Pathogenicity of *Macrophomina phaseoli* on Jute in the Presence of *Meloidogyne incognita* and *Hoplolaimus indicus*[1]

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Abstract: Seedlings of *Corchorus capsularis* (cv. C4444) were inoculated with *Meloidogyne incognita, Hoplolaimus indicus,* and a fungus pathogen of jute, *Macrophomina phaseoli,* separately and in all possible combinations. The significant damage of jute plants caused individually by the pathogens was aggravated when the fungus was associated with either of the nematode species. *M. incognita* alone caused greater damage than either *H. indicus* or *Macrophomina phaseoli* alone. Plants inoculated with *M. incognita* and *Macrophomina phaseoli* were more severely damaged than plants inoculated with *H. indicus* and the fungus. Plant growth was minimum and disease symptoms were maximum when all pathogens acted together. In the presence of the fungus, *M. incognita* produced fewer galls. The reproduction of *H. indicus* was not influenced by the other organisms.

During a nematological survey in September 1975, an experimental field on the Burdwan Agricultural Farm at Burdwan, West Bengal, planted with *Corchorus capsularis* L. and *C. olitorius* L. was found to be severely infested with the fungus *Macrophomina phaseoli* (Maubl.) Ashby. Identification of the fungus was made by the Mycology laboratory, Botany Department, Burdwan University. Examination of root and soil samples from this field revealed that the nematodes *Meloidogyne incognita* (Kofoid & White) Chitwood and *Hoplolaimus indicus* Sher were abundant. That finding led to this pot experiment, designed to study the effects of these pathogens, singly and in combination, on jute.

The literature is extensive (5, 6) on interactions of plant-parasitic nematodes and plant-pathogenic fungi, but only a few studies have involved the fungus *Macrophomina phaseoli,* and most of those concerned its interactions with *Meloidogyne* spp. on *Hibiscus cannabinus* (8), *Ligustrum japonicum* (2), and *Glycine max* (1).

MATERIALS AND METHODS

Three surface-sterilized seeds of jute (*Corchorus capsularis* cv. C4444) were sown in each clay pot of 20-cm diam. containing 3.5 kg autoclaved sandy clay loam soil. Water was applied to each pot as needed. Three weeks after emergence, the seedlings were thinned to one per pot and given one of the following eight treatments: 1) uninoculated control; 2) *Macrophomina phaseoli* alone; 3) *H. indicus* alone; 4) *M. incognita* alone; 5) *H. indicus* and *M. incognita;* 6) *H. indicus* and *Macrophomina phaseoli;* 7) *M. incognita* and *Macrophomina phaseoli;* and 8) *H. indicus, M. incognita,* and *Macrophomina phaseoli.* Each treatment was replicated five times, and treatments were arranged in a randomized complete block design. At the end of the experiment, statistical analysis of the data was done by analysis of variance and calculating L.S.D. values to compare the set of treatments.

Nematode inoculum levels were 2,000 juveniles of *M. incognita* and/or 2,000 adults and juveniles of *H. indicus* per pot. *H. indicus,* originally obtained from jute fields at the Burdwan Agricultural Farm, was isolated and monocultured in the screen-house on jute (cv. C4444). *M. incognita* was obtained from a monoculture on tomato (*Lycopersicon esculentum* L. cv. Golden Queen). Before inoculation, the nematodes were surface-disinfested with 0.001% 8-quinolinol sulfate for 30 minutes.

The pure culture of *Macrophomina phaseoli,* obtained from the Mycology laboratory, Department of Botany, Burdwan University, was grown at 24-26 C in 250-ml conical flasks containing 50 ml of Richard's solution. After 5 days, the fungal mat in each flask was separated, washed, slightly macerated in a mortar, and mixed with 100 ml distilled water. The suspension made from each fungal mat was used to inoculate a single pot.

For inoculation, the feeder roots of the seedlings were exposed by removing the

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surface soil, and inoculations were made by pouring suspensions uniformly over the exposed roots. The control plants received an equal amount of water. The surface soil was then replaced and watered lightly.

Seventy days after inoculation, the plants were uprooted carefully, and observations were made on the morphological characters of the plants and on the nematode populations. To estimate the population of *H. indicus,* a 100-g portion of soil taken from each pot was processed by sieving and modified Baermann funnel techniques. The nematodes extracted were counted by a dilution count method. To estimate the population of *M. incognita,* 100 g of soil was taken from each pot, mixed with 500 g of sterilized soil and placed in a 8-cm clay pot. In each pot, one tomato (cv. Golden Queen) seedling was planted. A month later, the tomato plants were harvested and primary galls were counted. The fungal population was not estimated, but its presence and infectivity were detected from the characteristic disease symptoms.

