutes les températures au-dessus de 22°C et est plus tolérant entre 30 et 34°C. La croissance des deux espèces est réduite de 50 p. 100 ou plus entre 20 et 22°C. Les ascospores de *M. musicola* provenant du Honduras, observées en 1963-64 étaient plus tolérantes à basse température que celles d'une collection de 1982 provenant de Panama.

INTRODUCTION

The effect of temperature on the germination of *M. musicola* on the banana leaf was reported from Honduras (STOVER, 1965). Since then, *M. musicola* in Honduras has been completely replaced by *M. fijiensis* var. *difformis*. A comparison of the temperature response of ascospore germ tubes of *M. fijiensis* var. *difformis* from Honduras and *M. musicola* from Panama was made and the results are presented. For brevity, *M. fijiensis* var. *difformis* is referred to as *M. fijiensis*.

METHODS

Ascospore germ tube growth was studied on the lower surface of a recently unfurled leaf of the Valery variety. A piece of the leaf was placed in a Petri plate, lower surface up, and moistened with distilled water from an atomizer. A mass-infected piece of banana leaf bearing ascospores of either *M. musicola* or *M. fijiensis* was wetted and placed in the Petri dish lid over the leaf for one-hour to discharge ascospores and then discarded. The wet leaf pieces were placed in incubators at various temperatures (± 1.5°C) for 24 or 48 hours. On removal, the fungus was stained by flooding the leaf surface with rose bengal. The germ tubes of at least 500 ascospores were measured. In some experiments ascospores were discharged in Petri plates onto 2 % water agar.

Diseased material was obtained from unsprayed Valery in Honduras (*M. fijiensis*) or in Armuelles, Panama (*M. musicola*). The *M. musicola* was stored in plastic bags at 4.4°C in a refrigerator. Studies showed that such storage, for up to 5 weeks, did not affect rate of germ tube growth. Rate of *M. musicola* germ tube growth from Panama was compared with that for the fungus from Honduras studied in 1963-64 (STOVER, 1965).

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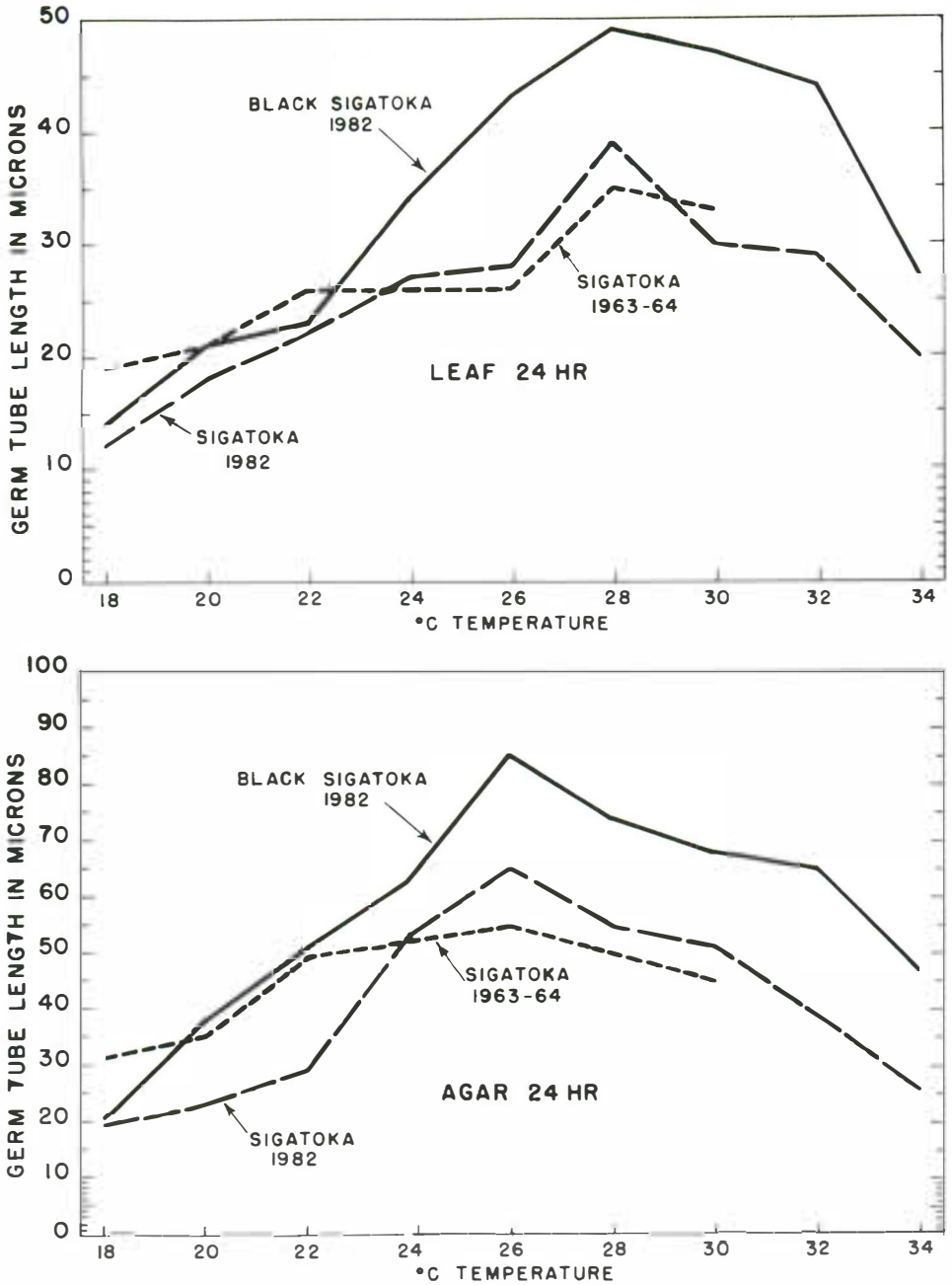

