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Influence of Potassium on Spore Germination in the Nematophagous Fungus, *Hirsutella rhossiliensis*[1]

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The nematophagous fungus *Hirsutella rhossiliensis* Minter and Brady produces adhesive spores that germinate directly through the cuticle of host nematodes (3). When juveniles of the plant-parasitic nematode *Criconemella xenoplax* (Raski) Luc and Raski were inoculated with spores of this fungus and incubated in water, only a small percentage became infected (3). Nematodes that were heat stressed or heat killed, however, were invaded and colonized by the fungus in water. These results indicate that *H. rhossiliensis* is a parasite of nematodes under stress, but later experiments (4) showed that addition of certain solutes including K^+ stimulated parasitism of unstressed individuals. Furthermore, the level of parasitism in soil extracts was positively correlated with conductivity measurements of the soil extract, which is a measure of salt content.

Many reports demonstrate increases in spore germination or more rapid fungal growth in response to cations in the medium. For example, *Fusarium oxysporum* f. sp. *vasinfectum* and *Verticillium albo-atrum* grew more rapidly on agar adjusted to −10 or −20 bars with salts than with no salt amendment or on a medium adjusted to the same osmotic potential with sucrose (5). Macroconidia and chlamydospores *Fusarium roseum* germinated more readily in KCl solutions of −1.4 to −20 bars adjusted with KCl than in nonadjusted solutions (6).

Because K^+ strongly affects colonization of *C. xenoplax* by *H. rhossiliensis* (4), we studied its influences upon spore germination. *Hirsutella rhossiliensis* (ATCC 46487) was cultured on Difco potato-dextrose agar at 25 C. Seaplaque agarose (FMC Corporation, Marine Colloids Division, Rockland, ME) was dissolved as 0.5% w/v in solutions of KCl (0, 0.05, 0.1, 0.15, 0.2, 0.3, 0.4, and 0.6 molal concentrations), autoclaved, and poured into four plastic petri dishes (60 × 15 mm) per KCl concentration. After the medium solidified, spores of *H. rhossiliensis* were transferred by gently touching the aerial portion of a 14-day-old colony to the agar surface. Spores dislodged from the phialides readily adhered to the agar surface. After 6, 12, 18, and 24 hours in darkness at 25 C, at least 30 spores from each of four plates per KCl concentration were examined at 250× magnification for germination.

Two days later, agarose discs cut with a cork borer from the agar medium were removed and placed on a glass microscope slide. One drop of 0.1% cotton blue in lactophenol was added and a coverslip was placed on the surface of each disc. Germ tubes of 10 germinated spores per disc in three replications were measured at 100 or 430× with an ocular micrometer. The experiments were repeated once.

Addition of KCl did not significantly ($P = 0.05$) affect germination of *H. rhossiliensis* after 6 hours, but it did increase germination after 12, 18, and 24 hours (Table 1). The KCl concentration did not affect the percentage of germination.

Potassium chloride in the medium also enhanced growth of the germinating co-

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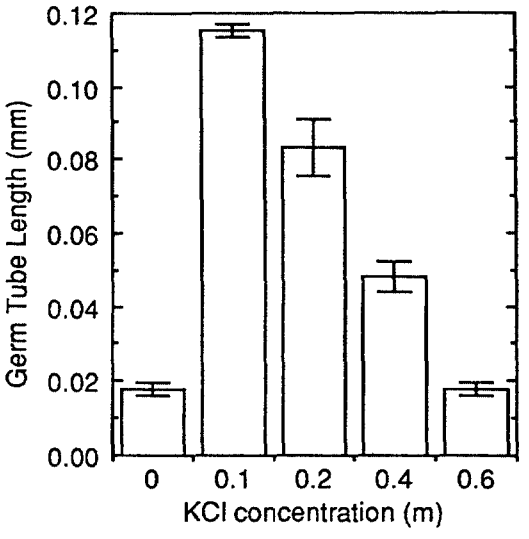

FIG. 1. Length of germ tubes of *Hirsutella rhossiliensis* as affected by KCl concentration in agarose medium. Data shown are average germ tube lengths after 48 hours. Bars show the standard deviations.

TABLE 1. Germination of *Hirsutella rhossiliensis* conidia on agarose medium at 6, 12, 18, and 24 hours in response to amendments with different concentrations of KCl.

KCl concentration (m)	Spore germination (%)			
	6	12	18	24
0	26	46	53	66
0.05	26	64	72	82
0.1	36	62	76	84
0.15	44	68	80	87
0.2	38	59	64	76
0.3	39	58	82	88
0.4	32	63	68	86
LSD ($P = 0.05$)	NS	10.6	10.9	7.3

Conidia were incubated at 25 C. Each value is a combined mean of two experiments of three replications each and at least 30 spores per replication.

nidia (Fig. 1). Germ tube length tended to be less in the higher concentrations (0.4 and 0.6 m) than in the lower concentrations. In a repetition of this test, germ tubes growing on the medium containing 0.6 m KCl were significantly ($P = 0.05$) smaller than those of the control.

Increased parasitism in response to KCl in solution reported previously (4) may be due in part to a more favorable environment for germination when K^+ is in the solution. However, the lack of response to increasing concentrations of K^+ indicates that its addition in the field probably will not enhance parasitism. This conclusion is supported by results of a field microplot experiment with peach seedlings (Zehr and Jaffee, unpubl.) in which KCl was added to soil infested with *C. xenoplax.* Neither the percentage of parasitism nor the population of the nematode was affected by the addition of KCl. Similarly, Eayre et al. (1) found in greenhouse tests that although parasitism increased slightly in response to KCl, the nematode population was not measurably affected. In another study, with *Heterodera schactii* Schmidt (2), KCl did not affect parasitism by *H. rhossiliensis.* Probably sufficient ions already exist in the soil solution so that biological control of nematodes with *H. rhossiliensis* in the field is not likely to increase in response to amendments of salts such as KCl.

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