RESULTS

In comparison with the uninoculated control, plant growth was reduced ($P = 0.05$) in all treatments receiving the pathogens alone or in combination. All treatments differed from each other in shoot height, shoot fresh weight, and shoot dry weight at the 5% level. Fresh and dry weights of roots did not differ significantly between treatments with *M. incognita* alone and *Macrophomina phaseoli* alone, or among the treatments with the two nematodes alone or combined (Table 1).

When the pathogens were inoculated singly, *M. incognita* was significantly more damaging than *H. indicus* or *Macrophomina phaseoli.* The growth suppression by any two of these pathogens was significantly greater than that caused by either pathogen alone. Plants inoculated with *Macrophomina phaseoli* and *M. incognita* were more severely damaged than plants inoculated with *Macrophomina phaseoli* and *H. indicus.* The combination of both nematode species with *Macrophomina*

TABLE 1. The effect of *Hoplolaimus indicus, Meloidogyne incognita* and *Macrophomina phaseoli* alone and combined on jute plants and nematode populations.[a]

Treatment	Shoot height (cm)	Fresh shoot weight (g)	Dry shoot weight (g)	Fresh root weight (g)	Dry root weight (g)	Nematode population	
						H. indicus per pot	No. of galls per root system
Control	127.4 s	129.6 s	17.9 s	42.6 u	5.6 u		
Macrophomina	110.3 t	101.3 t	13.9 t	34.7 v	4.5 v		
Hoplolaimus	98.2 u	92.5 u	12.6 u	29.8 w	3.8 w	34,500	
Meloidogyne	85.6 v	81.4 v	11.0 v	31.5 vw	4.0 vw		680 y
Hoplolaimus + *Meloidogyne*	77.8 w	72.7 w	9.8 w	28.6 w	3.6 w	32,400	640 yz
Hoplolaimus + *Macrophomina*	68.4 x	62.4 x	8.4 x	23.4 x	3.0 x	33,600	
Meloidogyne + *Macrophomina*	54.8 y	47.6 y	6.3 y	18.2 y	2.3 y		600 z
Hoplolaimus + *Meloidogyne* + *Macrophomina*	42.6 z	31.7 z	4.2 z	12.8 z	1.6 z	31,500	580 z
LSD at 5%	5.1	6.1	0.8	4.3	0.5	N.S.	64

[a]Mean of five replicates. Means not followed by the same letter are significantly different at the 5% level.

TABLE 2. Disease index[a] recorded three times after inoculation with *Macrophomina phaseoli,* singly and in combination with *Hoplolaimus indicus* and *Meloidogyne incognita.*

Treatment	Days after inoculation[b]		
	30	50	70
Macrophomina phaseoli	1.60 x	1.80 y	2.40 x
Macrophomina phaseoli + *H. indicus*	1.60 x	2.00 y	2.80 xy
Macrophomina phaseoli + *M. incognita*	1.80 xy	2.80 z	3.40 yz
Macrophomina phaseoli + *H. indicus* + *M. incognita*	2.20 z	2.80 z	3.60 z
Uninoculated control	1.00 w	1.00 x	1.00 w
LSD at 5%	0.58	0.77	0.74

[a]On a scale of 1–4, from no symptoms to plants almost dead.
[b]Mean of five replicates. Means not followed by the same letter are significantly different at the 5% level.

phaseoli caused the most severe suppression of shoot height and weight, and root weight (Table 1).

Significantly fewer galls were produced by *M. incognita* in the presence of *Macrophomina phaseoli,* and *Macrophomina phaseoli* plus *H. indicus.* The reproduction of *H. indicus* was not influenced significantly by any treatment (Table 1).

Disease symptoms induced by *Macrophomina phaseoli* were root-rot, black patches on leaves and stem, and signs of defoliation. These symptoms were more severe and appeared earlier in the presence of *M. incognita* and reached a maximum when both nematode species were present (Table 2).

DISCUSSION

Significant synergistic effects of *Macrophomina phaseoli* in the presence of *Meloidogyne* spp. have also been observed on *Hibiscus cannabinus* (8), *Ligustrum japonicum* (2), and *Glycine max* (1). The nematodes may predispose their hosts to greater fungus damage by wounding and providing infection sites, or by altering the biochemical nature of the roots so as to provide a better fungus substrate. This kind of interaction is probably occurring at the Burdwan Agricultural Farm and in other locations where these pathogens occur together.

The lack of differences in final nematode populations between the treatments with *H. indicus* and *M. incognita* alone and in combination suggest that those two nematode species do not compete for food or space. The influence of *Macrophomina phaseoli* on reproduction of *M. incognita* but not on *H. indicus* is consistent with some earlier observations. *Pythium aphanidermatum* suppressed egg-production of *M. incognita* on chrysanthemum (3) but reproduction of *H. indicus* was not influenced by *Fusarium moniliformae* on maize (4). It is possible that fungus invasion of giant cells (7), which are the feeding sites for *M. incognita,* may suppress reproduction of this nematode. The fungus would not interfere with the reproduction of the ectoparasitic *H. indicus* in this manner because it does not incite giant cells.

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