Figure 1 - Ascospore germ tube length in microns at different temperatures on the banana leaf (upper) and on agar (lower) after 24 hours.

RESULTS

The data in Table 1 and Figure 1 show that germ tube growth of *M. fijiensis* on the banana leaf exceeds that of *M. musicola* at all temperatures above 22°C, but especially at temperatures above the optimum of 28°C. Both fungi have the same optima of 28°C on the leaf and 26°C on water agar (Table 2).

The greater tolerance of *M. fijiensis* to higher temperatures is also shown in Table 2 and Figures 1 and 2. After 24 hours on the leaf at 30° and 32°C, germ tube growth of *M. fijiensis* was, respectively, 4 % and 10 % less than that at 28°C compared with 23 % and 26 % less for *M. musicola* (Table 2). On water agar the differences were less pronounced. There was very little difference between *M. musicola* tested in 1963-64 and the 1982 Panama fungus at temperatures of 24°C or higher, while below 24°C, the 1982 Panama fungus grew more slowly (Figure 1). The data, presented as a percentage of the maximum growth

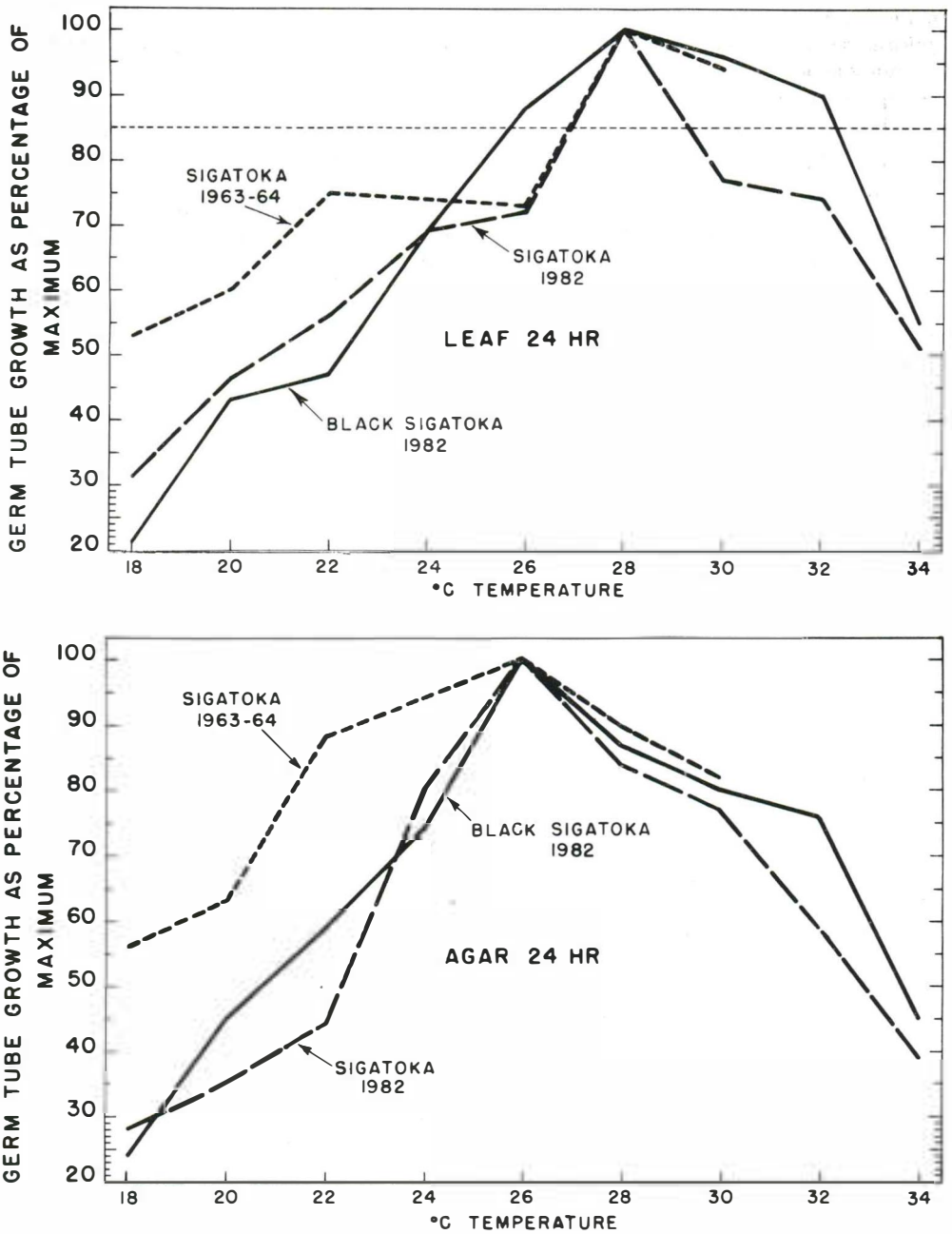

Figure 2 - Ascospore germ tube growth as a percentage of the maximum on the leaf (upper) and on agar (lower) after 24 hours.

(Figure 2), show that the *M. musicola* of 1963-64 was much less affected by lower temperatures. Between 26° and 32°C *M. fijiensis* grew 10-15 % less than at the optimum of 28°C, whereas *M. musicola* grew 25-30 % less (figure 2). At temperatures below 26°C there is very little difference between the two species.

In Table 3, data for 24 and 48 hours were averaged. Again, *M. fijiensis* is shown to be more tolerant of temperatures between 30° and 34°C than *M. musicola*. Between 20° and 24°C there was little difference between fungi.

DISCUSSION

Growth of both species was slowed to 50 % or more of the optimum at temperatures of 20-22°C. At higher temperatures, however, this rate of reduction is not reached until

TABLE 1 - Percent increase of germ tube growth of *Mycosphaerella fijiensis* var. *difformis* over *M. musicola* at different temperatures on banana leaf.

°C	% increase 24 h	48 h
18	11	37
20	16	14
22	4	8
24	26	7
26	53	27
28*	26	27
30	57	38
32	52	43
34	35	77

* - optimum temperature for germ tube growth.

34°C. At all temperatures above 22°C, rate of growth of *M. fijiensis* exceeds that of *M. musicola*. *M. fijiensis* is much more tolerant of temperatures above 28°C and up to 34°C.

The more rapid growth at temperatures around and above 28°C and the greater tolerance of *M. fijiensis* ascospores to higher temperatures undoubtedly contribute to the more rapid development of spotting and the higher virulence of *M. fijiensis*. Ascospores are produced in greater numbers in *M. fijiensis* than *M. musicola* and are the main source of inoculum (STOVER, 1980).

The greater sensitivity of *M. musicola* of 1982 to lower temperatures compared to the 1963-64 fungus may be due to the different origins of the ascospores used. The 1963-64 collection was from Honduras whereas the 1982 collection was from Panama. The minimum temperatures in Honduras are much more lower than in Panama from November to March.

TABLE 2 - Percent reduction from the optimum temperature in germ tube growth of *Mycosphaerella fijiensis* var. *difformis* and *M. musicola* on banana leaf and water agar after 24 and 48 hours.

	hours on leaf				hours on Agar			
	24		48		24		48	
°C	F*	M*	F	M	F	M	F	M
18	72	69	71	73	76	72	74	79
20	57	54	61	57	55	65	57	70
22	53	44	57	49	41	56	43	61
24	31	31	34	22	26	20	27	15
26	12	28	20	20	-	-**	-	-**
28	-	-**	-	-**	13	17	4	4
30	4	23	5	12	20	23	7	8
32	10	26	18	27	24	41	12	31
34	45	49	40	57	45	61	40	54

* - F : *M. fijiensis* M : *musicola* ** - optimum temperature

TABLE 3 - Percent reduction from the optimum temperature in germ tube growth of *Mycosphaerella fijiensis* var. *difformis* and *M. musicola* on banana leaf and water agar.

Temperature °C	Lower banana leaf surface *fijiensis*	*mucisola*	Water agar *fijiensis*	*musicola*
20	59	56	56	68
22	55	47	42	59
24	32	25	26	17
26	17	23	-*	-*
28	-*	-*	8	9
30	4	17	13	15
32	15	27	17	35
34	42	53	42	57

* - optimum temperature for germ tube growth. Measurements at 24 and 48 hours averaged.

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